OFFICIAL

REGIONAL RESEARCH PROJECT NE-9 (Rev.)

CONSERVATION AND UTILIZATION OF PLANT GENETIC RESOURCES

A cooperative effort among:

THE STATE AGRICULTURAL EXPERIMENT STATIONS

OF THE NORTHEAST REGION

and

THE U.S. DEPARTMENT OF AGRICULTURE,

AGRICULTURAL RESEARCH SERVICE

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PROJECT NUMBER: NE-9 (Rev.)

TITLE: Conservation and Utilization of Plant Genetic Resources

DURATION: 1 October 1998 - 30 September 2003

STATEMENT OF PROBLEM:

America's abundant and inexpensive supply of food and fiber is based on a productive and progressive agricultural system. The foundation for this productivity has been based on scientific knowledge and exploitation of useful genetic diversity for developing new, higher quality cultivars that can resist pests, diseases, and environmental stresses. The Regional Research Project NE-9 serves as a unique component of a national effort to enhance crop improvement by providing accessibility to genetic resources of selected horticultural and agronomic crops and by conducting problem-oriented research to establish higher quality collections for ultimate conservation and utilization.

JUSTIFICATION:

Biological diversity in plants benefits human welfare directly, as various species are used to satisfy basic human needs, and indirectly, as diversity supports many processes essential to human survival and progress (Office of Technology Assessment, 1987). Without an assured source of food we would not be free to engage in those activities which are associated with the quality of life to which we have become accustomed (Wilkes, 1983). However, if one surveys plant genetic resources native to the United States, one quickly realizes the paucity of domestic plant wealth. Among those native species of economic importance one may include only grape, sunflower, cranberry, blueberry, strawberry, pecan, and a few others. The tremendous progress made by the agricultural sector of the United States, therefore, has been founded almost exclusively on plant genetic resources imported from areas outside the U.S.

Another key to rapid progress towards increasing the productivity of the agricultural sector of the United States has been the evolution of the scientific disciplines associated with the conservation and utilization of plant genetic resources. Plant breeding and improvement began as fields of study around the turn of the century with the rediscovery of the principles of genetics established by Mendel and the development of the chromosome theory of heredity (National Plant Genetic Resources Board, 1984). Through the application, refinement, and advancement of the principles of genetics, plant scientists have utilized primarily imported germplasm and have created highly responsive uniform cultivars, selected for yield and quality, and adapted to specific environments or carry resistance to pests and diseases.

Agricultural leaders in the Northeast region and throughout the United States have recognized for many years that valuable plant genetic resources were being lost by (1) the almost universal

replacement of primitive land races with modern cultivars, (2) destruction of the habitat of wild relatives of crop plants, and (3) the lack of an effective organization and means for conservation and utilization of those plant genetic resources after they are introduced into the United States. In response, the 80th Congress of the United States passed the Research and Marketing Act of 1946 (Public Law 733). Under this act, regional research funds were established to initiate a network of four regional projects which provided the principal foundation for the entity that was later to become the National Plant Germplasm System (NPGS). As presently established, the NPGS is a network of federal, state, and private organizations that work cooperatively to acquire, maintain, document, characterize, evaluate, distribute, and improve germplasm. These organizations conduct research on the preservation of genetic diversity and on insuring propagule viability through improved procedures, and they monitor genetic vulnerability (Council for Agricultural Science and Technology, 1985).

Within this national framework, regional components exist. Four plant introduction stations, Ames, IA; Geneva, NY; Griffin, GA; and Pullman, WA, serve as a foundation for the effort. Each unit is responsible for the maintenance of genetic resources of specific crops. The Northeast Regional Plant Introduction Station (NERPIS) was established in October 1953 with support from the Regional Research Project NE-9. The scope and objectives of the NERPIS support that of the NPGS, i.e., conservation and utilization of plant genetic resources for the benefit of the present and future producers and consumers of the United States. Over the 45-year history of the NE-9 project, the priority crops assigned by the NPGS to Geneva have varied. Present seed collections include 11,682 accessions representing approximately 211 species in 54 genera. Major holdings include onion, vegetable brassicas, celery, winter squash, ornamentals (*Petunia*, *Rhododendron*, and *Aster spp.*, among others), and medicinals (*Datura spp.* and others).

To complement the four regional plant introduction stations, a number of additional repositories were established in the 1980's to support conservation of clonally propagated fruit and nut crops. As part of the national effort, the National Germplasm Repository for Apple and Grape (NGR) began its operations at Geneva in 1983 and was initially funded by CSREES/ARS combinations. From 1986-1993, the NGR was fully funded by ARS. In 1995 the tart cherry germplasm was also assigned to Geneva. The apple, grape, and tart cherry collections contain 54 species of apple (*Malus*), 23 species of grape (*Vitis*), and 8 species of cherry (*Prunus*) for a total of 6609 accessions. The Plant Genetic Resources Unit (PGRU) comprises the NGR and NERPIS.

Because of these assigned responsibilities, PGRU is unique in the NPGS in that large numbers of both seed and clonally propagated crops are maintained at a single site. Both the seed and clonal crops for which Geneva has responsibility are important components of agriculture in the northeast. Many northeastern State Agricultural Experiment Stations (SAESs) have research and extension responsibilities for these valuable commodities. In addition, PGRU shares with researchers in the Northeast many of the same agronomic and horticultural problems, questions, and needs, both practical and scientific.

As a part of the National Plant Germplasm System, PGRU benefits from research, acquisition, conservation, and research carried out at other units in the NPGS. Although crops are assigned to specific NPGS locations, information and germplasm are freely exchanged between repositories. Germplasm maintenance and regeneration techniques developed at other units in the NPGS have been incorporated into the ongoing activities of the PGRU, and germplasm explorations mounted by other repositories have provided germplasm for PGRU collections. At the same time, results of germplasm research done at Geneva have been incorporated into the scientific programs at other genetic resources collections. Thus, as a component of a national system, PGRU serves as a convenient conduit to and from the Northeast for all types of germplasm and genetic resources information.

Research at PGRU focuses on activities that are complementary to its conservation responsibilities. The scope of this research includes problem-oriented basic investigations which yield information and/or improved methods for increasing the effectiveness by which the PGRU performs its conservation and utilization mission. Primary disciplines associated with the research include plant genetics and plant pathology. This groundwork also may serve as a springboard for future germplasm enhancement within state experiment stations of the Northeast and the United States as a whole. In addition, the NGR is focusing research in the direction of alternative methods of germplasm conservation because current maintenance protocols are costly, labor intensive, and subject to problems encountered in the field. The principal alternative storage approach is cryopreservation of dormant buds, although other approaches, such as slow growth in vitro, tissue culture, or even the seed preservation of genes from clonally propagated crops, should not be overlooked. In fact, these other approaches may prove useful for the preservation of accessions not amenable to cryopreservation. Additionally, research in pathology (virus detection and eradication) is performed in cooperation with Cornell University and USDA pathologists.

In its broadest context, the Regional Research Project NE-9 is an effort to address the applied problems in the preservation and utilization of plant biotic diversity. Over the years, NE-9 has contributed greatly, either directly or indirectly, to the producer and consumer as evidenced by increased regional and domestic agricultural products and productivity. These contributions have been tangible, as in the form of germplasm, and intangible, as in the form of increased knowledge. Both service and research activities have been conducted concurrently. As tools of molecular biology have become more well developed, they also have become more integrated into effective plant conservation and utilization efforts. Contributions of plant genetic resource conservation and utilization efforts will affect future studies of plant biology as well as those of commodity improvement. The overall effort is an endeavor involving multiple disciplines, locations, and interests. Because of these complexities (biological, operational, and logistical in nature), the cooperating organizations are best served by a regional approach.

If we are to move towards greater utilization of plant genetic resources, research targeted at all six objectives (p. 19) of this project proposal must be integrated. Plant genetic resources acquisition, conservation, and use have had a major, positive effect on the improvement of field

and horticultural crops. Throughout history, plant scientists have shown flexibility in utilizing new resources and tools that contribute to progress in crop improvement. As biotechnology programs in the northeastern U.S. have grown, plant genetic resource conservation has become more critical. Molecular biologists must have the reservoir of genes available if they are to transfer useful genes to plants that breeders can then exploit. Continuing progress in improving the performance of crop plants while simultaneously improving our understanding of plant biology will be accomplished by the integration of new technologies with the broadest possible array of genetic resources.

RELATED CURRENT AND PREVIOUS WORK:

The Regional Research Project NE-9 partially supports and complements service and research activities encompassed within the scope of the responsibilities at Geneva. Similar regional research projects, i.e., North Central (NC-7), Southern (S-9), and Western (W-6), associated with other components of the NPGS are well-known. Despite similarity among missions at locations, unique regional interests as well as crop responsibilities determine the specific efforts of a location. The major crops supported by the Regional Research Project NE-9 are the genera *Allium* (onion), vegetable *Brassica* (cabbage, broccoli, cauliflower, kale, etc.), *Cucurbita* (winter squash), *Lycopersicon* (tomato), *Malus* (apple), *Prunus* (tart cherry), and cold-hardy *Vitis* (grape). Responsibility for United States national germplasm collections of these crops lies solely at Geneva. The data in Tables 1-4 provide a measure of the economic importance of these crops on a worldwide and domestic basis. (Tables begin on p. 11.)

Most crops of commercial significance in the northeastern U.S. are of exotic origin. NE-9 support has enabled the United States Department of Agriculture, Agricultural Research Service, other federal agencies, the Agricultural Experiment Stations of the 12 northeastern states and the District of Columbia, and other cooperators, to engage in a coordinated effort to conserve and utilize plant genetic resources. The continued demand for plant genetic resources underscores the importance of maintaining collections which preserve the vast reservoirs of genes needed to fulfill the plant and agricultural research activities so critical to the economic well-being of the northeastern U.S. and other regions of the United States. With the actual or potential loss of some of our most effective herbicides, fungicides, and insecticides, the need for novel sources of resistance or tolerance genes will increase. Furthermore, changing landscapes, urbanization, irrigation, and other habitat changes increase the need for plants having tolerances to more stressful environments.

Some of the notable achievements by PGRU representing plant genetic resources conservation and utilization accomplished during 1993-1997 through past NE-9 support are highlighted below.

Acquisition:

- 2295 new accessions added to the germplasm collections (Table 5)
- conducted four collection trips to Central Asia and China to collect wild apple and other germplasm, during which over 1000 new apple seed collections were made
- established a research evaluation quarantine block for evaluation of grape germplasm at Geneva; the high cost (ca. $3,000 per vine) of sanitation of the grapevines can now be postponed until the potential utility of the germplasm is determined
- established core subsets for apple and grape; these are intended to represent the range of diversity in Geneva's collections; the apple core collection has been planted in sites at Geneva, Illinois, North Carolina, and Minnesota for evaluation
- formed a tart cherry collection from 65 tetraploid cherry accessions

In a survey by the General Accounting Office (1997; hereinafter referred to as "the GAO Survey"), all 40 Crop Germplasm Committees (CGCs) stated that acquisition of additional germplasm is a moderately to extremely important activity and about one-half of the CGCs reported that wild and weedy relatives are under-represented in germplasm collections. We agree that judicious additions to all of PGRU's collections are needed. Because of changes in the international political climate as well as ramifications of the Convention on Biological Diversity, continued plant exploration and exchange is needed, particularly in the Caucasus, Central Asia, and China, with the focus being apple, tart cherry, and grape. A plant exchange trip to Russia is planned for summer of 1998 to collect elite cherry germplasm and to survey the large ex situ collection in Maikop. A proposal to collect wild apple germplasm in Turkey in 1999 has been prepared.

While Central Asia is the center of origin of the domesticated apple, the largest untapped source of wild grape species is China, with over 30 species. (There is only one native species, *Vitis vinifera*, from India to Spain). Plans already in place will facilitate addition of such germplasm to PGRU's collections, including collection trips to or exchanges with China. In addition, the Grape Crop Germplasm Committee has strongly recommended that over the next few years increased effort be expended to collect germplasm of North American species of grapes, which have been the source of most of the disease resistance and tolerance to abiotic stress factors that has been found in the crop. In 1997 a collection trip supported by PGRU and the Plant Exchange Office resulted in the designation of 6 locations for *in situ* preservation of the grape species, *Vitis rupestris*. A similar collection trip planned for 1998 will result in the collection of grape seed from these locations and the evaluation of possible preservation sites for the species *Vitis monticola*, endemic to Texas, and *Vitis shuttleworthii*, endemic to Florida. PGRU in cooperation with APHIS (Animal and Plant Health Inspection Service) also needs to take an active role in

developing improved quarantine procedures for both import and export of germplasm. This was an area that the GAO Survey (1997) also highlighted as needing additional attention.

Maintenance, regeneration, and characterization

- developed a novel method of sour cherry propagation that cuts propagation time in half
- passport data for apple, grape, and tomato is effectively complete--all major known sources of information have been consulted and the data entered into our databases
- plans are in place to barcode all plants in the orchards and vineyards, reducing typographical errors and making data collection more reliable and efficient
- repackaging of all seed accessions in moisture-proof, heat-sealed foil pouches is complete
- seed storage facilities renovated to maintain optimal moisture and humidity levels
- evaluation of 5700 apple seedlings from Kazakstan and China by Herb Aldwinckle (Cornell University) found resistant reactions to apple scab, fire blight, and cedar-apple rust
- Kazak seedlings are being evaluated in Canada, New Zealand, Japan, Germany, Norway, South Africa, British Columbia, Manitoba, Nova Scotia, AL, WA, AR, OH, IL, MN, WI, NY, CO, NJ, and NE
- cooperating on a capacity-building grant with Dr. Cyril Broderick (Delaware State University) and Dr. Donna Gibson (USDA, ARS, Ithaca) to eradicate latent viruses from grapes
- cryopreservation of apple dormant buds has been successful with no decline in ability to repropagate such buds over 8 years; over 1500 apple accessions are now in cryopreservation at the USDA-ARS National Seed Storage Lab in Fort Collins, CO
- a successful modification of the apple cryopreservation protocol has been developed for tart cherry, and research on recovery of cryopreserved grape buds is in progress
- virus-indexed all tart cherry accessions
- 50 descriptors installed on the Genetic Resources Information Network (GRIN) for tart cherry
- established a specific cooperative agreement to evaluate rootstock characteristics of tart

cherry

- established a specific cooperative agreement to evaluate apple germplasm for disease resistance

- optimized grape seed germination protocols in cooperation with Alan Taylor (Cornell University), which will facilitate importing grape germplasm in seed form; there are no quarantine restrictions on grape seeds

- in cooperation with the Plant Exchange Office of the National Germplasm Resources Laboratory, designated six wild populations of *Vitis rupestris* for *in situ* preservation

- established an overwintering room for honeybees, saving on purchase of hives each year

- seed cleaning and processing facilities have been upgraded

- have begun utilization of the USDA-ARS Parlier, CA grow-out site for selected accessions, when needed

It is no surprise that accessions having little or no characterization, evaluation, or passport data tend not to be ordered for use by cooperators. Consequently, despite excellent progress in these areas, additional work is needed, particularly in the characterization of Geneva's seed crops. Furthermore, accessions lacking adequate numbers of seeds cannot be securely backed up at the NSSL. Consequently, for seed accessions, both secure backup and characterization are dependent upon regeneration activities. Plans for regeneration and NSSL backup of the other major seed collections are in place, as are plans for further evaluation studies of clonal crops. Regeneration of our cucurbit collection could be made more efficient by the acquisition of larger pollination cages, which would obviate the need for labor-intensive hand pollinations. More attention should probably be paid to Geneva's minor seed crops, such as buckwheat (an important crop in Japan and a crop for which we have a breeder / researcher at Geneva, Thomas Bjorkman), artichoke, and radish. These three crops are particularly in need of regeneration. In addition, core subsets need to be established for the major seed crops, tomato, winter squash, *Brassica* (cabbage, etc.), and *Allium* (onion). The entire apple collection of approximately 2600 accessions must be repropagated on fire blight tolerant rootstock, EMLA7.

Documentation

- new file server, new network wiring schema, new network operating system

- computer network has been modified from stand alone local area network and is now seamlessly integrated into Cornell's wide-area network, enabled Internet access to every desktop

- plant genome databases RoseDB (including apple and tart cherry), VitisDB (grape), and CabbagePatch (vegetable Brassicas) have been constructed

- local databases are up-to-date and ready for uploading to GRIN

The computer infrastructure of the unit is sound. PGRU needs to be alert to continuing developments in this area, particularly with respect to the Plant Genome databases. The rapid pace of advances in computing and networking require that PGRU remain attuned to progress in desktop computing, so technologies that increase effectiveness and efficiency of germplasm preservation can quickly be adopted. The VitisDB is not yet publicly available because of lack of staff. Hiring of additional staff at the Plant Genome database unit will be necessary. Purchase of one or more personal digital assistants (data loggers) could make data collection in the field much more efficient, particularly in concert with use of bar codes for all plants in our orchards and vineyards. Moreover, with continued work in molecular markers at PGRU, hardware and software for data visualization and analysis will be needed.

Distribution

- *Malus* and *Vitis* catalogs for ordering accessions are accessible via the Internet

- order processing has been automated, and the information is immediately placed in GRIN (the national germplasm system database)

- During 1993-1997 17,180 seed accessions were distributed by PGRU (Table 6)

- During 1993-1997 16,799 clonal accessions were distributed by PGRU (Table 7)

- There were 340 orders for 5112 accessions sent to recipients in the Northeast region (Table 8)

- DNA of apples and grapes is being distributed as part of the normal order process; PGRU is the first germplasm unit in the country to do this

Catalogs for seed crops need to be made available over the Internet. More rapid movement of germplasm through the quarantine system needs to be encouraged by PGRU, for both seed and clonal crops. Work through the Plant Germplasm Operations Committee (PGOC) and the GRIN advisory committee needs to be carried out to achieve this, in cooperation with APHIS. PGRU, in collaboration with the Plant Exchange Office, must be prepared with a reasoned response to actual or potential restrictions to germplasm importation and exportation that may result from the Convention on Biological Diversity.

Research

The personnel associated with the Regional Research Project NE-9 cooperate and participate in activities associated with 11 relevant Crop Germplasm Committees (CGCs) of the NPGS. These activities include planning and participating in plant germplasm exploration/exchange proposals and conducting germplasm evaluation studies. In addition, research carried out by current and former members of the Regional Technical Advisory Committee for NE-9 has interfaced productively with the goals of the NE-9 project at PGRU (see Appendix I for a list of relevant publications).

Tables 5-8 highlight plant genetic resources conservation and utilization activities at PGRU over the five-year period from 1993-1997. As noted previously, these service activities are a component of a national conservation effort but in no way duplicate other ongoing programs, because division of effort among repositories is organized primarily along commodity lines.

In complement to these current conservation efforts, problem-oriented research has been conducted that facilitates improvements in germplasm acquisition, maintenance, and characterization. While the service activities described above could, in principle, be carried out independently of any research activities, research focusing on increasing the effectiveness and efficiency of the management of PGRU's germplasm is an essential component in achieving the unit's service goals. The primary goal of the research has been to describe intra- and interspecific genomic variation and to define genetic relationships among individuals, populations, and crops. Specifically, gene bank curators have used the results to establish and maintain useful and representative crop collections and core subsets based on the integrated information representing DNA sequences, genes, genotypes, and phenotypes. Such information has also been used to determine collection strategies for wild foreign germplasm in the field, and in designating domestic populations of wild species for *in situ* preservation.

Through the application of the latest theories and techniques of both molecular biology and population genetics, curators in gene banks now are able to type or "fingerprint" plants and accessions held in their collections. The selection of an appropriate fingerprinting strategy has depended on adaptability, cost-effectiveness, and desired level of resolution necessary for solving problems associated with either *ex situ* or *in situ* genetic resource conservation and use. Currently simple sequence repeat DNAs (SSRs) (Litt and Luty, 1989; Edwards et al. 1991; Lamboy and Alpha, 1998), amplified fragment length polymorphisms (AFLPs) (Vos et al., 1995), and DNA sequence of the nuclear ribosomal DNA internal transcribed spacer region (nrDNA ITS) (Baldwin et al., 1995) are being used and investigated for genotype and species identification. Previously random amplified polymorphic DNA fragments (RAPDs) (Welsh and McClelland 1990; Williams et al. 1990; Ren et al. 1995) and iso/allozymes (Lamboy et al. 1994; Lamboy et al. 1996) have been used. These latter methods are still extremely useful in specific situations, especially where the other methods have not been fully developed for the crop under investigation. Most of the research that has been done by PGRU in this area during 1993-1997 has been published (see list of citations in Appendix II). A detailed review of research activities

in support of our conservation efforts can be found in the Critical Review. It must be emphasized that the research activities of PGRU are restricted to those which directly or indirectly aid in the conservation of germplasm at Geneva and other units of the germplasm system. Theoretical or basic research projects having no immediate practical germplasm utility are not conducted.

Genetic diversity research projects that have been carried out at PGRU between 1993 and 1997 include the following:

- DNA fingerprinting using simple sequence repeat DNA fragments (SSRs) has been conducted on the core subsets in apple and grape, resulting in discovery of several duplicate genotypes among accessions in each subset.

- Developed a DNA extraction protocol useful across a wide range of plant genera

- Developed and applied SSR markers in *Malus* core collection to determine identity and relationships

- Upgraded our genetic analysis to an automated multiplexed fluorescent based technology

- Applied SSR markers in the *Vitis* core collection to determine genetic identity

- Collaborated with Diane Pavek and Ned Garvey (Plant Exchange Office, National Germplasm Resources Laboratory) to apply *Vitis* SSR markers to an *in situ Vitis rupestris* population study

- Established a DNA "bank" for all accessions in the *Malus* and *Vitis* core collections and were the first unit in the NPGS to make DNA available to our user community

- Submitted our *Malus* SSR data and gel images from our core study to the Plant Genome Rosaceae Database for public access

- A study partitioning allozyme diversity in *Malus sieversii* among sib-families, populations, and regions showed that the collection strategy that tends to optimize diversity in the material collected involves extensively collecting one or two populations within a geographic region, and doing this in as many regions as one can afford to visit.

- Characterized RAPD diversity among Chinese vegetable Brassicas and showed Chinese cabbage is more likely to have arisen as a hybrid between turnip and pakchoi than it is to have arisen by selection within either one of these subspecies.

DNA fingerprinting of apple, grape, and tart cherry accessions must continue using SSRs, until the collections are completely characterized. The resulting data has been and will continue to be

used to modify and update the core subsets for apple and grape as well as to locate duplicate genotypes in our collections. Work has begun on using the DNA sequence of the internal transcribed spacer (ITS) region of the nuclear ribosomal DNA as the species-specific marker for grape, which, if successful, will be expanded to apple. Both crops present tremendous difficulties in species identification, both in native American species and in the Asian species. If the ITS region does not prove useful for this purpose, inter simple sequence repeats (ISSRs) (Zietkiewicz et al., 1994) have been shown by Norm Weeden (Cornell University) to be useful in other genera, e.g., *Vigna*, and could be investigated. In collaboration with E & J Gallo Winery, we have carried out an AFLP study of a subset of the grape core collection. This has convinced us that AFLPs are a marker type that can be used in the future for determining relationships between species in our collections.

Table 1. Importance of PGRU's fruits to the United States. Geneva's crops in **bold**.

Fruit	Value paid to grower in millions of dollars, 1996
Citrus (all)	2590.2
Grapes	**2242.1**
Apples	**1840.2**
Peaches/Nectarines	493.3
Pears	297.5
Sweet Cherries	223.4
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Tart Cherries	**< 19.0**

Data from National Agricultural Statistics Service

Table 2. Importance of PGRU's vegetable crops to the United States. Geneva's crops in **bold**.

Vegetable	Production in millions of pounds, 1996.
Cucurbits	**9296**
Sweet Corn	8865
Lettuce	8502
Alliums (all)	**6699**
Tomatoes	**5367**
Brassicas (vegetable)	**4858**
Carrots	3837
Snap Beans	1891

Data from National Agricultural Statistics Service

Table 3. Importance of PGRU's fruits worldwide. Geneva's crops in **bold**.

Fruit	Production in million metric tons, 1997.
Citrus (all)	89.4
Bananas and Plantains	87.5
Grapes	**57.2**
Apples	**54.7**
Mangoes	22.0
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Tart Cherries	**0.913**

Data from the United Nations Food and Agriculture Organization

Table 4. Importance of PGRU's vegetable crops worldwide. Geneva's crops in **bold**.

Vegetable	Production in million metric tons, 1997.
Cucurbits	**101.9**
Tomatoes	**88.4**
Brassicas	**63.8**
Alliums (all)	**54.7**
Carrots	17.4
Eggplant	17.0
Peppers (all)	15.9
Lettuce	15.2

Data from the United Nations Food and Agriculture Organization

Table 5. Summary of conservation activities for the collections at PGRU for the period 1993-97.

Year	New Accessions Received	Total Accessions Maintained	Accessions for Which Seed Was Increased
1993	442	13,992	421
1994	299	14,434	824
1995	720	14,733	990
1996	537	15,453	1075
1997	299	16,181	1030
Annual Average	**459**	**--**	**868**

Table 6. Distribution of accessions from the seed collections at PGRU for 1993-1997 classified by cooperator type.

Cooperator Type	1993	1994	1995	1996	1997
Foreign, Commercial Companies	166	128	199	13	30
Foreign Individuals	0	1	0	77	2
CGIAR International Agriculture Research Centers	25	0	0	0	0
Foreign Public Organizations (non-gov.)	104	40	23	349	0
Foreign Public Organizations (gov)	944	255	350	466	417
USA Agency for International Development	0	25	0	0	0
USDA-ARS	2329	1717	303	0	3299
USA Commercial Companies	364	569	229	206	104
USA Individuals	30	117	10	2	24
USA Public Organizations	63	38	10	7	75
Other USA Federal Agencies	0	0	0	5	0
USA State Institutions	1842	966	365	543	349
Total	**5867**	**3856**	**1489**	**1668**	**4300**

Table 7. Distribution of accessions by category for clonal collections at PGRU for 1993-1997, classified by cooperator type.

Cooperator Type	1993	1994	1995	1996	1997
Foreign, Commercial Companies	0	0	0	1	0
Foreign Individuals	0	0	0	0	0
CGIAR International Agriculture Research Centers	0	0	0	0	0
Foreign Public Organizations (non-gov.)	95	216	143	32	15
Foreign Public Organizations (gov)	93	131	204	130	132
USA Agency for International Development	0	0	0	0	0
USDA-ARS	320	387	583	764	573
USA Commercial Companies	31	108	122	213	436
USA Individuals	383	452	103	200	696
USA Public Organizations	1408	94	137	100	67
Other USA Federal Agencies	0	0	0	14	16
USA State Institutions	1116	1998	2260	1128	1898
Total	**3446**	**3386**	**3552**	**2582**	**3833**

Table 8. Number of germplasm orders filled and number of accessions sent by PGRU to states in the Northeast, 1993-1997.

State	Orders Filled	Accessions Sent
Connecticut	17	137
Delaware	5	127
Massachusetts	10	84
Maryland	37	341
Maine	17	118
New Hampshire	2	36
New Jersey	8	78
New York	212	3505
Pennsylvania	24	210
Rhode Island	1	5
Vermont	3	11
West Virginia	4	460
Total	**340**	**5112**

OBJECTIVES:

1. To acquire, maintain / regenerate, characterize, document, and distribute plant genetic resources for use in the Northeast, the United States, and the World.

2. To ensure the identity of each accession as to species (or hybrid) and cultivar.

3. To determine the basis for and the extent of genetic variations, the geographic distribution of cultivated species, and their taxonomic relationships with closely related species.

4 To characterize and evaluate plant genetic resources for specific desirable traits.

5. To determine the genetic mechanisms controlling the inheritance of important traits.

6. To combine genes from diverse sources into germplasm more useful to plant breeders and to breed, release, maintain, and evaluate improved germplasm and cultivars.

Note: Objectives 4-6 require the cooperation of collaborators. Forging the links between PGRU and reliable and productive cooperators should be viewed as part of these objectives.