NCRPIS ANNUAL REPORT - 2008

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NORTH CENTRAL REGIONAL PLANT INTRODUCTION STATION
NC-7 ANNUAL REPORT, JANUARY 1 - DECEMBER 31, 2008

I. PROJECT TITLE:

NC-7 "Plant Germplasm and Information Management and Utilization"

II. COOPERATING AGENCIES AND PRINCIPAL LEADERS (current):

A. Administrative Advisor

*W. Wintersteen, Iowa

B. Regional Coordinator

*C. Gardner, ARS, Iowa

C. State Experiment Stations Representatives

Voting members

1. Illinois	T. Hymowitz	7. Missouri	S. Flint-Garcia
2. Indiana	J. Janick	8. Nebraska	G. Hergert
3. Iowa	R. Hall	9. N. Dakota	B. Johnson
4. Kansas	M. Stamm	10. Ohio	D. Francis
5. Michigan	A. Iezzoni	11. S. Dakota	K. Glover
6. Minnesota	J. Orf	12. Wisconsin	W. Tracy

Non-voting members

13. California-Davis	R. Karban	18. Michigan	J. Hancock
14. Connecticut	M. Brand	19. Missouri	P. Bueselinck
15. Delaware	J. Hawk	20. New Jersey	T. Molnar
16. Illinois	G. Kling	21. Texas	J. Da Silva
17. Iowa	K. Lamkey		

D. U. S. Department of Agriculture

1. ARS National Program Staff, Plant Germplasm	*P. Bretting
2. ARS Plant Exchange Office	*E. Garvey
3. ARS Area Director, Midwest Area	L. Chandler
4. Cooperative State Research, Education and Extension Service	A. Thro
5. National Center for Agric. Util. Research	*T. Isbell
6. National Center for Genetic Resources Preservation	*H. Shands

*Voting members

E. North Central Regional Plant Introduction Station, Ames, Iowa

See organizational chart, Figure 1 in the Appendix.

III. PROGRESS OF WORK AND PRINCIPAL ACCOMPLISHMENTS:

Personnel changes - June, 2007– May, 2008:
Departures: None

New Hires:
Trent Moore, ISU Agricultural Specialist, Maize; March, 2008
Luping Qu, Horticulturist / Medicinal Plants Curator, February, 2009

Promotions:
Pete Cyr, from a GS11 IT Specialist to a GS-12 Applications Software Dvlp. IT Specialist; May, 2008

Management of Federal STEP (Student Temporary Employees):
Student labor positions were held at 21 FTE in FY08, an increase over FY07. We chose to limit equipment purchases, postpone recovering a greenhouse for a year and focus on increasing the availability of the collections and quality of associated information. The STEP positions support curatorial activities including regeneration, seed processing, viability testing, farm and facilities operations, and IT support. Students were interviewed and selected by ISU Program Manager Larry Lockhart, ARS maize technician Matt Lively, or ARS IT Specialist Peter Cyr. Marci Bushman and Rachael Beyer managed the administrative aspects of all STEP hires, with support and guidance by Ames ARS HR Specialist Kim Grandon and Admin. Officer Carol Moran.

Budget:
Declining purchasing power of budgets and rising salary, energy and operational expenses continue to erode our ability to support core functions. In FY09-11, Hatch funds used for ISU staff salaries and some expenses are being supplemented by a component of a DOE grant evaluating Helianthus argophyllus for biomass potential on which Oilseeds Curator Dr. Laura Marek serves as a co-PI with PI Steve Knapp, Univ. of Georgia. The ARS PIRU Unit's medicinal curator position and a student position are supported 50% by ARS Horticulturist Dr. Mark Widrlechner's NIH research grant sub-contract on Botanical and Dietary Supplements, for which he serves as co-PI with Dr. Diane Birt of Iowa State University. Dr. Charles Block's Sclerotinia Initiative funding supports student labor and supplies used in that research. GRIN-Global grant funds support the salaries of contract development personnel and project connected travel of ARS personnel.

Construction and Facilities:
Water meter pits were installed for use with irrigation in our fields north of Mortensen Road; previously, water could only be delivered using the 'water wagon.' Following a very thorough evaluation of all aspects of our facilities and operations by OSHA, all listed citations or recommended improvements were abated. The headquarters building was cleaned and painted, a heater was replaced in Greenhouse #1, and the air conditioning systems in both the HQ building and entomology were updated with high efficiency systems.

Equipment:
Major equipment purchases included an irrigation gun, a Great Plains Min-Til Drill, a replacement for a 1975 flatbed truck, and a Conviron Germinator.
New farm operations equipment increased our capacity to support pumpkin regenerations, plantings for the two maize projects, maintenance of woody ornamental plantings, the entomology staff's efforts to supply pollinators to the regeneration cages, and general regeneration activities. See Farm section for more detail.

IV. PROGRESS IN GERMPLASM AND INFORMATION MANAGEMENT, RESEARCH, AND EDUCATION (C. GARDNER):

(Part IV. summarizes the accomplishments and progress presented in greater detail in the individual staff reports in the document.)

Acquisition and Documentation Highlights:
In 2008, (Appendix Table 1) 564 accessions were acquired, nearly 1% of the previous collection holdings. This compared with 450 new accession in 2007, 650 in 2006, 282 in 2005, and 450 in 2004. These include 284 from within the National Plant Germplasm System (NPGS) through exploration and exchange. A collection trip to Turkmenistan provided 74 accession of *Cucumis melo*; 55 accessions of Zea were transferred from the National Center for Genetic Resources Preservation (NCGRP) in Ft. Collins, CO; 68 ornamentals, mostly *Fraxinus* collected in the face of the Emerald Ash Borer (EAB) threat; 54 wild *Helianthus* from collection trips to the SE USA; eight *Thlaspi arvensi* accessions provided by donors; and wild *Amaranthus sp*. and spinach relatives;

Of ongoing concern is the successful entry of germplasm collected from international explorations into the U.S. It is critical that clean, pest- and pathogen-free seed be shipped or carried in by collectors; sufficient time needs to be devoted to collection sample preparation and sufficient care post-collection.

The excellent quantities of seed provided by collectors for many new accessions has made a significant proportion available and distributable immediately.

Over 660 accessions were assigned permanent PI numbers in 2007, the third highest number of assignments in the past 13 years. This focus will continue in 2009. Taxonomic re-identification was completed for 109 accessions. Forty nine were nominated for inactivation, three of these due to duplication. Voucher records were submitted to Iowa State University's Ada Hayden Herbarium for 163 accessions of medicinal plants. R. Stebbins continues to enter old passport information from logbooks for early Ames-numbered accessions.

Original seed samples continue to be scanned by L. Pfiffner and L. Burke, in order to provide useful visual references for comparison of regeneration lots with original samples.

Regeneration and Maintenance Highlights:
In 2008, 1,443 accessions were grown for regeneration and 1,113 harvested, including those grown in previous years and harvested in 2008. An additional 122 perennials are growing in permanent plantings. Over 1,120 accessions were made available to the public. About 499 lots were backed up at the NCGRP in Ft. Collins, CO; this compared with 2970 lots in 2007, and 880 in 2006. Seventy nine percent of the NCRPIS collections are backed up (Appendix Table 2). Overall collection available is 74%, a 1% increase, despite 2% growth in collection size since 2006. An additional 3,943 accessions were sent to Ft. Collins for assembly with accessions from other NPGS sites and deposit to the Svalbard Global Germplasm Vault.

Using an application designed in-house, Pocket Pollinator, information on pollinator insect actions connected with regeneration efforts is collected by our entomology staff and entered into the GRIN database. Over time, this will provide a rich database that can be explored to better understand effective plant-pollinator interactions with respect to seed production.

Assistance in regeneration was provided by USDA-ARS staff of Parlier, CA; Mayaguez, PR; the St. Croix quarantine nursery staff supported regeneration of maize accessions. Dr. Matt Krakowsky (ARS, Tifton, GA) increased several older public Georgia lines which have been difficult to increase in Ames. The maize curation project's winter nursery efforts on Kauai failed to thrive.

In addition to the *Daucus* regenerations grown in Ames, seed increases were received from R. Maxwell, Seminis Vegetable Seeds, ID, and R. Freeman, Nunhems, OR. Dr. Freeman and Dr. Maxwell were sent additional PI-numbered accessions, for regeneration in 2009.

Distribution:
2008 external distributions included 24,726 items of 12,709 unique accessions to fulfill 1,243 orders from 908 individuals. This compares with the record high (2006) of 26,100 items of 13,789 accessions. Approximately 27% were distributed internationally, and 73% were to domestic researchers (Appendix Table 3A). A detailed listing of distributions by site crop can be found in Appendix Table 5. The relative numbers of distributions generally correlate well with the proportional makeup of the collections. An additional 12,450 items were distributed within the NCRPIS for all internal genebank activities (Appendix Table 3B).

Research demand for our plant genetic resources collections continues to be very high; requests for biofuel applications and health and nutrition contribute increasingly to these increases, as well as for basic research applications, disease and insect resistance, photoperiod response, and an array of performance traits. *Echinacea* and *Prunella* plant materials were provided for NIH-funded research on botanical dietary supplements at ISU.

NPGS curators at all sites continue to receive many requests from individuals not affiliated with research institutions, generally for home gardening. Home gardeners are redirected to other sources of commercially available materials. Although our

resources cannot support maintaining and distributing the collections to home gardeners, we have tried to inform these requestors about plant genetic resource conservation, and to encourage interested individuals to save seeds, conserve and share germplasm and associated information. Increasingly problematic is the proliferation of websites instructing non-research requestors how to deceive curators at various germplasm sites in order to get free germplasm. The careful efforts that go into each and every increase, characterization, imaging, processing, storage, viability testing, and distribution surely make these seeds among the most expensive to provide in the world.

Curator	Collection Size – 2008	% of Total Collections	% of 2008 Ext. Distributions
Brenner	8871	18	12
Marek	11140	22	23
Qu	452	<1	1
Millard	20091	40	42
Reitsma	7440	15	21
Widrlechner	2319	5	2
Totals	**50313**	**100**	**100**

Evaluation and Characterization:
In 2008, the NCRPIS utilized 5,597 accessions for observation, evaluation and characterization for a wide array of descriptor information. About 32,900 observations were entered in the GRIN database (http://www.ars.grin.gov/npgs/). Images added to GRIN for the year number 963 (Appendix Table 4).

The amaranth project (Brenner & Flomo) loaded over 13,150 descriptor notes, includ*ing the Coriandrum* data provided by Dr. Pedro Lopez' dissertation research, and *Amaranthus* data. The oilseed project (Marek, Larsen, Bingaman) loaded over 7900 notes. The maize project (Millard, Lively Losure) loaded over 13,000 observations. The vegetable project's (Reitsma, Clark) *Daucus* and *Cichorium* evaluation projects have generated large descriptor datasets.

Information technology and telecommunications:
The NCRPIS is providing expertise and leadership for the development of GRIN-Global (the successor to the GRIN system); this has become the primary focus of two NCRPIS staff members. This project is undertaken as a partnership between USDA-ARS, Bioversity and the Global Crop Diversity Trust (the Trust) to develop a genebank information management system which can be deployed to any genebank in the world. National Program Leader Peter Bretting is the PI for this agreement.

The basic GRIN database schema is recognized as essential to preserve; improved interfaces and views are required to support the needs of genebank curatorial personnel and external, public users of information associated with the collections.

The source code for the products of development will be freely available. The system will be able to function on either networked systems or stand-alone PCs, and will be free of recurring licensing costs.

Ames-based development team members include Pete Cyr, the NCRPIS' Applications Software Development IT Specialist, Project Manager; Mark Millard, NCRPIS Maize Curator, Analyst; Lisa Burke, NCRPIS Seed Storage Manager beta tester. Other Ames-based personnel include developer Brock Weaver and web developer Rachelle Little, Bioversity consultants. Joseph Postman, Pathologist at the National Clonal Germplasm Repository in Corvallis, OR, and Tomás Ayala-Silva of the Miami Sub-Tropical Research Station provide valuable input as testers representing the clonal germplasm community. Together with the staff of the USDA-ARS Database Management Unit (DBMU) in Beltsville, MD, responsible for the current GRIN system, representatives of seed- and clonally-propagated NPGS sites, and our international partners, they are working to accomplish project objectives within tight timelines. U.S. curators and Bioversity International personnel are currently testing curator tool prototypes. International genebank personnel will test a release candidate in 2009. Work on the new public GRIN-Global interface will begin in 2009, to be deployed in late 2010.

Please see IT section for reports on support activities.

Germplasm's Viability and Health:
Over 2,410, or 5%, or the NCRPIS collections were tested for viability in 2008, fewer than in the past due to labor constraints. Accessions tested included 2% of the collections managed by D. Brenner, 4% of the oilseeds, 8% of the medicinal plants, 7% of the maize, 2% of the vegetables, and 9% of the ornamental collections (Appendix Table 2).

Experimental viability testing methods to release seed dormancy in *Echinochloa* and *Actea* were explored. The progress of after-ripening in *Calendula* was studied in with a goal of understanding loss of seed dormancy in cold storage. Use of a thermal gradient table has enabled D. Kovach to conduct a series of experiments comparing controlled temperature, light and humidity conditions to establish appropriate seed germination testing protocols for various crops. The table also is used by graduate student Ivan Ayala Diaz in his studies of *Thlaspi* and *Camelina*.

Pathology team research (C. Block), focused on resistance to Sclerotinia stalk rot in wild sunflowers, long-term survival and seed transmission of bacterial fruit blotch (*Acidovorax avenae* subsp. *citrulli*) in Cucurbits, and development of a TaqMan real-time PCR assay for detection of the pathogen (*Stenocarpella diplodia*) that causes diplodia ear rot of maize, a collaborative research project with Iowa State Univ. (ISU) Seed Science Center personnel. Field observations were made in the increase plots, and accessions were monitored in particular for diseases for which seedborne transmission is of concern.

Insect management:
Entomologists S. Hanlin and S. McClurg supplied 935 accessions in 809 cages with five types of pollinator insects in 2008. Interpretation of their field pollinator

research activities in 2008 is difficult due to the unusually wet weather we experienced. Please see their extensive section of the annual report for information on their continuing efforts to enhance the pollination program's effectiveness and efficiency, and many interesting observations.

The staff continues to compare use of solid 'fondant' sugar with corn syrup for feeding the honey bees. While fondant sugar use decreases labor needs, honeybees cannot store this sugar as a resource for winter. It may be possible to feed fondant part of the season, then use corn syrup feed to enable the bees to build honey stores.

Use of alfalfa leafcutter bees (ALC) as pollinators for a wide array of NCRPIS species is now accepted practice. Experiments aimed at determining pollination efficacy, as determined by amount of viable seed produced, continue. Use of ALC in combination with flies, or flies in combination with *Osmia* or honeybees, may prove advantageous over use of a single pollinator insect in some situations. Of more importance is how well the insect pollinators cross-fertilize the plants in the cage, and whether the genetic profile of the accession is maintained during regeneration. This will be a focus of future studies, and will require careful selection of parent lots and assay of their progeny using molecular markers or known discernible traits.

Enhancement:
The Germplasm Enhancement of Maize Project, or GEM, continues to work with public and private collaborators to adapt exotic maize germplasm to broaden the genetic diversity of temperate U.S. maize production and provide unique, key priority traits. The Project has released 202 lines from 2001-2008, representing 25 maize races. An important goal is development of a set of inbred lines that are representative of the diversity inherent to all of the races of maize. In addition to tradition introgression methods, the project is attempting to use a haploid inducer line and generate double haploid maize lines.

Research and breeding is designed to identify traits and genes to support improvement of agronomic productivity, disease resistance, insect resistance, and value-added grain characteristics, including total extractable starch to support ethanol production, and resistant starch – of importance to human health and nutrition.

Tropical maize often is photoperiod sensitive, not flowering until September in Ames. GEM and maize curation teams have continued to collaboratively develop an effective method for photoperiod control in the field. While successful, it is difficult to achieve the field scale needed to support the number of accessions that require photoperiod control treatment. This effort has been leveraged by the sunflower project, which has used it very effectively to induce flowering in a portion of the wild sunflower accessions.

Development of ornamental *Amaranthus tricolor* resistant to *Phomopsis amaranticola efforts continue.* A collaborativen project to evaluate outcrossing of grain amaranth cultivars with weedy amaranth species is in progress.

Outreach and Scholarship:
Approximately 550 visitors toured the NCRPIS during 2008. Our staff participated in teaching students from the grade K to postgraduate level, provided outreach events to civic and other organizations about germplasm conservation and management, and the work done at the NCRPIS. Scientific and technical staff members continue to publish scholarly journal articles, make presentations at scientific meetings, and supervise graduate research programs.

Current and future foci:
Processes involved in regeneration, characterization, and making viable germplasm available are labor intensive. Currently, resources do not allow maintenance and regeneration efforts, including viability testing, to keep pace with demand. We will continue to try to improve conservation methods to better use the resources available to us, and to develop labor and resource saving technologies. We will evaluate activities that can be reasonably reduced without sacrificing collection health and quality.

Continued emphasis will be placed on communicating with research stakeholders to identify and address collection development needs. Crop collections for biofuels and medicinal/nutriceutical applications need to be enhanced; wise selection of targets for these efforts requires use of complex and varied sources of information. 2009 collection expeditions are planned to acquire *Helianthus*, *Fraxinus*, wild spinach relatives from the High Plains; and *Chenopodium* and *Amaranthus*. *Thlaspi* acquisition is anticipated via collaborators.

Better characterization information is essential to enable well-target use of the collections, especially given the increasing constraints of limited research and conservation resources. Collaboration between vegetable curation staff at the NCRPIS and ARS researchers in Wisconsin will focus on *Daucus* characterization and taxonomy. Oilseeds curation staff will increase the Thlaspi and Camelina collections in order to better support biofuel researchers.

Horticulturist M. Widrlechner serves as chair of a national Technical Review Team that provides technical direction and oversight to an ARS project to update the USDA Plant Hardiness Zone Map using the best available technologies and data sets, and make it accessible via the Internet. The project is complete, save for public distribution. In addition, he serves as an investigator on an NIH grant to develop collections of medicinal plants and elucidate the basis of the phytopharmaceutical activity, and is working to develop inter-agency coordination of *Fraxinus* collection in the face of the Emerald Ash Borer threat.

Real-time PCR analytic methods will continue to be evaluated and modified by Pathologist Charlie Block's team for routine detection and identification of multiple pathogens from seeds.

Software development efforts for the next three years will center on the development of the successor to the GRIN system, GRIN-Global - its schema, internal and public interfaces. These efforts will be facilitated by contributions from germplasm

stakeholders in the U.S. and abroad, as we seek examples of use cases and desired features and functionalities of the new system.

V. IMPACTS OF GERMPLASM USE BY NORTH CENTRAL REGIONAL RESEARCHERS:

Impacts of germplasm use by the researchers at the NCR institutions:
A detailed list of examples of germplasm use in research being conducted at NCR institutions was not requested of the RTAC members this year. Please see Appendix Table 6 for a summary of the various CSREES regions order history, illustrating the demand for plant genetic resources to support research and educational activities. NC7 Region researchers typically account for nearly half of domestic plant germplasm distributions. Requests for germplasm continue to increase for research as well as non-research use. Requests become increasingly better targeted as the quantity and quality of information associated with the collection improves.

The linkage of the GEM Project, the maize curation project, and public and private collaborators throughout the U.S. has resulted in synergy which facilitates the use of exotic maize germplasm by public and private sector maize researchers. This unique partnership offers great potential for diversifying the genetic base of U.S. maize production, the purpose of the GEM Project.

Linkages among project participants and with other projects/agencies and contributions of the Regional Technical Advisory Committee:
Linkages are driven primarily by common research interests and objectives and by the heritage of the germplasm material utilized for research and education. All states utilize germplasm provided by the NCRPIS and many of the other 20 sites involved in the NPGS; the states have a complex array of collaborative research efforts between their institutions, and with the plant genetic resource curators at the NPGS sites.

The regional technical advisory committee (RTAC) has provided valuable direction in the following areas:

- requesting and suggesting organizational structure of information needed to determine project impact and provide accountability. This includes advice on useful formats for analyzing and evaluating the nature of distributions, whom they benefit, and how benefits are realized, which are essential for determining the impact and value of the project.
- identifying needed improvements to the public GRIN interface.
- providing input from their respective AES Directors to curators, genebank and other administrators.
- providing guidance to increase the NCRPIS program's relevance to NCR stakeholders.
- providing technical expertise, particularly in the areas of diversity assessment and taxonomy.
- providing added breadth in understanding issues at genebanks beyond the NCRPIS.

- understanding of challenges faced by public researchers partnering with other public institutions' researchers, both governmental and non-governmental. This has provided useful insights for ARS and NCR administrators to guide programmatic decision-making, as well as operational guidance; this function is key because of its direct impact on the public interest as well as the specific research interests of more directly involved stakeholders.

The technical committee gatherings provide an opportunity for the AES Directors' representatives to learn about and understand strategic issues which impact how their institutions operate and how they can cooperate more effectively to address their mission in today's environment, and then provide this information to their Directors.

Some of the NC-7 RTAC's specific suggestions and contributions from their 2008 Annual Meeting include the following:

- Crop Germplasm Committees must be encouraged by the leader of the National Genetics Resource Lab and Data Management Unit to ensure that CGC annual reports are made current and that they fulfill their obligations.
- Instructions should be developed and posted on the NPGS website on how to appropriately credit curators and other NPGS entities for their contributions to the success of research efforts (repeat from 2007).
- The public GRIN interface should be significantly improved for ease of use and information delivery (repeat from 2007).
- Insufficient numbers of individuals are being trained in plant breeding and genetics, plant pathology, entomology, and related disciplines to meet current and future US needs; this is of serious concern (repeat from 2007).
- The 2008 TAC meeting hosted by Burton Johnson (ND) highlighted the extensive investigations using plant genetic resources to explore new agricultural products and new cropping systems. The opportunity afforded by the meeting and field tours is key to establishing the types of collaborative relationships that lead to long-term partnerships for major research and development efforts.

VI. SUPPORT TEAM REPORTS:

A. Farm (L. Lockhart, L. Crim, B. Buzzell)

We supervised and coordinated daily operations at the NCRPIS farm, including management of all facilities, fields, and greenhouse space. We supervised or conducted pesticide applications in the field and campus greenhouses. We responded to maintenance requests from staff members at the farm and the campus location. We selected, coordinated and scheduled the student labor force of 21.0 FTE's. We coordinated and completed facility construction and upgrades.

Labor:
During 2008, 80 applications for hourly employment were received and reviewed. There were 46 interviews, resulting in 36 new or returning hourly employees hired. Currently there are 32 Biological Science Aides (15.6 FTE) working at the NCRPIS.

NCRPIS Farm Crew Personnel:
Larry Lockhart (Program manager II) has been on staff since 1985.
Lloyd Crim (Equipment Operator III) joined the staff in March 1998.
Brian Buzzell (Farm Mechanic) joined the staff in May 2002.
Scott McCubbin (STEP) was shared with vegetable and pollination projects.

Maintenance projects:
During the past year the farm staff initiated and completed several projects which enhanced the efficiency and safety of the station operations:

1. Coordinated installation of new water meter pit for north fields
2. Addressed and abated OSHA inspection citations
3. Remodeled Campus Lab 205
4. Constructed steel pallets for pumpkin cage frame storage
5. Coordinated cleaning and painting of headquarters building
6. Removed natural gas meter from vernalization facility, replaced with more efficient and economical electric heater
7. Added seven motion sensing light switches to reduce electrical consumption
8. Constructed new computerized sprayer for JD 6430
9. Coordinated installation of high efficiency ductless air conditioning units for headquarters and entomology
10. Replaced greenhouse heater GH1
11. Installed sulfur burners in all greenhouses
12. Installed poly-dome bulk bin for fertilizer
13. Acquired automated external defibrillator for Headquarters Building

Purchasing:
Larry Lockhart coordinated purchasing for the NCRPIS farm: this task included gathering and summarizing requests, writing specifications, and obtaining supplies for the farm. Major purchases included the following:

1. Truck to replace 1975 Flatbed
2. Front Mount Snow Blade
3. Conviron Germinator
4. Great Plains Min-Til Drill for planting cover crops

5. Irrigation Gun
6. Utility Vehicle
7. Rear mount blade

Tours:
This past year, we organized and conducted 11 large group tours. There were approximately 550 visitors to the NCRPIS during 2008.

Staff Training:
We conducted Tractor Safety and Utility Vehicle training sessions and Worker Protection Standard training sessions for the new student employees and existing staff, and staff training in the use of our AED equipment.

B. Information Technology and Telecommunications (P. Cyr)

The IT team composition has changed in 2008. Jesse Perrett has been acting as the first-line of support for NCRPIS during 2008 year. Jesse was supervised by Pete Cyr who has been temporarily re-assigned to manage a 3 year project to rewrite the GRIN Germplasm Management System. The following list outlines the progress made by the IT team during FY 2008 at NCRPIS.

Equipment:
As of December 2008 NCRPIS has 63 workstations installed for use by permanent staff members and part-time temporary student help. In 2008 18 new workstations were deployed to replace aging equipment on curatorial staff desktops. Where possible, the displaced computers were re-commissioned for light duty work in other areas of NCRPIS and/or donated to local community school systems.

The Firebox system firmware was upgraded to a new version to improve capability and reliability of our site firewall. Wireless networking upgrades were installed and tested. A new virtual machine server was installed and put into service and the DHCP and intranet servers were migrated to new virtual machines. NCRPIS now has a VLAN set up between all campus computers and the isolated network on the farm. This isolated network tunnel alleviates multiple synchronization problems and dual VPN concerns as well as increasing productivity for campus personnel. The backup drives were upgraded and the backups were restructured to take advantage of the added capacity. Installed and configured two new Xerox Workcenter multi-function devices to take advantage of new scanning, printing, and email capabilities. Installed new GRIN-Global server and implemented virtualization technology to facilitate multiple test machines at minimal cost.

Software:
All of the workstations at NCRPIS are standardized on Windows XP with Service Pack 3 installed for increased security and reliability. Daily updates to anti-virus definitions and periodic updates to anti spy-ware definitions help to ensure that these workstations remain vulnerability free.

During 2008 all workstations and servers at NCRPIS received security updates from Microsoft every month (on the second Tuesday of the month). PatchLink software

was used to manage, track, and apply non-Microsoft software vulnerability patches for all non-Microsoft software in use on the workstations and servers at NCRPIS.

All computer systems on campus and at the farm (servers and workstations) use Symantec Endpoint Protection for enhanced security against virus and spyware threats.

The NCRPIS Intranet website was upgraded with new features and capability including document management for safety documentation. All relevant machines were upgraded to Adobe Creative Suite 3. The Watchguard client was upgraded on all mobile machines, and the server software was also updated to a new version for managing the Firebox Firewall. The TrackIt help desk software was upgraded to enhance capabilities and usefulness. Individual VPN clients were installed on all machines in order to comply with the new security requirements for ARSNet email connectivity.

Documentation:
Posted staff meeting, committee meeting minutes, farm operation, safety, and health information to the NCRPIS intranet website.

Plans for 2009:
Continue to replace NCRPIS workstations on an as needed basis (targeting a 3-5 year lifespan for daily use workstations).

Upgrade the Symantec anti-virus software used to protect the servers and workstations at NCRPIS.

Upgrade to Microsoft Office 2007 for all computers at NCRPIS.

GRIN-Global:
The GRIN-Global project is a joint partnership between USDA-ARS NPGS, Global Crop Diversity Trust and Bioversity International. The goal of the project is re-write the current GRIN Germplasm Management System in such a way that it can be deployed on any size computer with a minimum amount of effort. The new Germplasm Management System (dubbed GRIN-Global) will support five different languages, three database systems and install on a single desktop computer. In 2008 the NCRPIS team attended a Technical Steering Group in Beltsville to discuss and review the achievements of the project in 2008. The highlights of the GRIN-Global team achievements during 2008 are as follows: Developed system specifications for GRIN-Global client interface, enhanced the database schema, migrated the current GRIN Oracle database to the MySQL and Microsoft SQL Server database platforms, and designed, developed and tested early prototypes of the Curator Tool client interface for the new GRIN-Global system.

C. Seed Research and Computer Application Development (D. Kovach, M. Erickson)

Seed Research:
Seed research for 2008 included the following genera:

- *Actaea* – Development of a standard germination method to overcome seed dormancy.
- *Calendula* – Documenting the progress of seed after-ripening at 4 and 23 °C. The primary goal is to document loss of seed dormancy during cold storage.
- *Daucus* – Testing methods to promote embryo development to increase germination percentages from secondary and tertiary umbels.
- *Echinochloa* – Investigating the effects of light and darkness on release of seed dormancy. Also researching new methods to release dormancy in some lines unaffected by light conditions.
- *Zea* – Ran seed-longevity statistics for maize with parameters specified by Dr. Philip Dixon and Allan Trapp II, ISU statisticians and collaborators in efforts to characterize and predict changes in seed germination over time to increase the efficiency of periodic viability monitoring.

We expect that results from this work will be prepared for publication in 2009.

Germination Testing:
During 2008, Maria Erickson and her crew conducted germinations on over 2,400 accessions.

Curator Group	Major Crop Tested	Total Accessions Tested
Brenner	Umbels (103)	164
Marek	Flax (256)	466
Medicinals	Medicinals (35)	35
Millard	Maize populations (966)	1399
Reitsma	*Daucus* (67)	128
Widrlechner	Ornamentals (214)	218
	Total:	2,410

In addition to routine germination tests, Maria Erickson participated in an Association of Official Seed Analysts (AOSA) sanctioned Pepper Referee, prepared by Chuck Boettinger of the Pennsylvania Department of Agriculture. Maria collaborated with David Kovach on a study pertaining to the development of a protocol to overcome dormancy in *Actaea*. Four accessions of *Actaea* were tested by using ethephon as one of the treatments. Another test will be conducted in 2009 to confirm initial results. In cooperation with David Brenner and David Kovach, Maria completed a preliminary cold-treatment study of three accessions of *Chenopodium*. Results were highly variable and will be repeated in 2009.

Computer Application Development and Graphics Support:
In 2008, David continued his work on computer application forms and reports to retrieve data from the GRIN Database, and used statistical software packages to run descriptive statistics and determine regressions for the maize seed-longevity study described in the Seed Research section. He also began preparing formal documentation on computer forms and reports. This will provide information to GRIN-Global developers and can also be used to support future changes, if needed, to these forms and reports. David continued to serve station needs by providing AutoCAD drawings and large-format printing for professional posters and local use. A new seed packet label was also designed to provide germination information to cooperators for the seed lots they receive.

Internet website related:
In 2008, David enhanced the station's website (www.ars.usda.gov/mwa/ames/ncrpis) by:

- Creating a new homepage graphic to illustrate our mission.
- Redesigning staff personal pages for easier navigation and a nicer appearance. The new navigation was strongly recommended to all sites by the USDA Consolidated Website Webmaster.
- Working with Ben Herman, student coordinator for the Plant Genome Database and Analysis Tools (Outreach Supplemental Request), to post information on the three Native American students under "News and Events".
- Posting posters for Charles Block, David Brenner, and Mark Widrlechner that were presented at various conferences and are provided for conference attendees and the general public at large. Also helped develop a poster for Veishea ('Open House' festival event at ISU).
- Creating a germination test methods area.
    - Information on our germination test methods is now provided to our cooperators. New seed-packet labels allow cooperators to locate specific methods used to test their samples.
    - A graphic was also loaded to explain our seed packets (http://www.ars.usda.gov/Main/docs.htm?docid=13482&page=2).

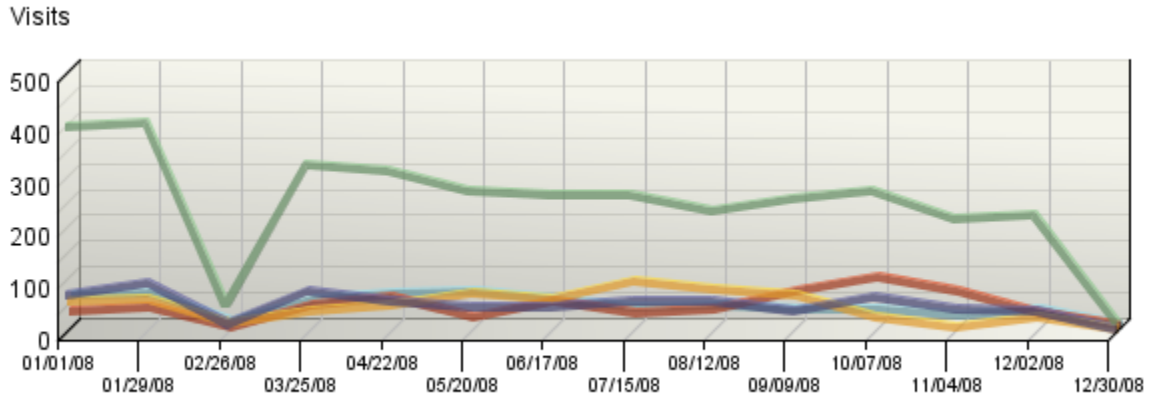
Visits to the station's website were tracked by software at the Web Branch of the OCIO. Government policy prohibits the use of 'cookies' to track specific user information, so how many individual users visited our website cannot be determined. But the number of times pages were viewed can. The following table summarizes the major uses of our website.

Visit Summary 2008	
Visits	16,005
Average per Day	43
Average Visit Duration (minutes)	5:29
Median Visit Duration (minutes)	1:37
International Visits	6.6%
Visits of Unknown Origin	58.2%
Domestic Visits	35.2%

Pages Visited (listed here if at least 175 visits)	Number Visits
Home page	3,931
News and Events	1,218
Ordering Germplasm	695
People and Places	557
Station Information – Crops Maintained (Page 1)	515
List of Maps, Printable Format (i.e. all pages)	488
Station Information, Printable Format (i.e. all pages)	436
Research Project: Proposal to Develop New Plant Hardiness Map Data for the United States	429
NCRPIS Staff List	416
Pollinators at PI, Printable Format (i.e. all pages)	405
Personnel Page, Candice Gardner	389
Organization Chart	370
Curator Responsibilities	315
Maps, Ukraine Hardiness Zones	302
Products and Services, Publications at this Location	287
Station Information, Station Facts and Purpose	282
About Us (Mission Statement)	280
Maps, China Hardiness Zones	259
Personnel Page, Mark Widrlechner	259
Station Information, Seed Storage Conditions	228
Curator Responsibilities, Ornamental Horticulture	220
NCRPIS Career Opportunities, Student Employment	219
GEM, Welcome Page	219
Pollinators at PI, Osmia Bees	217
Pollinators at PI, Honey Bees	207
Pollinators at PI, Bumble Bees	199
Maps, North Central US Moisture Balance	193
Pollinators at PI, Introduction	190
Support Staff Responsibilities	189
Curator Responsibilities, Amaranth	187
Contact Us Page	182
Pollinators at PI, Alfalfa Leaf Cutter	179
Publications, 2003, Structures Of Amylopectin and Starch Granules-How Are They Synthesized?	177

Somewhat surprising was the number of visits to our "News and Events" page. Although news items were not updated that often, people were looking to see what was new. We may wish to give more attention to this area in the coming year, which would require more frequent input from our staff. Other areas visited often included those related to hardiness zone maps, insect pollinators, our station's mission and organizational structure, and curatorial / staff responsibilities.

Pages Trend – Visits During 2008
(shown are the top 5 most-visited pages)



The above graft shows a significant drop in visits in late February and early March. According to the ARS Webmaster, this was due to a failure in their web-traffic monitoring software. The falloff at year's end is typical of the holiday season.

The Ames Civil Rights website (www.ars.usda.gov//Main/site_main.htm?docid=8446) was regularly updated with information provided by the NCRPIS Civil Rights Committee representative, Robert Stebbins. This included regular observance information, creation of graphics or the posting of graphics provided by the NADC graphics department to support observances, changes in personnel, and the posting of committee meeting minutes in pdf format.

Cooperative efforts:
In 2008, David contributed to the following station-wide projects:

- Station Statistics reported in each year's annual report.
- Statistics summarizing and contrasting activities to those of the four PI Stations in response to a request by Candice Gardner.
- Special printing requests for brochures and posters, large spreadsheets and AutoCAD drawings

Training:
Maria Erickson attended the Association of Official Seed Analysts - Society of Commercial Seed Technologists (AOSA-SCST) Annual Meeting from June 6-11 in St. Paul, MN. At this conference, she attended the Statistics workshop which provided new methods applicable to viability testing. She remains a member of the AOSA TZ Testing Committee.

D. Kovach & M. Erickson:
Took required online training from USDA-ARS's AgLearn and ISU's EH&S. David and Maria contributed to the development of Job Safety Assessments (JSA) and Personal Protective Equipment (PPE) documentation for their area of work.

M. Erickson:
Management of Unwanted Materials for Laboratory Personnel (Online EH&S).
Lab Safety: Fundamental Concepts (Online EH&S).
Tax Free Ethanol (Online EH&S). This covers the regulations related to the purchase, use, and proper storage of ethanol used for research purposes.

Plans for 2009:
Seed research projects are planned for the coming year based on results from 2008. Several of the projects showed real promise and require follow-up. Collaborations will continue with Dr. Philip Dixon and Allan Trapp, ISU Statistics, on a prediction model to more accurate describe viability change over time, predict seed longevity, and help define necessary periodic testing intervals.

D. Information Management-Germplasm Collections (R. Stebbins, R. Beyer)

Acquisition:
The North Central Regional Plant Introduction Station (NCRPIS) acquired 515 new accessions in 2008. Of these new accessions, 284 were received from within the National Plant Germplasm System (NPGS) through exploration and transfer. This included 74 accessions of *Cucumis melo* from an NPGS collection trip to Turkmenistan, 55 accessions of *Zea* transferred from the National Center for Genetic Resources Preservation (NCGRP), and 68 accessions of ornamentals and 54 accessions of wild *Helianthus* from collection trips conducted by NCRPIS personnel.

The remaining 231 accessions, received from outside the NPGS, included 114 accessions of ornamentals from various sources and 63 accessions of *Chenopodium* from Brigham Young University.

As new accessions are recorded in the Germplasm Resources Information Network (GRIN) database, an effort is made to include as much passport information as possible. Typical passport information would include a source history, cooperator records, collection-site description, pedigree, secondary identifiers, and any other pertinent information provided by the donor.

Maintenance:
Robert Stebbins provided assistance with curatorial management by processing requests for taxonomic re-identifications and nominations of accessions to the inactive file. In total, 109 accessions received taxonomic re-identifications. Among these were 26 accessions of *Daucus* and 22 accessions of *Cucumis*. Also, 49 accessions were nominated for inactivation, including 28 accessions of *Helianthus* and 10 accessions of ornamentals. Two of these were inactivated due to duplication.

The inventory lots of these accessions were combined with the lots of their respective duplicates.

Additionally, 663 accessions were assigned PI numbers, the third highest number in the past 13 years. Included in this group were 298 accessions of *Daucus* and 166 accessions of *Cichorium*.

Projects:
Robert Stebbins entered voucher records for 163 accessions of medicinal plants that were deposited at the Ada Hayden Herbarium at Iowa State University.

In September, Robert began a two-year term on the Ames Area Civil Rights Advisory Committee (AACRAC). He also constructed two display stands for the NCRPIS exhibit at VEISHEA.

Rachael Beyer completed a review of *Echinochloa* passport data for amaranth curator David Brenner. On behalf of Mark Widrlechner, she used Google Earth to map *Fraxinus* collection sites in Indiana and other seed collection sites in Michigan. She completed Agronomy 338, Seed Science and Technology at ISU.

In 2008, Rachael continued a project updating the library database. She entered 2,648 journals into the database and labeled all of the main-collection books.

Rachael worked extensively and contributed to several health and safety areas. She prepared for and assisted Candice Gardner and Larry Lockhart with an OSHA audit of the station. She created templates for staff use in developing JSA and PPE training documentation for 278 types of station activities and equipment, and made all electronic changes to content and format after receiving revisions from Candice Gardner and other members of the NCRPIS Safety & Security Committee. She worked with Jesse Perrett to make all documentation available on our internal SharePoint site, and shared the organizational structure and documents with ARS Midwest Area personnel and with the College of Agriculture and Life Sciences at ISU. She maintained the safety supplies inventory, and, together with Lisa Pfiffner, updated First Aid kits in all vehicles, and serves on the safety committee.

Conclusions:
Compared to 2007, new accessions received at NCRPIS were up by 118 in 2008. Among the maintenance areas, re-identifications were down by 42%, nominations to the inactive file were down by 6%, PI-number assignments were 74% lower, and duplications were 88% lower than the previous year.

All figures for acquisitions and maintenance were below the 13-year average with the exception of PI-number assignments, which were 32% above average.

E. Order processing (R. Stebbins, R. Beyer)

During 2008, 1,745 orders were entered into GRIN, a new record for the NCRPIS. These orders led to the external distribution of 24,726 items (primarily seed packets, but also vegetative samples) (Table 3A). Of these, 18,142 items (73%) were distributed within the United States, and 6,584 (27%) were sent to foreign requestors. Additionally, 12,450 items (Table 3B) were distributed within the NCRPIS, for such uses as regeneration, evaluation, and germination and disease testing.

The number of orders entered into GRIN in 2008 was 8% greater than that of 2007; also, the number of items distributed was up by 2,223 or 6%. The number of requests received electronically this year was 1,366, an increase of 13% from 2007.

In order to increase the depth of staff expertise and capacity to handle seed distributions, Candice Gardner requested that Robert mentor Rachael in all aspects of order processing, including the public GRIN request system, GRIN order-processing functions, methods used to communicate with the curators and plant pathologist, and methods for US Mail and FedEx shipping, internal filing, and the processing of international requests.

F. Seed Storage (L. Burke, L. Pfiffner)

Two full-time, permanent federal employees (Lisa Burke and Lisa Pfiffner), and one part-time, temporary student staffed the seed storage area. L. Pfiffner continued to serve as the federal supervisor for several of the crews guided by ISU supervisors.

In 2008, we stored 2099 inventory lots, including 783 original seed lots. Of the original lots stored, 295 were *Fraxinus*, 125 *Helianthus* and 163 *Zea.* Of the increase lots, 1052 Ames increases, 213 non-Ames increases, and 38 check lots were stored. During storage, 110 lots were bulked with previously regenerated samples to create 97 new bulked lots. Of those, 96 became available for distribution. Of all stored lots, 817 lots were made available for distribution. We split 187 original lots to make them available for distribution in limited quantities. We reviewed 6365 inventory lots for seed quantity, and any discrepancies were corrected in the GRIN database. Six hundred seventy-one samples were prepared and transferred to a -20C freezer for long-term storage.

In 2008, 109 accessions received taxonomic re-identification. We re-labeled the 196 seed samples affected and filed the pertinent documentation. In addition, seed samples of 49 inactivated accessions were removed from the active collection and placed in inactive storage. We also re-labeled 276 seed lots associated with the assignment of 133 new PI numbers, and then corrected their cold-storage locations in GRIN to reflect the change in numbering.

We filled 1342 seed orders in 2008, including those for distribution, observation, germination, transfer and backup. There were 499 lots sent to the National Center for Genetic Resources Preservation (NCGRP) for backup, involving both accessions new to NCGRP and supplemental lots for previously supplied accessions. NCRPIS

distributed 30,749 packets (the majority filled by seed storage personnel) to meet distribution and observation requests. We transferred 42 inventory lots to other NPGS sites. To fill gaps in viability data, we initiated 6 germination orders.

The prepacking program was continued in 2008. With the aid of our student worker, we prepacked 29,445 packets of 2446 inventory lots. A large portion of the prepacking program focused on recently acquired expired PVP maize accessions. Most of these accessions are in high demand as soon as they are received. Prior to regeneration, the distribution lots (original seed) are prepacked in 15-seed packets. Once the accession has been successfully regenerated, standard distribution amounts (100 k) are prepacked from the new lot. Expired PVP lines continue to be of intense interest; in 2008, we received 22 expired maize PVP accessions; these were distributed as 611 order items in 101 orders.

NCRPIS continued to participate in sending seed to the Arctic Seed Vault in 2008, by preparing 3943 accessions for backup there. Each sitecrop was reviewed for newer, good-quality distribution lots, and 39 orders were created. Sample amounts ranged from 200 to 800 seeds, depending on the amount of seed needed for two regenerations. An inventory action code (SVALBARD) was added to all lots shipped for tracking purposes. Packets were filled and orders were sent to NCGRP for repackaging and consolidated shipment.

Another project continued in 2008 was the creation of nine orders for NIR analyses of 422 maize samples by Sue Duvick to evaluate starch, protein and oil content. Seed samples sent to R. Bergquist (Pioneer Hi-Bred, DuPont) in 2000 and then returned to the NCRPIS, comprised the bulk of the 2008 NIR analyses.

Seed storage personnel continued to maintain the germplasm distribution display in the farm headquarters hallway. New maps were printed at the start of 2008, and domestic and international distribution destinations were noted.

Scanning of original seed samples continues. In 2008, 585 scans were taken, mostly of original samples. 84 of those accessions are *Fraxinus* from North American collections. We have been working with Jeff Carstens to streamline the imaging and storing process for *Fraxinus* as much as possible.

Some imaged samples were new to the station while others were being pulled for regeneration when the entire sample was needed. Creating a visual reference of seed lots that have been used up for planting is important for comparison with the increase lots by curators and storage personnel.

In the summer of 2008, the station continued to participate in Native American Intern program. In seed storage, one student worked for a week learning the basics of genebank management.

Lisa Burke has been working with the GRIN-Global team on the Beta version testing and assisting with development (Section B, Information Technology).

VII. CURATORIAL AND SCIENTIFIC TEAM REPORTS

A. Controlled Insect Pollination Service Program (S. Hanlin, S. McClurg, with contributions from C. Gardner)

Progress:
Over the past eight years, a conscientious effort has been made to transition from use of stinging insect pollinators to non-stinging insect pollinators where feasible. Of primary importance is the preservation of the genetic profile of an accession, as well as seed multiplication efficiency. Now that protocols for use of ALC are well-established for a number of NCRPIS crops and seed increases are reliably obtained, we will pursue investigations designed to better understand the impact of use of various pollinators on the genetic profile of the progeny.

Bee pollinators (minus the alfalfa leafcutter bee) were supplied to 296 cages for controlled pollination of 268 accessions. The table below summarizes use of insect pollinators on NCRPIS accession regenerations in 2008, and the figure which follows graphically illustrates the fact that the number of accessions for which alfalfa leafcutter bees (ALC) were used, either singly or in combination with other insects, now exceeds the number of accessions for which honeybees served as the primary pollinator.

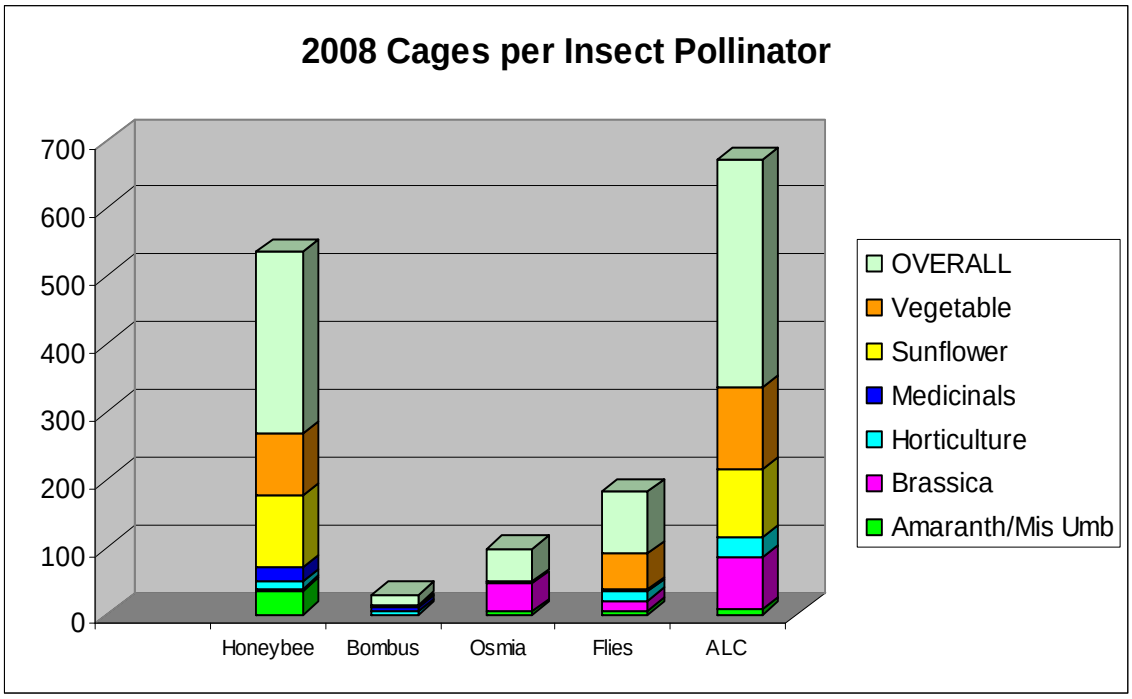
Summary of Pollinators supplied to regeneration cages in 2008

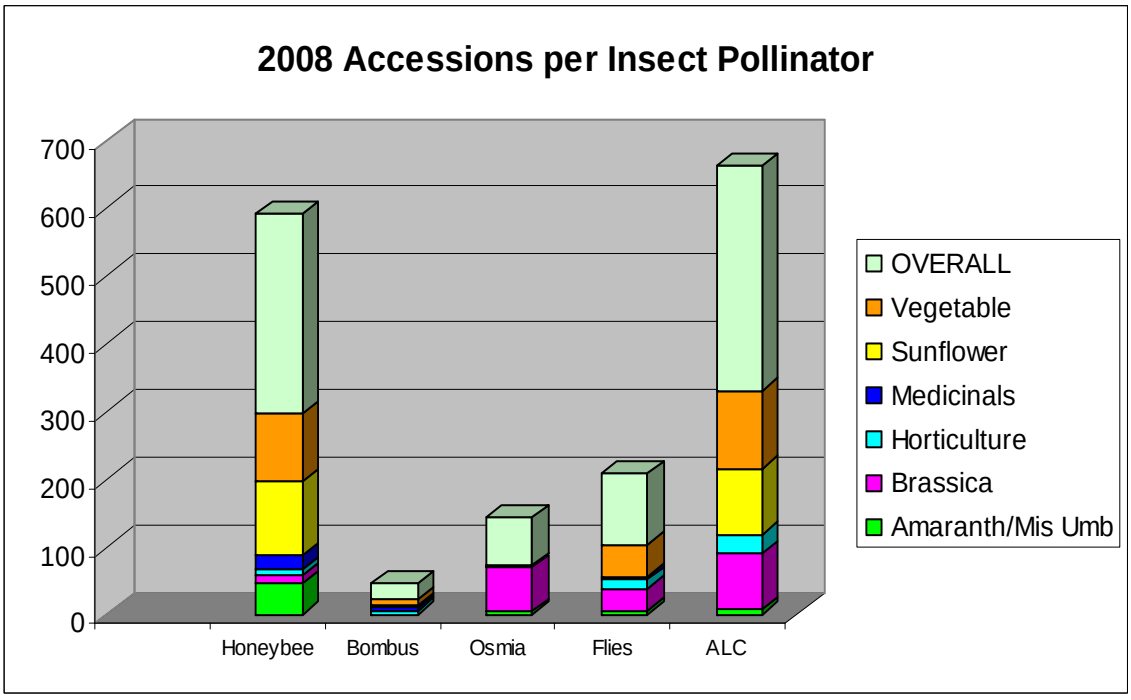
Number of Unique ACCESSIONS per pollinator

	Honeybee	Bombus	Osmia	Flies	ALC	TOTAL
Amaranth/Mis Umb	47	0	4	6	7	49
Brassica	10	0	66	33	83	158
Horticulture	10	6	1	14	28	70
Medicinals	21	5	0	3	0	27
Sunflower	109	3	0	0	98	232
Vegetable	99	9	1	48	115	273
OVERALL	296	23	72	104	331	809

Number of TOTAL CAGES per pollinator

	Honeybee	Bombus	Osmia	Flies	ALC	TOTAL
Amaranth/Mis Umb	36	0	4	6	8	79
Brassica	3	0	43	15	76	156
Horticulture	10	5	1	14	29	72
Medicinals	20	5	0	3	0	29
Sunflower	107	3	0	0	101	272
Vegetable	92	2	1	53	122	327
OVERALL	268	15	49	91	336	935


2008 Cages per Insect Pollinator
700
600
500
400
300
200
100
0
Honeybee
Bombus
Osmia
Flies
ALC
OVERALL
Vegetable
Sunflower
Medicinals
Horticulture
Brassica
Amaranth/Mis Umb


2008 Accessions per Insect Pollinator
700
600
500
400
300
200
100
0
Honeybee
Bombus
Osmia
Flies
ALC
OVERALL
Vegetable
Sunflower
Medicinals
Horticulture
Brassica
Amaranth/Mis Umb

Honey bee pollination (Hanlin):
Honey bees were used to pollinate 256 accessions in the field and 19 accessions in the greenhouse. Crops details are presented in the table below.

Crop	# Field Accessions	# Greenhouse Accessions	Total
Helianthus	88	3	91
Cuphea	10	3	13
Vernonia	2	1	3
Cucumis	32	11	43
Daucus	28	0	28
Cucurbita	21	0	21
Echinaceae	7	0	7
Prunella	6	0	6
Hypericum	5	0	5
Aronia	3	0	3
Calendula	2	0	2
Misc. Ornamentals/Medicinals	6	1	7
Coriandrum	12	0	12
Melilotus	10	0	10
Anethum	6	0	6
Celosia	3	0	3
Sium	2	0	2
Miscellaneous Umbels	2	0	2
Brassica	2	0	2
Eruca	1	0	1
Brassica – Eruca Pollination Study	8	0	8
Totals	256	19	275

101 parent colonies of honey bees, 153 double-story nucleus colonies and 29 single story nucleus colonies were overwintered in the indoor wintering facility in late 2007. There was a survival rate of 84% for the parent colonies and 41% for the nucleus colonies, which was higher than last year's 73% and 22%. We left 16 two-story parent colonies and 35 double story nucleus hives outside in a well protected yard due to an early season snowstorm and then impassable roads. Although these hives were wrapped with tar paper, the survival rate was 38% for the parent hives and 0% for the nucleus hives.

In December 2008 we overwintered indoors 66 parent colonies, 121 double-story nucleus hives and 11 single story hives. We left 23 strong three-story hives at two locations; the hives were placed in groups of two and each group was wrapped with tar paper (30 lb.).

To prepare for early spring 2008 cage pollinations, we purchased 50 "Buckfast" queens. The first 50 queens arrived in mid-April with 60% loss (20 queens alive); 50 replacement queens were received. From our over-wintered bees we made 70 nucleus hives with two frames of brood and three frames of adhering bees in each nuc. We then placed a caged queen in each of those nucs; by mid-May we had

productive nucs to place into cages. This protocol allows us to have a limited supply of hives prior to the start of our own queen grafting to fill our early spring pollination requests.

We also supplemented our over-wintered bees with twenty "Buckfast" three pound bee packages purchased in mid-April. The packages were placed into full size hives in late spring 2008. Throughout the summer, we collected four local swarms; these were made into colonies and included in the resources for producing nucleus hives.

In late May, the "Atomic" bee location flooded and all hives located at this site at the time were damaged. By the end of the season, a total of ten colonies and five nucleus hives had been lost either because of initial flood damage or stress caused to the bees through the summer. Within several weeks after the flood, the affected equipment was either hand or power washed; excess water was removed from the frames with a honey extractor. During the summer, bees chewed wax and foreign materials out of ¾ of the recovered frames; these frames could not be re-used and were discarded at the end of the season.

The "Hines" bee location had flooding which occurred on two separate occasions, however no water reached the hives. To prevent possible hive loss in our continued wet spring, in June all hives were relocated to the ISU Horticulture Farm yard until late August when they were moved back to the Hines Farm location.

In mid-May we selected queens from resilient overwintered parent colonies to use for producing our own queens for nucleus hives during summer 2008. These queens were set up in cell builder colonies. Queen rearing throughout the summer 2008 produced an average of 32 queens per week. During much of June and July, only one frame of queens was grafted weekly because of reduced student labor available. Nucleus hives were produced until early August, with hives not used in cages for pollination being fed and strengthened for overwintering.

In early September, 26 strong double story nucleus hives were made into colonies and all strong single story nucleus hives were doubled to prepare them for overwintering. Because of low early fall temperatures, the nucleus hives being prepared for overwintering showed a decline in numbers of around 37%. The reduction in nucs was especially high in the single story nucleus hives at 80% and the double story nucs were 21%.

As part of our regular assessment of bee health, in April 2008, a fourth of the surviving overwintered hives were sampled for mites. The population range of mites found was 0 to 20 with an average of 9 mites per 100 bees. In early September 2008, half of all parent and double story nucleus hives were sampled for mites; populations ranged from 0 to 31 mites per approximately 100 bees and an average of 17 mites per 100 bees. Mite populations in both spring and fall 2008 were determined using the "sugar roll" method: 1 tablespoon of powdered sugar was placed in a pint jar with 100 bees randomly sampled from the hive. Bees were rolled in the sugar and then shaken vigorously over a white pan; mites drop off into the pan and were counted. Because of the wide variation in and relatively low mite numbers, no hives were treated in the spring or fall 2008.

Since no hives were treated in 2008, additional sampling will be conducted in 2009. This time sugar roll sampling will be combined with the use of a "sticky board" to determine mite populations in spring 2009. The "sticky board" method consists of placing a piece of plywood coated in vegetable oil on the bottom board and adding a single mite strip (either coumaphos [Check-Mite^R] or fluvalinate [Apistan^R]) into the middle of the brood frames; after 24 hours all mites which drop and adhere to the board are counted. If 20 mites or more are found, infested hives will be treated with Check-Mite^R or Apistan^R. If no mite treatment is applied in the spring of 2009, hives will again be sampled for mite populations in the fall using only the sugar roll method. If fall mite populations are 30 or more mites per 100 bees, hives will be treated with Apiguard® (thymol - an organic product). This product is not used more than once every few years to minimize the risk of mite resistance developing.

All parent colonies and nucleus hives to be overwintered were provided two feedings of Fumidil-B syrup during the fall of 2008, for prevention of dysentery while the bees are in the overwintering room.

For wax moth control during the summer of 2008, stacks of supers containing empty frames were treated with paradichlorobenzene (Para-moth®) crystals on a bimonthly basis to fumigate for moth larvae. Because of the cooler outdoor temperatures during the winter of 2008/2009, the "environmental control method" was used to our advantage. Equipment was stacked in an unheated storage area which was opened to the outside below-freezing temperatures. Wax moth does not tolerate extended periods of extreme cold, so pest emergence was reduced.

We continued to use our present syrup feeding system of two 1000 gallon polypropylene tanks (one inside the shop and one outside), a 30 gallon "mixing" tank and a dish washer for cleaning syrup jars with good success. Prior to cold weather setting in, all syrup was pumped from the exterior storage tank. The interior storage tank may not hold all syrup on hand; any excess syrup was stored in fifty-gallon metal barrels in the bee shop. An immersible heater was used to liquefy the contents of the barrels prior to transfer of that syrup into the small mixing tank. To prevent crystallizing of the high fructose corn syrup in the large interior storage tank, the contents were circulated by running the pump for at least five minutes daily.

Bombus pollination (Hanlin):
Fourteen "research" colonies of *Bombus impatiens* were ordered during the spring/summer of 2008 from a commercial supplier. *Bombus* colonies were used to pollinate 23 field cages. One *Bombus* colony is used for pollinating more than one cage with a minimum lapse of 48 hours between the two locations to prevent pollen contamination. Bees pollinated four accessions of *Hypericum*, three accessions of *Caragana*; four accessions of miscellaneous ornamentals/medicinals, eight accessions of *Cucurbita*, and three accessions of *Helianthus*.

We continued to use 60-quart protective plastic containers to house/protect hives while in field cages. The plastic container and hive were placed on a stand consisting of a honey bee hive body and lid; two water-filled quart containers were

placed on either side of the hive to prevent the wind from blowing the container and hive off of the stand.

Three "mini-research" hives were ordered and tested in the spring. A mini-research hive contains a queen and approximately 15 worker bees and is approximately $35.00 less than "research hives" which contain ca 35 workers and the queen. The "mini" hives were recommended by the supplier for use in small cages or cages with limited blooming plants. These hives seemed to work well in the spring, but were not strong enough to pollinate during the summer when cages had increased plant populations.

Osmia cornifrons/*O. lignaria* pollination (Hanlin):
Osmia were used to pollinate a total of 64 field cages and eight greenhouse cages with 49 accessions. Bees pollinated 29 accessions of *Brassica*, five accessions of *Sinapis*, four accessions of *Thlaspi* (three in the field and one in the greenhouse), two accessions of *Eruca*, three accessions of miscellaneous oilseeds, two accessions of *Ammi* (greenhouse), two accessions of *Sium* (greenhouse), one accession of *Cucumis* (greenhouse) and one accession of *Berberis* (greenhouse). In addition to the domiciles listed above for Brassica-Oilseeds, a total of 22 domiciles were used for a Brassica pollination comparison in cages containing two accessions of *Brassica* and one accession of *Eruca*.

Approximately 7,150 Osmia bees were used to fill 175 domiciles in 2008, and 73 domiciles used in cages in 2008. We collected approximately 908 bees in 2008 for use in the spring of 2009. This is about 842 bees less than in 2007 as a result of a wetter/cooler spring and a delay or lack of blooming of target plants at increase locations. Approximately 5,000 bees will need to be purchased in 2009.

Because of a fear by commercial orchardists that honey bee pollinator numbers will decline as a result of colony collapse disorder (CCD), the demand for *Osmia* bees as a replacement pollinator has increased. This increased demand on commercial suppliers of *Osmia* has made it more difficult to purchase additional bees to fill the void between NCRPIS increase numbers and the total bees needed. In 2008, 900 unsorted straws were purchased from which we harvested approximately 4500 bees. For spring 2009, it appears it could be difficult to obtain the necessary bees from suppliers used in the past.

From late May through mid-June 2008, the Des Moines Water Works Park (which is the primary *Osmia* increase site utilized by NCRPIS) was flooded by the West Raccoon River. Approximately 80% of the domiciles located at this "increase site" suffered one of the following fates: domiciles were either filled with mud or ripped out of the tree, in some cases the entire tree had been removed by the flood water. Fifteen total domiciles from this location were lost to the flooding; this loss of bees and domiciles was a huge factor in the lower numbers of bees produced during 2008.

In order to accurately track the physical location of the *Osmia* domiciles at increase sites for retrieval later in the summer when they may be hidden by foliage, we used both a GPS unit and paper maps. As domiciles were placed in the early spring,

coordinates were recorded from the GPS unit and each domicile position was plotted on a map. The map of Water Works Park was created from a Google Earth photo by NCRPIS staff several years ago; we used a computer-generated plot of the Iowa Arboretum as available from their pamphlets at the Madrid site

Alfalfa leafcutter bee (ALC) *Megachile rotundata* (McClurg):
ALC bees were present in germplasm increase cages every week of the year in 2008. Numbers of active ALC cages (those cages where ALC bees have been supplied at least once) ranged from an overall low of 4 at the end of May as curators transitioned from greenhouse to field cage use, to an overall high of 89 at the end of August. The average number of active cages differed by season as may be expected. The number of active cages that must be weekly re-supplied with bees varies by season as well. When ALC bees are used beyond their normal range (fall through winter to early spring), more active cages must be supplied more frequently. During late spring through summer (the normal emergence period for ALC bees), fewer active cages need to receive new bees weekly. The frequency of re-supplying ALC bees then is determined by the attractiveness of accessions present in the cages and the physical structure and location of the cage. Following is a 2008 seasonal summary of average number of total active cages vs. those cages which were actually re-supplied with ALC bees and the low and high number of active cages during that time span.

2008 Season	Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec
Lo to Hi number of cages	8 to 17	4 to 74	8 to 89	8 to 16
No. average active cages	14	23	63	12
Avg. No. cages supplied weekly	9	18	27	10

A total of 824 deliveries of ALC bees were made from 21 December 2007 through 31 December 2008 to pollinate caged plant accessions in 11 locations; a total of 184 cages containing 158 unique accessions of 19 genera and 38 plant species were surveyed on a rotating basis weekly to every other week, with bees re-supplied as needed for individual accessions.

Breakdown of ALC bee use by project from the smallest to largest project users is as follows. Miscellaneous Umbel had 6 deliveries to 2 cages of one accession of *Melilotus* located in a very wet section of the field to replace the curator-requested honey bees which would have drowned in this location. The ALC worked steadily and formed many leaf cells in their domiciles in spite of the wet conditions of these two cages. Horticulture had 15 deliveries to 4 cages in 2 locations containing 6 accessions of 5 genera (*Berberis, Calendula, Heteropappus, Prunella, Trichostema*) with 5 plant species. Sunflower-Oilseeds received 68 deliveries to 10 cages in two locations containing 12 accessions of 4 genera (*Cuphea, Euphorbia, Helianthus, Vernonia*) and 6 plant species. Brassica-Oilseeds received 257 deliveries to 82 cages in two locations containing 65 accessions of 7 genera (*Brassica, Camelina, Eruca, Erucastrum, Linum, Sinapis, Thlaspi*) and 5 plant species; of the deliveries to Brassica, 27 were for a field pollinator study with 8 cages, 3 accessions of two genera

(*Brassica, Eruca*) and 3 plant species. Finally 478 deliveries were made to the Vegetable project with 87 cages in four locations, containing 74 accessions of two genera (*Cucumis*, *Daucus*) and 21 plant species.

New genera which received ALC bee pollinators in 2008 included *Heteropappus*; this accession proved very attractive to the ALC based on the 54 cells filled in the domicile. This compares to the 60 and 77 filled cells in the *Melilotus* cages; *Melilotus* is a standard ALC bee-pollinated crop. In comparison, the next best "cell fill" in ALC domiciles was in two accessions of *Brassica napus* with 15, 22 and 44 cells completely filled in the 14 cm long x 9 cm wide commercial Styrofoam nest blocks provided to all ALC cages.

Euphorbia was another first-time ALC pollinated genus. While the bees appeared to work successfully on these plants, they did not seem to want to compete with the flies in the cages. This could be due in part to the minimal amount of plant material present in these cages and the lateness of the growing season.

ALC bees were supplied to fewer total accessions, genera, and cages in 2008 compared to the last annual report. The primary reasons for this include: 1) most standard genera increased at NCRPIS have now been tested with ALC so less effort was made to seek out new genera to try; 2) some curators seem hesitant to request ALC as additional pollinators for certain crops as they have not observed greater seed set with previous ALC use (e.g. for wild-type *Helianthus* pollinated late in the field season, September – October, when temperatures are outside the normal ALC bee range of operation, so reduced ALC activity and pollination are probable).

We made a few changes in ALC handling protocols during 2008. Due to reduced demand for ALC bees in the wintertime, we initiated a shorter weekly work schedule for incubation and emergence; bees were available and distributed only one or two days a week rather than four days per week as in the spring through fall. Our experience is that winter-emerged bees usually need an extra week of incubation (i.e. five to six weeks instead of four weeks) to obtain the maximum number of bees from a given set of cells.

We created new incubation containers from rectangular shaped plastic food storage containers (4 cup capacity, 22 cm long x 14.6 cm wide x 3.8 cm high) by gluing Lumite^{R} screen inserts to the lids and bottoms of the boxes. These new containers are much safer to handle and faster to clean than pint glass jars used previously. The new containers hold three times the amount of cells that we could place in a single pint jar, so fewer containers are needed. Bee emergence box set up time is reduced as a result of handling/using fewer containers at a time.

ALC leaf cells were again purchased from two separate suppliers in an attempt to make these bees available year-round to curatorial staff in 2008. We submitted a small order in November 2007 to the only supplier willing to provide cells earlier than normal and placed a second large order December 2007 with another supplier whose cells have proven to be of very high quality. We had difficulty obtaining the first small shipment of cells before our previous supply of ALC cells was exhausted.

As a result, bees were not available for winter greenhouse cages for two weeks in January 2008.

Since receiving an early ALC shipment in a timely way has proven difficult for several years, we placed a single large order with the preferred supplier of high quality cells to cover all needs in 2009. We gave that supplier a "heads-up" of our intent to order in the late fall of 2008 and submitted our official order in early December 2008. The supplier was able to have the bees in the U.S. ready to ship ca mid-December in order to receive the new cells the first week of January 2009, leaving no gap in providing ALC bees to the current greenhouse cages.

Farm personnel starting using sulfur pots in the greenhouses in November 2008 for powdery mildew control. While this treatment appeared to be very effective for plant disease control, it seemed potentially detrimental to the ALC bees introduced to the wild *Cucumis* cages. Initially it appeared that fewer bees survived and worked in the cages; dead bees were seen on the cage screening. ALC emergence and longevity is reduced at this time of year anyway since the cells are being incubated beyond their normal range of use; it has been difficult to fully assess the sulfur's impact on the bees. Curatorial staff observed that fruit formation continued to occur in the cages however, so at least some bees remained alive, in spite of the fact that they appear to be more "elusive" while sulfur is in use.

Flies (Blue Bottle Flies and Houseflies) (McClurg):
Fly pupae of two species (Calliphoridae and *Musca domestica*) were again purchased from two suppliers and used from 11 January through 16 October 2008 for caged plant pollinations in both the greenhouse and field. A grand total of 1493 deliveries were made twice weekly in the winter (January through May) and then weekly in the summer and fall (from June through mid-October). A total of 11 fields and greenhouses with 168 cages containing 153 accessions representing 19 genera and 36 total plant species received fly pollinators.

The overall average number of cages supplied with flies in 2008 was 27 cages/week, ranging from 75 cages in July to 7-8 cages in January and September. The average number of cages supplied with flies by season was: 17 in winter, 25 in spring, 50 in early and late summer, and 24 in fall. For the first time in several years no flies were requested for late fall – early winter greenhouse cage pollinations in 2008.

Breakdown of fly use by project from the smallest to largest users: Horticulture had 19 deliveries to 5 cages in 5 locations containing 5 accessions of 4 genera (*Ampelopsis, Cornus, Hypericum, Spiraea*) with 5 plant species; Sunflower-Oilseeds received 61 deliveries to 7 cages in one field containing 7 accessions of *Euphorbia*; Miscellaneous Umbels obtained 177 deliveries to 26 cages in two locations with 24 accessions of 6 genera (*Ammi, Anethum, Coriandrum, Foeniculum, Sium, Torilis*) and 6 plant species; Brassica-Oilseeds received 442 deliveries to 51 cages in three locations containing 63 accessions of 13 genera (*Brassica, Camelina, Crambe, Eruca, Erysimum, Goldbachia, Hesperis, Isatis, Lepidium, Linum, Matthiola, Sinapis, Thlaspi*) and 32 plant species; of the deliveries to Brassica, 60 were for a field pollinator study with 8 cages, 3 accessions of two genera (*Brassica, Eruca*) and 3

plant species; and finally 794 deliveries were made to the Vegetable project with 58 cages in three locations, containing 53 accessions of two genera (*Daucus, Pseudorlaya*) and 12 plant species.

Euphorbia and *Goldbachia* were two genera new to fly pollination at NCRPIS this year. Curatorial and entomology staff observed flies working on the flowers of both genera; no feedback is available on seed set at this time.

There were no changes in fly incubation or distribution protocols in 2008. Entomology crew constructed a large number of new fly pupa holders in spring 2008 to replace original holders deteriorating after several seasons of use.

Pollinator Request database and Pocket Pollinator (McClurg):
In 2008, McClurg improved the queries (SQL embedded in an Excel workbook) she previously developed to use with the Pollinator Request database so that less file manipulation in Excel was needed to prepare work orders and delivery summaries. McClurg also learned to write and use queries in Access which simplified finding database records needing to be corrected. She attempted to correct records in Access soon after problems were discovered during the 2008 pollination season, rather than waiting until the end of the year to make all corrections, as in 2007.

This growing season, McClurg made it a priority to review Pocket Pollinator data entries and make data corrections in Access within two weeks of the actual fly and ALC deliveries. Staying current on record keeping enabled McClurg to provide curatorial staff with fly and ALC delivery summaries via Excel workbook by the end of October 2008, which was much earlier than previous years. Hanlin was able to produce a comparable Excel workbook for the introduction and removal of honey bees, *Osmia* and bumblebees by early December 2008. Hanlin and McClurg both attempted to provide the curatorial staff with "almost ready to load to GRIN Inventory records" by converting the Pollinator Request INSECT_IN and INSECT_OUT records to the new Inventory action codes which specify which pollinator was placed in or out. E.g. INSECT_IN for honey bees is now designated in Inventory Actions as INS_IN_HB and INSECT_OUT for houseflies is INS_OUT_HF. *This enables development of a long-term database records relating pollinator insect use practices to regeneration results.*

McClurg worked with P. Cyr to create improved versions of Pocket Pollinator through the spring of 2008, based on suggestions from curatorial and entomology staff users during the 2007 pollination season, and started using a new version of the Pollinator Request database in March 2008. The new database shows which program user modified an original record, an aid in sorting out problem requests which were closed unexpectedly (e.g. before pollinator placement or removal was acted on by entomology staff). In October 2008, McClurg submitted another list of potential improvements for Pocket Pollinator to P. Cyr for consideration to further improve user-friendliness and prevent additional, typical error requests made by infrequent program users.

In spring 2008, McClurg produced a new curator flagging guide which uses barcodes for registering "error" request comments; use of these comments clarifies users'

intent when an insect request is stopped. McClurg developed standard barcode comment guides for entomology use in ongoing fly-ALC deliveries, enabling summarization of data records to be more streamlined and accurate.
McClurg continued to assist curatorial staff with setting up Query-embedded Excel files for working with the Pollinator Request database and solving Pocket Pollinator operational problems. Hanlin and McClurg held a "how to submit pollinator requests with Pocket Pollinator" workshop for NCRPIS curatorial staff on 30 May. Fewer error requests were made in the 2008 pollination season and curatorial staff to be more independent in resolving their own issues.

In addition, McClurg wrote Pocket Pollinator "basic user" protocols and posted these on the new Entomology section of NCRPIS Sharepoint for all interested curatorial and entomology staff. She made use of a PDA emulator for illustrating most techniques and steps; improvements were made to protocols in response to feedback.

Pollinator Insect Research Trials (Hanlin/McClurg):
Compare effectiveness of alfalfa leafcutting bee vs honey bees as companion pollinators to *Osmia* in *Brassica*:
Osmia bees are excellent early spring pollinators and thus have been used for *Brassica* germplasm cage increases at NCRPIS. However, the *Brassica* pollinations sometimes extend into the warmer part of the summer, after *Osmia* bees are no longer viable. Historically we have used honey bees following the *Osmia* in the warmer part of the field season. In 2006, adding ALC bees to *Brassica* cages seemed to result in effective pollination as well. The *Brassica* curation staff favored the ability to work in the field cages amongst the non-stinging ALC, znc considered changing their pollination protocol. In order to verify that ALC are as effective at pollinating *Brassica* as honey bees, we conducted a field test in summer 2008 to ensure that seed quality and quantity were not compromised. We also tested flies as a pollinator of *Brassica*, as some people report positive results for this. Since some *Brassica* bloom early and require pollination in late winter-early spring greenhouse cages, we needed to verify if it was appropriate to use flies as fill-in pollinators for this situation as well as in field cages.

A total of 24 cages were used in the main 2008 field plot planted in cooperation with the Oilseeds curators. The experimental design used two accessions (*B. rapa* PI 603027 and *B. napus* PI 436557); four treatments (*Osmia* combined with ALC, *Osmia* combined with honey bee, Flies, and control); and three replications.

It has been noted that ALC bees are sensitive to plants with strong "odors" such as the cabbage smell from some *Brassicas*. In addition ALC seem to perform better in cages that contain multiple plant genera. For these reasons we decided to do an additional study where a more pleasant smelling plant (*Eruca*) was included in the cage with *Brassica*. An additional six cages were set up with half *Brassica* (three cages for each of the two accessions in the main plot) and half *Eruca sativa* (PI 650182) plants. The smaller study included only the three insect treatments and no replications due to budget restrictions.

We experienced a very wet cool spring in 2008 which delayed initial planting of the test plot; additional rains through June created very wet field conditions which were not well tolerated by the *B. rapa* accession. Test results were probably impacted by these weather conditions.

Data collected included total seed harvested per cage and plant count at harvest. Grams of seed per plant and average 100-seed weights were calculated, and viability was tested. D. Kovach analyzed the data using SAS. For both accessions together and *B. rapa* alone (less self-pollinating), there was no significant difference among treatments for 100-seed weight and viability data; the quality of seed produced was comparable for all treatments. In the *B. napus* accession (more self-pollinating), there was a significant difference among treatments for 100-seed weight only; seed formed in cages with *Osmia* and ALC bees was lighter in weight compared to the other three treatments. We feel it would be wise to look at more *Brassic*a species and accessions in a larger test to determine impact on seed quality when using ALC bees in combination with *Osmia*.

There were no significant differences between treatments for either accession analyzed alone or together for total seed per cage or grams of seed per plant. Having flies in the cage made a definite impact on seed formation for *B. rapa* but not for *B. napus*. In conclusion, having insect pollinators in cages will result in greater quantity of seed set; ALC combined with *Osmia* were successful in this limited comparison with *Osmia* and honey bees. Increases of *Brassica* accessions known to have a lower frequency of self-pollination will be positively impacted by the presence of flies as well; where the "self-pollinating" capacity of an accession or species is not well known, flies should probably not be relied on as the only insect pollinator.

In the future (resources allowing), the research leader has suggested comparing efficacy of pollinators for cross-pollination and comparing the rate of cross pollination via molecular marker or trait analysis of progeny vs. parent seed lots.

<u>Compare covered vs open stands for elevation/protection of honey bee and bumblebee colonies within large *Curcubita* pollination cages</u>:
In cooperation with the Vegetable curation staff, we conducted a study to determine if protecting bee hives from vegetation is beneficial to pollination. Large amounts of vegetation in the pumpkin cages may impede bee flight and possibly result in reduced fruit production. We speculated that placing the bee hives within a protective stand and raising them above ground level would allow increased bee flight throughout the cage.

A total of 16 cages were used for the 2008 summer field test. We used two accessions, Blue Hubbard squash (Ames 29124) and PI 379323, *Cucurbita pepo*; two pollinators – *Apis mellifera* (honey bee) and *Bombus impatiens* (bumblebee); two types of "bee stands" (covered vs open front); and two replications.

Bee stands were created from ¾" diameter metal conduit; the overall dimensions were 42" long x 36" high x 30" wide. The stands included a raised platform to hold the bee hives; the platform was placed 12" from the bottom of the legs which

elevated the hives ca 8-10" above ground level. In order to protect the bee hives from vining plant material, the sides and top of the stand were covered with Lumite^{R} cage screening. So that we could determine whether the hive openings could be protected further from vegetation, half of the stands had chicken wire secured to the front (covered front), while the other half were left open.

Unfortunately we had a very wet growing season during 2008 and the pumpkin cages didn't have a typical amount of vegetation within. We did make observations on insect behavior and collected data on fruit and seed production.

Overall insect behavior was similar for both bees in the two stand types (covered front vs open front). In open front stands, bees flew directly in and out of hives freely. In covered front stands, bees seemed to hesitate before moving in/out of chicken wire or they learned to fly around to the open back of the stand. It appeared that fruit was produced throughout all of the cages which verified that bees were active throughout the cages.

Total fruit number, total weight of seed, and average 100-seed weight were collected on harvested fruits from each cage, and grams of seed produced per plant were calculated. Viability testing will be done when the seed has matured properly, and data will be analyzed. Data "trends" (from looking at means of currently available data) indicate that cages with either honey bees placed in open front stands or bumblebees placed in covered front stands had greater seed set. We speculate this is because honey bees prefer open areas around their hives, while in nature bumblebee nests are more likely to be hidden in vegetation. From this limited study, it appears to be beneficial to use bee stands within the very large pumpkin cages; Hanlin will continue this practice in 2009.

Safety:
All work areas were cleaned and additional electrical outlets were added to the rearing rooms for safe operation of required supplemental heaters and light fixtures.

McClurg updated the "Chemical Hygiene Plan" with newly updated Laboratory Safety Manuals obtained online from ISU Environmental Health and Safety for Entomology project use.

To fulfill OSHA requirements, JSA and PPE training documentation was developed written for Entomology/Insect pollination tasks as recommended by the NCRPIS safety committee in August - September 2008.

Presentations, Outreach:
On March 9 through 11, McClurg and Hanlin presented a seminar at the North Central Soil Research Lab in Morris, MN on the insect pollinators and methods used at NCRPIS. They toured the Morris facilities and discussed pollination issues regarding proposed MN field plot research, providing their expertise.

On May 14, S. Hanlin spoke at the Squirrel Hollow Outdoor Classroom to approximately 200 sixth graders in 7 sessions about beekeeping and honey bees.

We both participated in three station tours this summer: 18 Jun 2008 – plant breeders tour; 25 Jun 2008 – University of Florida students tour; 23 Jul 2008 – ISU Agronomy distance class tour. Field presentations of NCRPIS insect pollination basics were provided for these audiences.

During the week of June 23, 2008, the entomologists hosted Marcus Begay, Native American student participating in the George Washington Carver summer Internship program at Iowa State University and his mentor, Ben Hermann. We gave Marcus ideas for developing lesson plans on pollinators/pollination for upper elementary school children as well as introducing him to all the NCRPIS insect pollination protocols.

S. Hanlin participated in "Honeyfest 2008" at the Indian Creek Nature Center in Cedar Rapids on September 21. Steve promoted use of native pollinators "in your backyard" by exhibiting some of the non-*apis* pollinators used at NCRPIS.

Publications:
Seed-set evaluation of four male-sterile, female-fertile soybean lines using alfalfa leafcutting bees and honey bees as pollinators. E. Ortiz-Perez, R.M.A. Mian, R.L. Cooper, T. Mendiola, J. Tew, H.T. Horner, S.J. Hanlin & R.G. Palmer. Journal of Agricultural Science 146:461-469.

In April 2008, we reviewed the pollinator section of NCRPIS Operations Manual and submitted appropriate updates.

Entomology building improvements:
This summer a new outlet was installed in Equipment room so that freeze dryer operation could resume. In the fall, a new air conditioning system was installed in the same room; this provides more stable ambient air conditions for proper operation of the Thermal Gradient Table, as well as the growth chambers and freezers.

Plans for 2009:
<u>Fondant feeding study for honey bees</u>:
In 2007, visiting scientists recommended to Hanlin that he feed honey bees fondant (a solid or powdered confectioner's sugar). It was felt this could potentially save labor costs over the current practice of feeding high fructose corn syrup which is distributed to nucs in cages on a weekly basis. Use of this syrup entails large storage tanks and continuous washing of equipment. A small study was done with two forms of fondant in summer 2007; it appeared that solid fondant could be supplied to bees every-other-week, saving time. In addition, solid fondant requires less storage space; minimal equipment is needed to cut and distribute feed cubes.

A concern about use of fondant feed is that honey bees can not store this form of food for overwintering, thus we cannot entirely do away with feeding corn syrup. Use of fondant during a portion of the summer season is feasible. We must also ensure that alternate bee feed will still maintain healthy high quality nucs; use of honeybee nucs in small confined cage spaces is already stressful to the health of the bees.

A two-part study is planned for 2009 to compare resulting bee health from the two feed regimens. In both components of the study, half the bees will be fed syrup and half solid fondant. Part one of the study will utilize 12 nucs left in an open area of the station; four nucs will be started each month of May, June, and July. The nucs will be checked weekly to assess bee health, adult populations, brood, and honey stores. Part two of the study will use 10 cages from each of three plant genera (*Cucumis, Daucus,* and *Helianthus*). Cages will be set up in "pairs" to compare fondant vs. syrup fed nucs; these nucs will receive a quick weekly assessment of bee health at the time food is introduced (good health is considered to be a large number of bees appearing at the open feeding hole) with a thorough health check pre- and post- placement, as described for part one of the study.

Enhancement of ALC bee pollination in *Cucumis*:
ALC bees are used for *Cucumis* pollination primarily in winter greenhouse cages as they are more reliably available than honey bees at that time. The curatorial staff thinks that honey bee droppings may contribute to *Cucumis* leaf diseases in the winter greenhouse. Honey bees are usually requested for the summer *Cucumis* field cages; sometimes ALC bees are added to field cages also, especially where honey bees appear to be less active.

The curatorial staff is challenged in maintaining accessions with unknown vining potential. The foliage of these accessions may quickly fill up the interior of the small (5' x 5' x 20') field cages, making it more difficult for insect pollinators to reach the flowers. While trellising with wires and fence posts within the cages helps expose the flowers to pollinators, this creates additional labor and equipment needs which we prefer to avoid.

In summer 2008, curators indicated they found more fruit formed in non-trellised, foliage-filled cages where ALC served as primary pollinators in the vicinity of the ALC domicile. They wondered if placing multiple ALC domiciles in a cage would encourage greater fruit formation. Since we have observed that the ALC do tend to spend time resting on and returning to their domiciles frequently during the day, this seems reasonable. ALC bees live and work an unpredictable length of time on the variable germplasm maintained at our station. It is standard practice to check all "active ALC cages" on a weekly basis and re-supply cages only where bee populations are reduced. The Vegetable curatorial staff was concerned about the small number of fruit produced in one accession of *Cucumis dipsaceus* where ALC was the primary pollinator; entomologists had only introduced ALC twice during the summer due to the apparently adequate bee populations. Curatorial staff wonder if older ALC may be less efficient in pollinating and if more frequent introductions of younger bees would result in greater fruit production in this accession.

2009 Plans: Where ALC are requested for C*ucumis* cages with copious quantities of foliage, multiple ALC domiciles will be added to the cage to see if fruit production is enhanced. We will also compare the effect of weekly versus normally scheduled ALC distributions for the accession of *Cucumis dipsaceus* that had poor fruit increase in 2008.

Seed pest investigations:
There are two seed pests of current concern to NCRPIS staff members, Angoumois grain moth which infests maize nursery accessions, and the sunflower seed weevil that infests perennial sunflower plots.

Angoumois grain moth: This moth infests corn in the field prior to harvest, and can proliferate in stored grain. Although the tropical nursery plots are chemically treated for this pest, treatment application is not always effective and infested ears may be sent to Ames. This becomes a greater problem as the moths emerging from infested ears can re-infest other corn in the seed processing area. The emerging moths can impact other personnel (e.g. seed storage, pathology) working with samples of the seed, an additional effort is required to prevent the distribution of infested seed to cooperators or seed requestors.

Additional chemical treatment (e.g. Vapona) could be applied to seed after received in Ames, but this would pose hazards for staff in handling and processing the seed for storage that must be considered. Sanitation in warm work areas is essential to help control re-infestation; personnel are aware of protocols to follow to aid in this effort. They have instituted use of pheromone sticky traps to capture moths; corn should be kept in cool storage areas when it is not actually being worked with.

We will cooperate with D. Kovach to evaluate low hazard, non-chemical treatments (e.g. use of carbon dioxide and nitrogen gas) of potentially infested maize to kill the larvae in the infested seed.

Red and gray sunflower seed weevils: These insects overwinter in the soil and infest sunflower field plantings throughout the summer in Ames. This problem is most severe in the perennial plantings of *Helianthus tuberosus* and *H. strumoses*, and can result in seed losses of up to 75%. Some infestation of cultivated plots occurs also. A single weevil larva is likely to destroy multiple seeds on a wild-type head as it matures, while in cultivated-type sunflowers it may complete growth within a single achene. If weevil larvae do not exit the seed they are feeding in prior to harvest/processing, it increases the difficulty of to sorting infested seed from good seed with seed-cleaning machines.

Normal control of this pest in cultivated sunflowers is achieved with chemical application to infested plots and crop rotation. It is difficult to employ these control techniques in permanent perennial sunflower plantings that also need to be caged for controlled insect pollination. Although some chemical spray treatments have been utilized in the past few years, more effective control methods are needed. We plans to explore alternate chemical application strategies for field plots (e.g. soil treatment, spraying more frequently or on weekly schedule, use of more effective chemical treatments), and also non-chemical treatments for potentially infested harvested seed with the cooperation of D. Kovach.

B. Plant Pathology (C. Block, B. Van Roekel)

Research Notes:

Maize:

We continued a collaborative research project with scientists at the ISU Seed Science Center to develop a TaqMan real-time PCR assay for detection of *Stenocarpella* (*Diplodia*) *maydis* from maize seed. Forty-two *S. maydis* isolates were obtained from 10 U.S. states. The identity of each isolate was confirmed by morphology, conventional PCR, and by DNA sequencing. DNA sequences were obtained for the internal transcribed spacer region (ITS) between the nuclear ribosomal 16S and 28S rDNA regions. The U.S. strains formed a very closely-related group with almost identical DNA sequences. The TaqMan real-time PCR was highly specific and sensitive and able to detect and quantify *S. maydis* infection.

Sunflower:

C. Block and B. Van Roekel continued evaluations for resistance to Sclerotinia stalk rot in wild sunflowers, with co-investigators Dr. T.J. Gulya at Fargo, ND and Dr. L.F. Marek (NCRPIS) at Ames. Greenhouse screening allows for rapid screening of much larger plant populations than could be managed in field trials. In 2008, 255 accessions were evaluated, including all available accessions from the diploid annual species of *H. argophyllus*, *H. debilis*, *H. exilis*, *H. neglectus*, and *H. praecox*, 45 accessions of wild *H. annuus* and five accessions of the perennial species *H. resinosus*. Accessions with superior wilt resistance were identified in all species except for *H. exilis*. Field trials showed that the three most resistant accessions were *H. resinosus* (PI 650079 and PI 650082) and *H. argophyllus*, (PI 649863) with 100% and 94% survival respectively.

Cucurbits:

C. Block, in collaboration with L.M. Shepherd of the ISU Seed Science Center, published research findings on long-term survival and seed transmission of *Acidovorax avenae* subsp. *citrulli*, the causal agent of bacterial fruit blotch (full citation under Publications). The pathogen was recovered via seed transmission from melon and watermelon seedlings, the oldest seed lot being 40 years. This is the longest reported survival time and seed transmission for any bacterial plant pathogen from seed. The findings suggest that *A. avenae* subsp. *citrulli* is highly resistant to aging and may survive as long as the seed is viable.

Disease observations on seed increase crops:

Field observations for plant diseases were made in the seed increase plots of maize, cucurbits, sunflower, Brassica, and carrots. The pathology team inspected plots or cages of approximately 600 accessions and conducted ~1,200 plant and seed health lab tests. This work directly contributes to the Station's ability to verify that germplasm meets phytosanitary requirements for international seed shipments.

Maize:

The maize seed increase plots (410 entries) were surveyed during August for the presence of all bacterial and fungal diseases, with particular emphasis on notes for Stewart's wilt, Goss's wilt, common rust, common smut, gray leaf spot, and northern

leaf blight. Stewart's wilt, which is usually the main disease of phytosanitary concern, was absent, as were Goss's wilt and crazy top. Gray leaf spot and northern leaf blight were present at low levels. Common rust was variable in severity and mainly dependent on susceptibility of the genotype. Lab tests were run on 476 maize seed lots for various pathogens, the dominant test being Stewart's wilt with 332 seed lots.

Cucumber species (*Cucumis sativus* and *Cucumis* spp.):
The bacterial fruit blotch (BFB) management plan entered its fourth year of successful implementation. The objective is to prevent seed transmission and spread of *Acidovorax avenae* subsp. *citrulli* in cucurbit plants by the use of vertical plastic walls between accessions, bottom watering, and frequent plant inspections. This is especially important for regenerations done from old melon seed lots (pre-1987), some of which are infected. No BFB was detected in the greenhouse or in the field. Accessions were monitored regularly between transplanting and harvest. Powdery mildew was the only disease problem in the field, necessitating two fungicide sprays for control.

Cucurbit virus-testing:
All cucurbit transplants in the greenhouse were tested by laboratory ELISA for seed-borne squash mosaic virus to prevent virus introduction into the field planting. No seed transmission was found in any of the *Cucumis* or *Cucurbita pepo* (squash, pumpkin) accessions in 2008 (Table 1).

Table 1: Squash mosaic virus testing results for 2008.

Species	Accessions tested	Accessions with infected plants	Plants tested	# of SqMV infected plants
Cuc. sativus	31	0	901	0
Cucumis spp.	26	0	831	0
Cucurb. pepo	20	0	687	0
Total	**77**	**0**	**2419**	**0**

Sunflower:
The main disease of phytosanitary interest in sunflower is downy mildew, caused by *Plasmopara halstedii*. Two field inspections were conducted prior to flowering, examining all plants in each plot for symptoms of downy mildew, viruses, or aster yellows. None of these diseases were observed in the field in 2008.

Brassica and related *Brassicaceae* genera:
Seventy seed increase plots were surveyed for all diseases in late June. Diseases of interest included black rot (*Xanthomonas campestris* pv. *campestris*), blackleg (*Leptosphaeria maculans, Phoma lingam*), powdery mildew (*Erysiphe cruciferarum*), Alternaria diseases (*Alternaria* spp.), downy mildew (*Peronospora parasitica*) and white rust (*Albugo*). The two diseases present in 2008 were powdery mildew (20 accessions) and black rot (8 accessions).

Publications:
Block, C.C. and Shepherd, L.M. 2008. Long-term survival and seed transmission of *Acidovorax avenae* subsp. *citrulli* in melon and watermelon seed. Online. Plant Health Progress doi:10.1094/PHP-2008-1219-01-BR.

Marek, L.F., Block, C.C. and Gardner, C.A. 2008. The USDA sunflower collection at the North Central Regional Plant Introduction Station, Ames, IA, USA. Proceedings 17th International Sunflower Conference, June 8-12, 2008, Cordoba, Spain, p 735-740.

Training:
First Aid/ CPR certification (Block).
Annual medical review for Occupational Health Monitoring Program (Block, van Roekel).
Tractor safety training (Block, van Roekel).
Pesticide respirator certification (Block, van Roekel).
Pesticide applicator license renewed (Block, van Roekel).
Fire Safety training (Block, van Roekel).

C. *Amaranthus, Celosia, Chenopodium, Coronilla, Dalea, Echinochloa, Galega, Marina, Melilotus, Panicum, Perilla, Setaria, Spinacia* and miscellaneous Umbelliferae and Poaceae (D. Brenner and S. Flomo)

Acquisition and inactivation (Table 1):
One-hundred-three accessions were acquired. Of these, six help address collection gaps and acquisition priorities in *Amaranthus, Gomphrena*, and *Monolepis*. David Brenner collected 10 new accessions from wild plant populations.

David Brenner developed two plant exploration proposals that were funded by the National Plant Germplasm System through the Plant Exchange office, National Germplasm Resources Laboratory, USDA-ARS, Beltsville, Maryland. The Plant Exploration in Western Nebraska for Wild Relatives of Spinach was postponed until 2009 due to high water in the collecting area. The Plant Exploration in Texas for Wild Relatives of Pseudocereals and Bedding Plants was successful for most of the target germplasm; *Chenopodium berlandieri* subsp. *berlandieri* var. *berlandieri* was not collected after an unsuccessful search.

Thirteen *Amaranthus* accessions were acquired; seven (Ames 29380 - 29386) were donated by ECHO (Educational Concerns for Hunger Organization) so that I could determine the taxonomic identities of grain production lines that are popular in Kenya. Two accessions (Ames 29504 and Ames 29505) were donated by Embrapa-Cenargen of Brazil, a notable exchange. Two accessions (Ames 29685 and Ames 29686) were collected in Texas by David Brenner on a NPGS-sponsored plant exploration, including our first accession of *Amaranthus polygonoides*. Dr. Patrick Tranel of the University of Illinois donated two lines (PI 654436 and PI 654437) of weedy amaranths with well documented herbicide resistance.

Sixty-four *Chenopodium* accessions were acquired. One of them (Ames 29674) was donated by Jimmie Dean Thompson of Ames, Iowa to fill a gap in our collection for *Chenopodium standleyanum*. Sixty-three accessions (Ames 29755 to Ames 29817) were collected in 2008 by Rick Jellen of Brigham Young University, on an NPGS sponsored plant exploration to add taxonomic and bio-geographic diversity from the Intermountain SW United States.

Eleven *Melilotus* accessions (Ames 29452 to Ames 29453) were donated by Dr. Douglas A. Johnson from a 2007 plant exploration in Russia.

Dr. Ken Vogel transferred 350 *Melilotus* seed lots to us from University of Nebraska storage. They are part of a working collection assembled by Dr. Herman Gorz. Many of the seed lots duplicate material already in the collection, some are breeding lines. Following evaluation, useful seed lots will be incorporated in the collection.

Four accessions of *Monolepis nuttalliana* (Ames 29618 to Ames 29621) were donated by Grace Kostel of Black Hills State University. These accessions are of great interest as wild species genetic resources related to spinach.

Three *Setaria* accessions (Ames 29675 - 29677) were donated by the Kika de la Garza Plant Materials Center of the NRCS. They are native Texas species for use in rangeland planting. David Brenner collected a *Setaria pumila* (Ames 29692), a species that is under-collected and under-represented in the U.S collection.

Seven miscellaneous accessions were acquired. A wild *Altenanthera* (Ames 29375) was donated by Ryan Goss of New Mexico State University and a *Tridens flavus* (Ames 29377) was donated by the Jimmy Carter Plant Materials Center in Georgia. David Brenner collected A *Blutaparon vermiculare* (Ames 29687), two *Echinochloa* (Ames 29688 and Ames 29689), a *Gomphrena nealleyi* (Ames 29690), and a *Perilla* (Ames 29691). The *Gomphrena* is especially important since it is our first representative of its species, in a commercially important ornamental genus. *Blutaparon* is closely related to *Gomphrena*.

Two accessions of *Portulaca* (OPGC 2874 and OPGC 2875) that are also new species for the NPGS were collected by David Brenner in Texas and donated to the Ornamental Plant Germplasm Center in Columbus, OH.

Maintenance and distribution (Tables 2, 3A, and 3B):
Three-hundred-eighty-one accessions were planted in 2008. Of these, 156 plantings were for regeneration, and 225 were for observations. Most of the observation plantings were grown in single plastic flats in a greenhouse to confirm taxonomy and for other trait observations.

Germplasm distributions of my crops increased in 2008 (Table 5). The legumes, *Melilotus*, quinoa and *Setaria* all reached five-year highs for number of orders. In the cases of *Melilotus* and quinoa, growing research interest is resulting in more germplasm use.

The new Svalbard Global Crop Seed Vault on Svalbard Island opened in February 2008 and 221 accessions from 18 genera of these crops were deposited. Additional accessions (1,022) of these crops were shipped in 2008 for deposit in 2009.

The number of accessions tested for germination, 164, is down from 338 in 2008. The numbers fluctuate depending on station priorities, the age of the inventory lots, and normal variations in scheduling. To better compensate for the backlog in germination testing we are going to longer (10 year) testing intervals for most of these crops, but keeping to five-year testing intervals for *Chenopodium*, *Perilla*, and the Umbelliferae.

David Kovach developed a new protocol for geminating *Angelica* seed which was effective for two of five original seed lots in a seed regeneration effort. Mr. Kovach plans to test the new protocol in a controlled trial with a large regenerated seed lot.

Amaranthus and *Chenopodium*:
We have 98 seed lots that are harvested and await processing and/or storage.

Echinochloa, *Panicum*, *Setaria*, miscellaneous Poaceae:
We have 68 seed lots that are harvested and await processing and/or storage.

Melilotus and other legumes:
The 2008 *Melilotus* plants were transplanted into field S-9 before heavy rains fell which repeatedly left some accessions in standing water. One *Melilotus albus* accession (Ames 23790) yielded an adequate seed crop even though it was in standing water for weeks and had to be pollinated by *Osmia* bees since there was no dry place to put a honey bee hive. The *Osmia* bees were useful as their domiciles hung above the water within the pollination cage.

Spinacia:
In 2008, seeds of 70 accessions were sent to Salinas, CA for regeneration by a cooperative effort of the USDA-ARS and Sakata Seed America, Inc.

Miscellaneous Umbelliferae:
Most of the backlog of harvested seeds was cleaned, and 100 accessions were stored.

In 2008 seeds of 25 accessions of parsley were sent to the National Arid Land Plant Genetic Resource Unit at Parlier, CA for regeneration.

Five accessions of parsley were planted on March 28, 2008 in Ames, and grown in field S-9. They were dug and removed from the field on November 3, 2008 and brought into GH-2 in large pots. Brian Buzzell operated the Egedal Side Digger mounted on a 6430 John Deere tractor to dig up the plants. The Digger was very helpful and efficient. The intention is to transplant the plants into the field for seed production in 2009.

Characterization/taxonomy/evaluation (Table 4):
There were two major observation data-loading efforts: *Coriandrum* and *Melilotus*. The last observations on *Coriandrum* were loaded from the dissertation research of Pedro Antonio López to the GRIN database. There was also substantial progress on loading *Melilotus* observations to GRIN, with 3,400 observations loaded in 2008.

The Vegetative Structure (VEGSTRUCT) descriptor was approved for the MILLET-FOXTAIL research crop by the Grass CGC.

In 2008 David Brenner made 42 taxonomic changes for accessions of these crops. Changes were made in 12 different genera, but mostly in *Amaranthus* and *Chenopodium* to reflect current taxonomic standards.

Enhancement and/or utilization:
<u>*Amaranthus*</u>:
I am conducting research in cooperation with Mike Owen of ISU and eleven cooperators in other states. The goal is to evaluate weedy hybridization rates of PI 538327 (D136-1), a low outcrossing line, in comparison with the higher outcrossing PI 558499 ('Plainsman'). In 2007 the cooperators grew plants from our seeds and returned harvested seed for evaluation of natural outcrossing rates with local weed amaranths. This evaluation was postponed in order to make crosses in 2008 with herbicide resistant weed accessions (PI 654436 and PI 654437); progeny will be assayed for the herbicide resistance trait in 2009 in order reliably demonstrate the frequency and parentage of hybrid plants.

The *Amaranthus tricolor* enhancement breeding continued with efforts to combine disease resistance and ornamental coloring. So far the most attractive ornamental breeding lines are not uniform, and have excessive seed dormancy.

Publications and presentations:
David Brenner and Kenneth J. Moore. 2008. Winter Sweetclover to Improve Sustainable Switchgrass Biomass Production. *In* 2008 Agronomy Abstracts. ASA, Madison, WI. Poster presentation at the American Society of Agronomy meeting October 2008 Houston, TX

Revised www posting:
David M. Brenner. 2008. Perilla. (An online document updated in 2008.)
http://www.hort.purdue.edu/newcrop/CropFactSheets/perilla.pdf

Grant Proposals funded by the National Plant Germplasm System through the Plant Exchange office, National Germplasm Resources Laboratory, USDA-ARS, Beltsville, Maryland:
David M. Brenner 2008. Plant Exploration in Texas for Wild Relatives of Pseudocereals and Bedding Plants

David M. Brenner 2008. Plant Exploration in Western Nebraska for Wild Relatives of Spinach

Conferences attended and Presentations:
September 7 to 11, 2008. The Association for the Advancement of Industrial Crops, College Station, Texas. (http://www.aaic.org/).

October 5 to 9, 2008. American Society of Agronomy, Houston, Texas (https://www.acsmeetings.org/).

David M. Brenner 2008. Status of the Amaranthus Seed Collection. Amaranth Institute meeting. October 22-24. Montgomery, TX.

Written Progress Reports were prepared for the Crop Germplasm Committees: Clover and Special Purpose Legumes, Forage and Turf Grass, Leafy Vegetable, and New Crops.

Plans for 2009:
Collaboration:
Dr. Dipak Santra, is the new Alternative Crop Breeding Specialist at the UNL Panhandle Research and Extension Center in Scottsbluff, Nebraska. He began there in November 2008. I plan to work closely with Dr. Santra, in support of his work with the millet collection. People in his position have been important collaborators with the NCRPIS since at least 1968, a tradition to build upon.

Evaluation:
Melilotus evaluation is one of the station's 5-year project plan milestone priorities. The *Melilotus* poster (cited above) was part of the preparation and networking for this effort. There is new research interest in winter crops, which could include *Melilotus*. Our task is to design and conduct evaluations, the information from which can be used to guide decisions on use of *Melilotus* as a winter cover crop. We plan to make experimental fall plantings on about September 15, 2009 and evaluate the results.

We are cooperating with the *Amaranthus* cell-wall research of Dr. Olga Zabotina (Iowa State Univ.). She is investigating *Amaranthus* as a bio-fuel crop.

Maintenance:
Our first accessions of *Monolepis nuttalliana* need to be regenerated, which is my highest priority. We will also have small plantings of many other genera and need to process the backlog of seed lots that have already been harvested.

Acquisition:
Specific acquisition objectives for 2009 include collection of *Suckleya suckleyana* from western Nebraska and *Chenopodium pallescens* from Missouri.

I plan to prepare a proposal for a 2010 plant exploration near the border with Mexico. The targets there will include *Amaranthus*, and *Gomphrena*.

Acknowledgments:
Grace Kostel of Black Hills State University collected *Monolepis* germplasm for us.

Rachel Beyer entered passport data into GRIN from printed PI books especially for the genus *Echinochloa*.

Larry Lockhart arraigned for the special manufacture of new nylon-mesh harvest bags. These bags are effective, appropriate for us, and a pleasure to work with.

Some research publications derived directly from use of our germplasm and associated information:

Gélinas, Bruce and Philippe Seguin. 2008. Evaluation of management practices for grain amaranth production in Eastern Canada. Agron. J. 100:344–351.

Gélinas, Bruce and Philippe Seguin. 2008. Development and yield potential of grain amaranth in Southwestern Québec. Canadian Journal of Plant Science 88:133–136.

Heyduck, R.F., D. D. Baltensperger, L. A. Nelson, and R. A. Graybosch. 2008. Yield and agronomic traits of waxy proso in the Central Great Plains. Crop Sci. 48:741–748.

Kong, Xiangli, Jinsong Bao, and Harold Corke. 2008. Physical properties of *Amaranthus* starch. Food Chemistry 113:371-376.

López, P.A., M.P. Widrlechner, P.W. Simon, S. Rai, T.D. Boylston, T.A. Isbell, T.B. Bailey, C.A. Gardner, and L. Wilson. 2007. Assessing phenotypic, biochemical, and molecular diversity in coriander (*Coriandrum sativum* L.) germplasm. Genetic Resources and Crop Evolution. 55:247-275.

Mallory, Melanie A, Rozaura V. Hall, Andrea R. McNabb, Donald B. Pratt, Eric N. Jellen, and Peter J. Maughan. 2008. Development and characterization of microsatellite markers for the grain amaranths. Crop Sci. 48:1098–1106

Maughan, Peter J., Nicholas Sisneros, Meizhong Luo, Dave Kudrna, Jetty S. S. Ammiraju, and Rod A. Wing. 2008. Construction of an *Amaranthus hypochondriacus* bacterial artificial chromosome library and genomic sequencing of herbicide target genes. Crop Sci. 48(suppl1)S85–S94.

Mou, Beiquan. 2008. Evaluation of oxalate concentration in the U.S. spinach germplasm collection Hortscience 43:1690–1693.

Mou, Beiquan, Steven T. Koike, Lindsey J. du Toit. 2008. Screening for resistance to leaf spot diseases of spinach. Hortscience 43:1706–1710

Mou, Beiquan. 2008. Leafminer resistance in spinach Hortscience 43:1716–1719.

Zabotina, Olga, 2008. Cell wall science for biofuels. *In* Iowa State University, Plant Science Institute, 2008 Annual Report. p. 6-7.

Research indirectly related to our germplasm:
Butola, Jitendra S., and Hemant K. Badola. 2004. Effect of pre-sowing treatment on seed germination and seedling vigour in *Angelica glauca*, a threatened medicinal herb. Current Science 87:796-799

Dansi, A., A. Adjatin, H. Adoukonou-Sagbadja, V. Falade´, H. Yedomonhan, D. Odou, B. Dossou. 2008. Traditional leafy vegetables and their use in the Benin Republic Genet Resour Crop Evol. 55:1239–1256

Nachay, Karen. 2008. Amaranth popper can help fight hunger. Food technology 62:14-15

Neffati, M. and B. Marzouk. 2008. Changes in essential oil and fatty acid composition in coriander (*Coriandrum sativum* L.) leaves under saline conditions. Industrial Crops and Products 28:137-142.

Pandey, Anjula, K. C. Bhatt. 2008. Diversity distribution and collection of genetic resources of cultivated and weedy type in *Perilla frutescens* (L.) Britton var. *frutescens* and their uses in Indian Himalaya. Genet Resour Crop Evol 55:883–892

Park, Yong-Jin, Anupam Dixit, Kyung-Ho Ma, Ju-Kyung Lee, Myoung-Hee Lee, Chan-Sik Chung, Miyuki Nitta, Kazutoshi Okuno, Tae-San Kim, Eun-Gi Cho, V. Ramanatha Rao. 2008. Evaluation of genetic diversity and relationships within an on-farm collection of *Perilla frutescens* (L.) Britt. using microsatellite markers. Genet Resour Crop Evol. 55:523–535

Silva-Sánchez, C., A. P. Barba de la Rosa, M. F. León-Galván, B. O. de Lumen, A. De León-Rodríguez, and E. González de Mejía. 2008. Bioactive peptides in amaranth (*Amaranthus hypochondriacus*) seed. J. Agric. Food Chem. 56:1233–1240.

Zheliazkov, V.J., K.M. Bowes, C.D. Caldwell, J.A. Pincock, J.C. Roberts and L. Mapplebeck. 2008 Cultivar and sowing date effects on seed yield and oil composition of coriander in Atlantic Canada. Industrial Crops and Products 28:88-94.

D. Horticulture (M. Widrlechner, J. Carstens)

Acquisition:
During 2008, we worked with Robert Stebbins to enter information for 154 new accessions of ornamentals and mint-family plants into the GRIN database (Table 1). Many of these new acquisitions resulted from collections of *Fraxinus*, most from Iowa, Missouri, Illinois and China. Other important collections included samples of wild populations of *Aronia* (all but one collected and donated by Mark Brand, Univ. of Connecticut) and *Cornus*.

Plans for the acquisition of *Fraxinus* germplasm from both North America and northeastern Asia moved forward with some urgency in the face of the destruction of native ash populations by the introduction and spread of Emerald Ash Borer. As part of the process to assemble representative *Fraxinus* collections, the USDA-ARS

Plant Exchange Office supported reconnaissance and collection trips to Missouri and southern Illinois in 2008 and a collection trip involving Beijing Botanic Garden, the Morton Arboretum, Morris Arboretum, and National Arboretum to Shaanxi Province, China. At the end of 2008, Mark Widrlechner organized a meeting for January 2009 to bring together the National Plant Germplasm System, the US Forest Service, the Natural Resources Conservation Service, the Bureau of Land Management, public gardens, and state agencies with the purpose of developing a coordinated, national collection strategy.

Maintenance:
Maintenance efforts shifted in 2008 towards vegetative re-propagation and preparations for a major cage effort in 2009. We're entering the third year for two cage fields for woody shrubs, one currently including 42 accessions, focusing on *Cornus*, *Rhus*, *Ligustrum*, *Staphylea*, *Aronia*, and *Physocarpus*, and the other using larger, hoop-house cages for *Cornus alternifolia* and *Rhus typhina.* Jeff Carstens initiated experiments to test the effects of paclobutrozol in reducing the height and hastening the flowering of *R. typhina.* If growing conditions are favorable, this should result in 2009 being one of our most productive years for the caged seed regeneration of shrub genera.

In 2008, Jeff began using a single-row cultivator from the maize project to cultivate young trees and shrubs in our nursery beds. The horticulture crew continues to work on mulching long-term field plantings in order to increase plant growth and reduce labor and time requirements associated with mowing and weeding.

Availability:
During 2008, approximately 45% of the ornamental collections and 72% of the mint-family plants were available for distribution (Table 1), figures slightly above those reported in 2007 (45 and 70%).

Back-up:
Approximately 38% of the ornamental collections and 73% of the mint-family plants are duplicated at NCGRP (Table 2), figures slightly above those reported in 2007 (37% and 71%). Routine back-ups of dormant *Salix* buds with the National Center for Genetic Resources Preservation in Fort Collins, CO are now underway.

Regeneration:
Regeneration efforts in 2008 focused more heavily on vegetative re-propagation and on arrangements for seed production in 2009 than on current seed increases. The harvests listed in Table 2 include 16 successful cage increases and 26 woody-ornamental seed increases. There were also 12 accessions of woody plants established from seeds and 60 accessions vegetatively re-propagated. Through these efforts and those from the previous year, 103 accessions were made available for distribution in 2008.

Viability Testing:
In 2008, lots of 218 accessions were tested for germination (Table 2). This included the completion of tests initiated late in 2007, periodic re-tests for stored distribution

lots, and new tests on bulked samples. We also conducted cut-tests of more than 300 lots of newly harvested *Fraxinus* seeds to assess initial quality.

Distribution:
As summarized below (and in Table 3), requests for accessions of ornamental germplasm increased in 2008, with five-year highs in the number of shipments and the number of different requestors. The 352 "order items" included all the distributions for the NC7 Trials (described in the following section), along with 10 plants, 358 cuttings, 1320 buds of *Fraxinus* for cryogenic-storage experiments plus 20 other budwood sticks, 31 samples for DNA extraction, and 219 seed packets, distributed to fulfill external requests for ornamental plant germplasm. This group encompassed 50 genera; those most in demand were *Salix* (146 cuttings), *Calendula* (76 packets), and *Fraxinus* (22 packets, 21 samples for DNA extraction and 1320 buds).

Demand for mint-family germplasm also increased in 2008, with five-year highs in both the number of packets distributed and the number of accessions requested.

Historical Summary of External Distribution Activity:
Note: In the summer of 2004, about 240 accessions of *Echinacea* and *Hypericum* were transferred to the Medicinal Project for curation. In addition, since 2002, more than 500 accessions of herbaceous ornamental germplasm representing 23 genera once part of this project were transferred to the Ornamental Plant Germplasm Center (OPGC) in Columbus, OH for maintenance. Statistics presented in the summary tables at the end of this Annual Report exclude activity in the transferred accessions. However, for comparative purposes, statistics reported in the historical distribution table (below) do include activity related to the transferred accessions conducted prior to their transfer.

Crop	Year	No. of Orders	No. of Recipients	No. of Items Distributed	No. of Accessions Distributed
Ornamentals	04	87	81	361	297
	05	58	53	241	187
	06	89	76	436	322
	07	75	71	268	196
	08	**92**	**83**	352	249
Mint Family	04	17	16	45	37
	05	17	16	59	38
	06	19	19	55	37
	07	10	10	54	47
	08	14	14	**88**	**64**

Characterization/taxonomy:
All the herbaceous ornamentals in the cage fields and many of the tree and shrub accessions being regenerated were checked to verify identifications, and past records were checked as part of the PI-numbering decision process. In all, 5 ornamental accessions were re-identified. During 2008, Lisa Pfiffner captured seed images of 178 ornamental and mint-family accessions for our local database (Table 4). These are named following our standard protocol. In 2008, 256 images were loaded to GRIN, by using the mass-loading system for images developed by Pete Cyr.

Evaluation:
Evaluations are ongoing for two ornamental shrub genera curated in our project: *Aronia* and *Spiraea*. Dr. Mark Brand (Univ. of CT) is determining ploidy levels and measuring landscape characteristics of *Aronia* as part of a CGC-endorsed project. Dr. Mike Mickelbart's laboratory at Purdue Univ. is conducting an evaluation of light and water requirements and adaptation of *Spiraea alba* and *tomentosa*.

Descriptors and floral images captured during the 2006 field evaluation of 76 accessions of *Calendula* were loaded to GRIN early in 2008.

Enhancement:
There was no major progress to report with enhancement activities in 2008. One small, long-term project to conduct recurrent selection on *Fraxinus ornus* (flowering ash) for improved winter survival advanced to the next cycle when seedlings from trees selected in Urbana, IL were transplanted to the field at the NCRPIS farm.

Coordination of the NC-7 Regional Ornamental Trials:
Plant Distribution:
In 2008, Mark Widrlechner and Jeff Carstens distributed 234 plants of five accessions to 19 sites for long-term evaluation, with an additional 76 plants of these accessions provided to 8 public gardens. This year, all accessions were shipped dormant and bare-root. In April, Mark and Jeff took a productive trip to meet trial site cooperators in Iowa, Illinois, Michigan, and Indiana. During that visit, hands-on training was given to cooperators on how to use the computer-generated, web-based planting reports.

Web-based planting reports and one- and five-year performance report forms developed by Pete Cyr and Jeff Carstens were fully implemented in 2008. These electronic forms drastically reduce the amount of time spent via cooperators and the NCRPIS technician entering data. Only the ten-year reporting forms remain to be converted to the web-based format. In 2008, these were distributed as paper forms.

A brief paragraph with an overview of the NC-7 Regional Ornamental Trials Program has been added to GRIN records for the five accessions distributed in 2008. In addition, links directing Public GRIN users to the NC7 trials webpage have been updated for those accessions.

Germplasm activities in crops other than those curated:
Since 2002, Iowa State University and the University of Iowa have been awarded two grants from the National Institutes of Health (NIH) to establish and support a

Center for Research on Botanical Dietary Supplements, which studies health-related effects of *Echinacea, Hypericum*, and *Prunella*. Mark Widrlechner continues his involvement with the Center by overseeing a subcontract to ARS, which supports the curation and distribution of the Station's *Echinacea, Hypericum,* and *Prunella* germplasm collections so they can be evaluated for chemical composition, genetic diversity, and bioactivity. Details about his involvement and research publications resulting from these efforts are elaborated in the Medicinal Plant section of this Annual Report.

During 2008, Mark Widrlechner was involved with a number of other collaborative germplasm activities including:

1. the publication of an article for the nursery professionals involving multiple NPGS sites that describes NPGS germplasm collections and how they can contribute to (and be used by) the industry;
2. the publication of an article for Systematic Botany, which describes a new species of *Cucumis* from Zambia, involving collaborations with Kathy Reitsma and Cindy Clark (NCRPIS), Amanuel Ghebretinsae (St. Louis Univ.) and Joseph Kirkbride (USDA-ARS, Washington, DC);
3. service on a team led by Carolyn Lawrence and Candice Gardner (USDA-ARS, Ames, IA) to coordinate summer internships related to plant germplasm and genetics for Native American students, which led to a short publication in Maize Genetics Cooperation Newsletter;
4. service with David Kovach (NCRPIS), Dr. Philip Dixon and Allan Trapp, II (ISU) on a project being conducted as part of Allan's M.S. thesis to predict maize seed longevity from long-term viability test results; and
5. collaboration with Kathy Reitsma on taxonomic verification of *Daucus* germplasm, as part of a larger project involving Drs. Philipp Simon and David Spooner (USDA-ARS, Madison, WI), which should ultimately result in the development of a monograph for the genus.

Research products:
A new book on the trees and shrubs of Minnesota authored by Welby Smith includes a key and descriptions of species of *Rubus* (blackberries and raspberries) contributed by Mark Widrlechner. This reference includes an extensive collection of photos, range maps, and habitat information, which should be particularly useful to field botanists and naturalists.

Through the efforts of the Vegetable Project, accessions of a newly described species of *Cucumis*, *C. zambianus*, related to cultivated melons, are now known to science (see point 2 in preceding section) and available for research.

Mark Widrlechner's other research and training activities:
Collaboration continued with George Yatskievych of the Missouri Botanical Garden, which will ultimately result in the development of keys and descriptions for *Rubus* species for an updated "Flora of Missouri."

Collaborations also continued on the development of models to predict the risk of naturalization of non-native woody plants. During 2008, we tested a widely used,

risk-assessment model developed by Reichard and Hamilton and three models developed in Iowa on two data sets – one for the calcareous soil region in northeastern Illinois and the other for the sand and muck region in northwestern Indiana and southwestern Michigan. A manuscript presenting the results of these tests is nearing completion. It will soon be submitted to the Journal of Environmental Horticulture. While the Iowa models were sometimes able to increase classification rates or reduce error rates in comparison to Reichert & Hamilton, no clearly superior model has emerged from the validation process. This work is now being expanded to collect and test data sets from Minnesota and Missouri through ARS funding for a Specific Cooperative Agreement with Iowa State University, which is supporting Emily Kapler, an M.S. student, who will focus on regional risk-assessment models.

In 2008, Mark Widrlechner continued his service as chair of a national Technical Review Team that provides technical direction and oversight to an ARS project to update the USDA Plant Hardiness Zone Map by using the best available technologies and to make the next version of the map accessible via the Internet. As part of that service, he coordinated the review of draft maps for Hawaii, Puerto Rico and Alaska and assisted in the development of a pilot project being conducted at Oregon State University to develop an interactive, web-based map server to help answer questions about projected costs, speed, and accessibility. He serves as ADODR on a Specific Cooperative Agreement with Oregon State for that project.

Mark Widrlechner gave an invited presentation to the joint Eastern and Western Regional meeting of the International Plant Propagators' Society (IPPS) in Denver, CO in September, describing NPGS collections of ornamental plants, how they are pertinent to IPPS members, and how they can be obtained. He also prepared a database to link NPGS holdings to the references, "Toxic Plants of North America" and "Handbook of Poisonous and Injurious Plants," which he distributed to curators throughout the NPGS.

Other Horticultural project-training and staff-development activities:
In 2008, Mark Widrlechner and Jeff Carstens attended the Iowa Shade Tree Short Course.

Manuscript and Proposal Review:
Mark Widrlechner continued his service on the Editorial Review Boards of Genetic Resources and Crop Evolution, the Journal of the American Rhododendron Society, and the Journal of Environmental Horticulture. He served as a peer reviewer for manuscripts submitted to six other scientific journals, and as an internal reviewer for two papers prior to journal submission. He also reviewed NPGS Plant Exploration proposals.

Posters, Presentations and Seminars:
Widrlechner, Mark P. 2008. Prairie shrubs? Invited presentation to the winter meeting of the Iowa Prairie Network, Ankeny, IA, 26 Jan.

Widrlechner, Mark P. 2008. Risk-assessment models for non-native woody plants. Invited presentation to the 2008 Annual Meeting of the Iowa Weed Commissioners' Association, Ames, IA, 6 Mar.

Widrlechner, Mark P. 2008. Ornamental plants and the US National Plant Germplasm System: Conserving, evaluating, seeking and sharing. Invited presentation to the 2008 Annual Meeting of the Eastern and Western Regions of the International Plant Propagators' Society, Denver, CO, 16 Sep.

Publications (other than those involving the Medicinal Plant Collections) which appeared in print in 2008:
Lawrence, C.J., C.A.C. Gardner, M. Widrlechner, and V. Brendel. 2008. Maize genetics outreach to American Indians. Maize Genetics Cooperation Newsletter 82: 2.

López, Pedro A., Mark P. Widrlechner, Philipp W. Simon, Satish Rai, Terri D. Boylston, Terry A. Isbell, Theodore B. Bailey, Candice A. Gardner, and Lester A. Wilson. 2008. Assessing phenotypic, biochemical, and molecular diversity in coriander (*Coriandrum sativum* L.) germplasm. Genetic Resources and Crop Evolution 55: 247-275. doi: 10.1007/s10722-007-9232-7.

Robbins, James, Mark Widrlechner, Richard Olsen, Sandra Reed, Alan Meerow, Kim Hummer, Peter Bretting, Pam Allenstein and Mark Krautmann. 2008. Gene banks offer breeders access to germplasm: Germplasm collections help to preserve genetic diversity. Nursery Management and Production 24(5): 53-56, 58.

Widrlechner, Mark P., Joseph H. Kirkbride, Jr., Amanuel G. Ghebretinsae, and Kathleen R. Reitsma. 2008. *Cucumis zambianus* (Cucurbitaceae), a new species from northwestern Zambia. Systematic Botany 33: 732-738.

Widrlechner, Mark P., and Welby R. Smith. 2008. *Rubus*, blackberries and raspberries. Pages 440-511 In: Trees and Shrubs of Minnesota, by Welby R. Smith. University of Minnesota Press, Minneapolis, MN.

Departmental Activities:
Mark Widrlechner continued as an active member of the Plant Breeding and Genetics Advisory Panel of the Agronomy Department at Iowa State University. He also served on Agronomy Department's Greenhouse & Growth Chamber Committee and the faculty of the Horticulture Department. He continued to serve as a member of the POS Committee for a Ph.D. candidate in Natural Resources Ecology and Management and became a member of POS Committees for two M.S. candidates.

Conclusions and Plans for 2009:

Curation:

Curation efforts in 2008 focused on *Fraxinus* acquisition and seed processing, with samples from more than 300 mother trees processed by the end of the year. Given the serious threat caused by the continued expansion of Emerald Ash Borer in the North Central Region, we will continue to collaborate with Kevin Conrad (National Arboretum), Ned Garvey (Plant Exchange Office), Dave Ellis (NCGRP), Kris Bachtell (Morton Arboretum), and Bob Karrfalt (USDA Forest Service) to refine and execute plans to conserve North American ash (*Fraxinus*) germplasm (and acquire Chinese germplasm). We are also planning a collection trip to southern Wisconsin and northern Illinois and possibly another to northeastern Ohio for the fall of 2009. Collaboration with Dave Ellis is planned for 2009 to correlate the results of cut-tests and x-ray image analysis to determine embryo development and seed quality in *Fraxinus*.

Also related to the acquisition of tree germplasm, we have established a collaboration with Andy Schmitz at the Brenton Arboretum, Dallas Center, IA to assemble collections of *Gymnocladus* (Kentucky Coffee-tree), which can be accomplished during the late winter, with plans to obtain samples throughout the Midwest early in 2009.

Regenerations in 2009 will focus on producing control-pollinated seeds from the large number of shrub accessions now established in field cages.

An extensive collection of evaluation data was received from NC-7 trial-site cooperators in 2008. These evaluation data, along with a backlog of trial-site data since 1994, will be summarized and linked to GRIN through the descriptor list approved by the Woody Landscape Plant CGC.

An extensive collection of reports on the evaluation of NC7 Trial plants was published from the 1960s until about 1980. These reports are not widely available. During 2002, Kyle Cavanaugh scanned these reports and created .pdf files. These reports have been indexed and, in 2009, we plan to link them to accession records in GRIN.

With regard to IT advancements, we look forward to testing new features resulting from the ongoing development of GRIN-Global and also to the completion of a web-based system for the capture and management of all data from the NC-7 Regional Ornamental Trials.

Ames-numbered, ornamental and mint-family accessions that are currently available for distribution will be considered as candidates for the assignment of PI numbers in 2009, which involves passport-data proofing, identity verification, and duplication checks.

Research:
Considerable progress was made on a wide range of research projects during the past year as outlined above.

Research efforts for the coming year will focus on:

1. writing up and submitting for publication the results of the validation of risk-assessment models for the invasiveness of non-native woody plants in the Midwest with data collected from the Chicago region and the expansion of this project to develop broader, regional models;
2. coordinating technical advice and relaying appropriate research information from the PRISM group at Oregon State University as they complete a pilot project to determine how best to deliver the new USDA Plant Hardiness Zone Map and associated data to a wide range of audiences;
3. completing and submitting a study for publication that uses long-term germplasm viability records and distribution histories to estimate target quantities for seed regeneration; and
4. evaluating recently developed algorithms to identify appropriate intervals for stored maize samples that balance the resources used to conduct these tests with the need to identify samples that are declining in viability.

Staff Development:
Plans for staff development for 2009 will focus on training experiences for Jeff Carstens, which are likely to include attendance at the Iowa Shade Tree Short Course, coursework to improve his ArcGIS skills, and safety training.

E. Maize Curation (M. Millard, M. Lively, T. Moore)

Equipment:
The maize curation project and the GEM Project began using a new ALMACO 4-row cone planter. This new planter featured adjustable row spacing from 18 to 36 inches and a cable winder. It also has optional splitters to reduce manpower needed to ride the planter. We found good plant spacing and decreased planting time. We can plant twice the number of rows with the same size crew than was possible with our twenty-five year old ALMACO 2-row planter and we no longer need to mark the field for manual tripping guides. The 2-row planter will serve as a backup and for use by other NCRPIS curation projects

Personnel:
Trent Moore filled the vacancy left by David Losure, one of our two maize curatorial program technicians (ISU Ag Specialist) who resigned effective at the end of December 2007 to pursue other opportunities. Mr. Moore began in the position in March 2008 after previously working as an ISU student employee beginning at the beginning of 2008. He has previously been employed as a soybean tech for Pioneer Hi-Bred/DuPont, on Kauai. Matt Lively, our federal maize technician, was extremely helpful during the transition.

Research Progress:
The GRIN-Global project is a collaborative project between The Global Crop Diversity Trust, Bioversity International, and USDA-ARS to create the next generation of the GRIN system. A scalable, database neutral system, it will provide tools and web interfaces for the management of genebank collections and germplasm information, and for their users. The project development team is led by IT Specialist Pete Cyr of Ames and commenced full bore in early 2008. The maize curator, who has a long history of working with the current GRIN system, was assigned to serve as an analyst on the development team. He is tasked with working with GRIN users to identify and provide work flows and system needs to the software developers, and to help develop specifications for the new curatorial software tools. The database project has required over a third of his time in 2008 and is expected to be completed by the end of 2010, when it will be fully available for deployment to international genebanks. Please see the project website at http://www.gringlobal.org/index.php/Main_Page for additional information.

Acquisition:
The maize curator decided in coordination with the NCRPIS research leader to further break down maize statistics for the 2008 annual report to emphasize specific groups within the maize collection which have become increasingly active during the past five years. Thanks go to David Kovach for the effort given to developing the scripts he developed to dissect the larger maize figures. The genus *Zea* has been split into GEMS, expired PVPs, all other maize inbreds, improved and unimproved maize populations, and teosintes.

GEMs are public line releases from the GEM project. These accessions started as unimproved landraces, tropical inbreds, or hybrids and were crossed either with one or two elite corn belt private company inbreds. The identity of the company inbreds used is confidential to encourage donations of the very best germplasm to the new GEM populations. Contrary to this scheme, GEMS-0001 was actually a landrace accession improved by an elite public line. It is expected that a percentage of all future GEM accessions will have known elite inbreds in their parentage to study maize enhancement techniques. Both public inbred lines and expired PVPs are utilized. It is hoped by knowing the elite inbred line genetic profile that it will be easier to determine the contribution of the original unimproved landrace or unadapted tropical elite germplasm. One of the major goals of the GEM project is to diversify the genetic base of maize in the Corn Belt.

Expired PVPs are inbred lines of maize that have had a period of intellectual property protection, currently 20 years. They receive a Plant Variety Protection certificate. The PVP office website is http://www.ams.usda.gov.
A voucher sample is deposited at National Center for Genetic Resources Conservation (NCGRP) for the protection period. When a certificate expires, a portion of that sample is deposited at the active site for inclusion in NPGS. These inbreds have been the most frequently distributed germplasm within the maize collection in recent years.

Inbred lines of maize have become an increasingly important part of the collection. Early in NCRPIS history, only non-U.S. inbred lines were held in the collection as

part of the "plant introduction" mandate. Public lines were generally maintained by the many public maize breeding institutions. During the last two decades, public maize breeding program mandates have changed. The NCRPIS has been designated to conserve these U.S. genetic resources, to which so many man-years were dedicated. A renaissance in their use has occurred with the interest of molecular biologists in their research. For many studies, they are a more useful scientific tool due to their adaptation and predictable genetic profile. Startup companies both here and abroad still find them useful in combination with locally adapted elite germplasm.

Teosintes, maize nearest wild relatives, are a huge reservoir of genetic diversity in diminishing distributed taxa. Ex situ conservation will become more and more important as their habitats disappear in Latin America. While distributions increase, maintenance difficulties mount.

Finally, the maize population collection is the largest *Zea* collection. Its size is stabilizing as only underrepresented races are added.

Statistics show a 150 accession increase in 2008 (Table 1). These include thirty-three expired Plant Variety Protected (PVP) accessions, and over 100 accessions from the Australian Germplasm System, including waxy inbreds brought in through quarantine. Finally, 17 additional TZ inbred lines from the Nigerian program were brought in through quarantine increase on St. Croix.

A spreadsheet inventory list of 1800 items (mostly inbreds) was sent by Dr. Don White at the University of Illinois. So far 430 items have been identified as already being in the NCRPIS. There appears to be 200-300 items that are proprietary. That could mean up to an additional 800-1000 additional items could be added to the collection. After items are identified as not being in the collection, I will seek guidance from Illinois as to whether they can be shared. Maize CGC members may be called upon to indicate whether a particular item should be included (i.e. there is a Mo17C and a Mo17D on the list).

Regeneration:
There were 618 regeneration attempts made in 2008 or 3.1% of the 20,057 accessions on inventory. This compares with 788 or 4.0% of 19,928 in 2007 and 546 or 2.8% of 19,687 in 2006. Fewer single row attempts were made in 2008.

There were 377 accession regeneration attempts made in Ames in the summer of 2008 compared to 588 in 2007 and 439 in 2006. Fewer single row increases were attempted on original seed in 2008, resulting in fewer accessions being grown even though the number of rows for increase was approximately equivalent to the 2007 nursery. Increases included 160 inbreds (25 expired PVPs) and 217 populations. As in other recent years, we are growing populations at smaller population sizes (50-60 plants vs. 200) to make seed available as soon as possible. When availability improves we will regenerate a second or third time and bulk the increases. We are maintaining balanced samples for the next regeneration. Balanced samples will be bulked so that when the parent seed is exhausted, there should be a sample representing approximately 100 parent ears to carry forward. The season was cool

in April so all planting was delayed until May. We did get two-thirds of the nursery planted in early May before rains again set in, and were able to finish just after mid-May. As mentioned previously, using an ALMACO 4-row cone planter in place of our twenty-five year old 2-row ALMACO belt-cone planter proved very helpful. Rainy weather continued throughout the early pollinating season making pollinations more difficult than average, but at least irrigation was unnecessary. In August things dried up a bit and kernel fill was better than expected due to continued cooler weather. Frost was later than average and few accessions were damaged when a hard freeze occurred. When a hard freeze is predicted, we harvest the ears in the husk and dry slowly at just above room temperature. This allows for some physiological processes to proceed normally, giving better viability. No Stewart's wilt was observed in any increases, which means no ELISA testing is necessary on 2008 Ames increase lots to meet phytosanitary requirements. All factors considered, the maize regeneration year would be rated above average as a whole for Ames during the summer of 2008, despite difficult working conditions.

An increase of 55 tropical accessions was attempted near Waimea, Kauai through the facilities of Hawaiian Seed Research. Unfortunately, the newer site at a higher elevation had soil aluminum toxicity issues and therefore performance was poor. A small quantity of seed was received back on 26 accessions. This year's St. Croix quarantine nursery consisted of 185 accessions, compared to 126 accessions in 2007. There were 140 Australian inbred lines, 14 Nigerian inbreds, and the rest were populations mostly from Africa.

Greenhouse increases included six Zea accessions consisting of one Gaspe type, and three Zea diploperennis accessions and two Zea perennis accessions. Three Coix were started in the greenhouse and one Tripsacum was overwintered there.

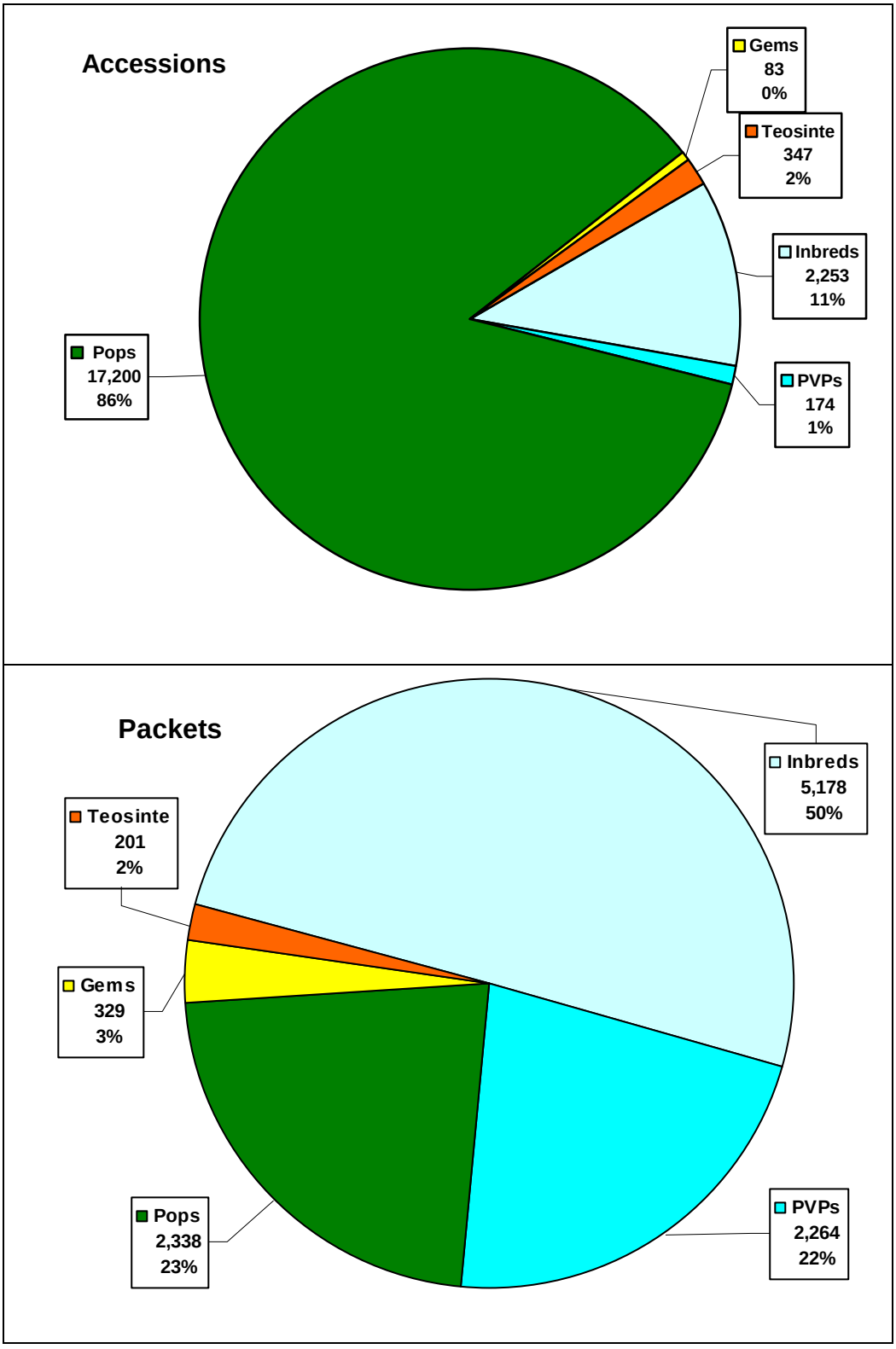
Maintenance:
Table 1 indicates that maize accession availability increased from 64% to 65% at the end of 2007. It also increased by 1% in 2007. Effort has been focused on increasing inbreds and expired PVPs to meet demand. Availability reflects this effort although PVP availability lags due to unexpired Utility Patents that restrict distribution although the seed has been increased. A total of 424 maize accessions were made available in 2008 for a net gain in availability of 298 accessions compared to 321 accessions in 2007.

In 2008, 1,399 accession or 7% of the collection were tested for viability compared to 965 accessions or 5% in 2007 and 1670 accessions or 8% in 2006. In 2008, 368 accessions were backed up compared to 1,027 accessions backed up in 2007 and 89 in 2006. The percent backup held at 74% in 2008.

Distribution:
Table 5 shows that maize packet distributions, orders, and the number of requestors were significantly higher than the previous year. This required a much greater amount of time to be devoted by the curator to orders than in previous years. The expired PVP inbred lines continued to be popular distributions. A pie chart below shows the contrast in the number of accessions in each group and the number of packets distributed.

Crop	Calendar Year	No. of Orders	No. of Recipients	No. of Items Distributed	No. of Accessions Distributed
Maize	2004	334	241	4473	2207
	2005	381	275	4425	1828
	2006	585	356	7927	2477
	2007	553	376	8870	2175
	2008	601	405	10310	3451
Average		**491**	**331**	**7201**	**2428**

Zea Subdivisions	Calendar Year	No. of Orders	No. of Recipients	No. of Items Distributed	No. of Accessions Distributed
Populations	2004	149	127	1438	1055
	2005	149	135	1302	1005
	2006	195	163	2132	1463
	2007	207	174	1722	1016
	2008	234	191	2338	1547
Average		**187**	**158**	**1786**	**1217**
GEMs	2004	24	21	310	66
	2005	13	12	142	66
	2006	28	25	334	66
	2007	23	22	381	67
	2008	27	23	329	81
Average		**23**	**21**	**299**	**69**
Teosintes	2004	46	43	225	82
	2005	46	43	253	77
	2006	59	49	303	77
	2007	67	62	272	43
	2008	60	58	201	42
Average		**56**	**51**	**251**	**64**
Inbreds	2004	160	124	1892	961
	2005	161	132	1633	604
	2006	265	197	2956	760
	2007	259	203	3314	919
	2008	271	209	5178	1628
Average		**223**	**173**	**2995**	**974**
PVPs	2004	69	39	608	43
	2005	103	51	1095	76
	2006	214	95	2202	111
	2007	188	106	3181	130
	2008	189	106	2264	153
Average		**153**	**79**	**1870**	**103**


Accessions
Gems
83
0%
Teosinte
347
2%
Inbreds
2,253
11%
PVPs
174
1%
Pops
17,200
86%
Packets
Inbreds
5,178
50%
Teosinte
201
2%
Gems
329
3%
Pops
2,338
23%
PVPs
2,264
22%

Characterization:
There were 15,641 data points loaded into GRIN on 2,026 accessions in 2008 compared to 13,001 data points on 2,436 accessions in 2007 and are similar to the 15,476 loaded to GRIN on 2,852 accessions in 2006.

We imaged 1,378 accessions in 2008 compared to 829 accessions in 2007 and 1,559 in 2006.

Evaluation:
Two disease screening nurseries were sent out in 2008. Dr. Bill Dolezal, Pioneer Hi-Bred/DuPont, screened 250 accessions for northern leaf blight resistance and diplodia ear rot screening. As was true in 2007, infection levels of both diseases were excellent, and resistant and highly susceptible accessions were identified. Dr. Charles Block, USDA-ARS at the NCRPIS, screened 280 accessions for Stewart's wilt resistance.

We sent 4,226 packets for NIR evaluation in the lab of Dr. Linda Pollak and Ms. Sue Duvick in 2008. We have received a substantial amount of compositional data on %starch, %oil, %protein, and density. This data should be loaded to GRIN in 2009.

Communication:
Again in 2008, several tours were given and there were many venues for exchanges of ideas. The GEM project field day continues to generate visits from many maize scientists who are also interested in the maize germplasm collection. There was an interview from a crew with the Discovery cable program "How Things Work". This interview appeared on the episode in January 2009 "How Things Work: Corn". This marks the second year in a row that interviews for major television programs occurred.

Plans for 2009:
The GRIN-Global project will take a considerable part of the maize curator's time and therefore this list is shorter than in previous fiscal years. Regeneration remains this curator's first priority because without viable seed, no other research can be done. Expected reduced student labor staffing due to fiscal constraints will make this a challenge; 30% fewer student labor resources were available in 2009.

Acquisition:
The University of Illinois retired pathologist Dr. Don White has a large collection of inbred lines. We plan to review those holding for important missing accessions and begin receipt of accessions. We are also planning to contact Dr. Zeno Wicks, retired maize geneticist from South Dakota to ensure there are no additional inbred lines or population cycles that are important to add to the maize collection.

After a short six month hiatus in expiration of PVPs due to an open PVP examiner position 18 years ago, there will be approximately 35 new maize PVP lines added to the collection in 2009.

More GEM accessions will be released for distribution by the NCRPIS in 2009.

Regeneration:
Funding will not support tropical maize regenerations in 2009. Efforts will be confined to small increases in the GEM tropical nursery and voluntary increases by the private sector. Some effort will be put into photoperiod control in Ames. The GEM group continues to improve a photoperiod control system with substantial success. We plan to pursue their method for inducing photoperiod sensitive germplasm to flower under the Ames summer photoperiod via use of light-excluding enclosures. A challenge is to scale up the system to needed production levels.

Regenerations in Ames will be maintained at 300-350 accessions annually. Quarantine regenerations on St. Croix will continue at the 30-50 accession level during 2009.

Maintenance:
Ames numbered accessions will be reviewed and PI numbers assigned; it is estimated that over 1,200 Ames-numbered accessions and 400 currently available NSL-numbered accessions could be assigned permanent PI numbers. This process is a priority for 2009-2010, following the GRIN-Global project work.

Viability tests will be increased in 2009 to maintain the maize testing schedule of 10 years to provide timely data for regeneration priorities.

Evaluation:
I will attempt to augment the collection of images currently on GRIN of 5,000 accessions with images of additional accessions in 2009. These images have already been captured, and will be loaded with the new GRIN loader software developed by NCRPIS staff.

The maize curator will continue to work with the NCRPIS pathologist and interested private and public pathologists to systematically obtain data on maize pathogen resistance in the collection. Additional evaluation information will result in more effective use of accessions in the future.

F. Medicinal Plants (M. Widrlechner)

With the vacancy created by the departure of Dr. Joe-Ann McCoy late in 2007, Mark Widrlechner assumed responsibility for the curation of these collections and led two national searches to find a replacement. At the end of 2008, this process succeeded in finding a suitable candidate, Dr. Luping Qu, who accepted our offer to begin work in March 2009. Mark is grateful for assistance provided throughout 2008 by Jeff Carstens and Nathan Johnson, a STEP employee, who had been working for Joe-Ann and who provides important continuity to this project.

Germplasm Collections:
Perennial crop collections currently curated by the Medicinal Plant project include *Echinacea* (prairie coneflower), *Hypericum* (St. John's wort), *Actaea racemosa* (black cohosh), *Prunella vulgaris* (heal all), and various miscellaneous species managed under the NC7-medicinals site-crop.

Acquisition:
During 2008, we received and/or collected 8 new accessions of medicinal species representing 2% of the current collection (Table 1). The collection currently consists of 452 accessions.

The main focus of germplasm acquisition in 2008 was on native *Hypericum* and *Prunella* populations that could be obtained in conjunction with efforts to collect *Fraxinus* in eastern Missouri and southern Illinois.

Availability and Backup:
Sixty-four percent of the NC7 medicinal accessions are currently available (Table 1). In 2008, 45 seed lots of these accessions were made available and 60 accessions were backed up, with a total of 305 accessions now backed up in Fort Collins, representing 67% of the total collection (Table 2).

Regeneration and Maintenance:
The majority of the growing season was spent maintaining 36 field cages. Regeneration efforts focused on the completion of caged plantings established in previous years, along with the establishment of 39 new accessions to fill in gaps in the existing cage field created by earlier successful harvests. Seeds from 19 perennial accessions of *Echinacea, Hypericum,* and *Prunella* regenerated in field cages were harvested and processed for storage in 2009.

Distribution:
232 items were distributed in 2008 (the lowest number since 2004); of these, 96% were domestic and 4% were foreign distributions (Table 3A). Along with seed distribution, fresh materials of *Echinacea*, *Hypericum*, and *Prunella* from caged-regeneration plots were sampled by Dr. Ludmila Rizshsky at ISU for metabolomic analyses. In the fall, *Echinacea* roots (5.66 kg dry wt) and *Hypericum* (2.65 kg dry wt) and *Prunella* plants (3.45 kg dry wt) were harvested, dried and ground by Wiley mill and made available to projects associated with the NIH-funded Iowa Center for Research on Botanical Dietary Supplements (Botanical Center) grant project.

Characterization and Taxonomy:
All the medicinal plants in the cage field were checked to verify identifications and herbarium specimens were taken for accessions that had not been vouchered previously. In 2008, 18 accessions were vouchered and no re-identifications were required.

Digital images of plants were taken for 44 accessions, primarily images of seeds taken by Lisa Pfiffner. An extensive collection of data (577 observation records on 263 accessions) and images for 264 accessions were loaded to GRIN in 2008 (Table 4).

Two interesting papers reporting on the bioactivity *Hypericum* and *Prunella* were submitted for publication in 2008:

-- An overview of the Botanical Center's research progress on evaluating the anti-inflammatory and antiviral activities of Hypericum was presented by Dr. Diane Birt to the Society for Economic Botany and then developed into a

multi-authored paper that has been submitted to the journal, "Pharmaceutical Biology."

-- A research group led by virologist, Dr. Wendy Maury, at the University of Iowa submitted a paper on the inhibition of replication of Equine Infectious Anemia Virus caused by extracts of *Prunella vulgaris*, which was accepted for publication in the online journal, "Virology Journal," late in 2008.

Pathogen Observations:
Field plantings were monitored weekly during the growing season, for *Colletotrichum gloeosporioides* and aster yellows disease symptoms. Both pathogens had been present in 2005 field plantings. A *C. gloeosporioides* seed screening protocol for *Hypericum* accessions continues to be utilized for all new and harvested seed accessions. All germination and pathogen data collected have been entered in the GRIN database.

Medicinal Plant Posters & Publications by Mark Widrlechner for 2008:
Birt, Diane F., and Mark P. Widrlechner. 2008. Putting science behind botanical supplements. Stories in Agriculture and Life Sciences. Fall 2008: 17. (Additional information posted at www.ag.iastate.edu/stories)

Birt, Diane F., Mark P. Widrlechner, Carlie A. LaLone, Lankun Wu, Jaehoon Bae, Avery K.S. Solco, George A. Kraus, Patricia A. Murphy, Eve S. Wurtele, Qiang Leng, Steven C. Hebert, Wendy J. Maury, and Jason P. Price. 2008. *Echinacea* in infection. American Journal of Clinical Nutrition 87(suppl.): 488S-492S.

Flagel, Lex E., Ryan A. Rapp, Corrinne E. Grover, Mark P. Widrlechner, Jennifer Hawkins, Jessie L. Grafenberg, Inés Álvarez Fernández, Gyu Young Chung, and Jonathan F. Wendel. 2008. Phylogenetic, morphological, and chemotaxonomic incongruence in the North American endemic genus *Echinacea*. American Journal of Botany 95: 756-765.

Rizshsky, Ludmila, Joe-Ann McCoy, Mark Widrlechner, and Basil J. Nikolau. 2008. Fingerprinting of *Prunella vulgaris* and metabolic analysis of medicinal plant extracts used by the Botanical Center. Poster presented to the Annual Meeting of the Iowa Botanical Center's External Advisory Committee, Ames, IA, 26 Sept.

Plans for 2009:
There are two important goals for the Medicinal Plant project in the year ahead. First, efforts will be focused on mentoring Luping to ensure that he becomes a skillful curator who can effective build and manage these collections while meeting the needs of the Botanical Center collaborators. This will involve many aspects of our operations and many staff members, who can share information about recordkeeping, seed germination, processing and storage, plant cultivation, IT, GRIN, imaging, and collaboration with Botanical Center researchers. To this end, Mark and Luping will work together to proof passport data and request the assignment of PI numbers for those medicinal-plant accessions that have been successfully regenerated and otherwise meet the requirements for PI-number assignment.

Second, in 2009, there will be an opportunity to apply to NIH for a renewal of the grant that supports the Botanical Center. The current grant ends in 2010, but a competitive renewal process for an additional five years of funding is scheduled. Drs. Widrlechner and Qu plan to contribute extensively to the development of a strong renewal proposal.

In addition, the herbarium specimens collected by Mark and Nathan in 2008 are scheduled to be deposited in the Ada Hayden Herbarium at Iowa State University and recorded in GRIN early in 2009.

G. Oilseed Crops (L. Marek, B. Bingaman, I. Larsen)

Acquisitions:
We received 73 new oil seed accessions in 2008.

Helianthus:
Eleven cultivated *Helianthus annuus* accessions, all with expired property rights protection (CSR), were requested and received from NCGRP, Ft Collins. Five of the new cultivated accessions were increased in 2008; the remaining six will be increased in 2009 and 2010. During a 14 day trip to Georgia, South Carolina, North Carolina and Tennessee in October, Dr. Marek and USDA sunflower researcher Dr. Gerald Seiler, Fargo, ND collected 51 accessions of *Helianthus* from wild populations [*H. angustifolius* (1), *H. argophyllus* (2), *H. atrorubens* (2), *H. divaricatus* (1), *H. floridanus* (1), *H. giganteus* (1), *H. glaucophyllus* (11), *H. heterophyllus* (4), *H. laevigatus* (3), *H. microcephalus* (4), *H. radula* (8), *H. resinosus* (11), and *H. smithii* (2)]. Three additional accessions, immature at the time of the collection trip, were collected in November and donated by local collaborator Stella Osborn, senior wildlife technician, Ft Stewart, GA. The 2008 wild sunflower exploration was funded by the NPGS Plant Exchange Office. Forty percent of the new wild accessions will be available as original seed when accessioning is complete. These new collections represent the first time germplasm for *H. heterophyllus* will be available in amounts large enough to allow standard distributions.

Brassicaceae:
Eight new *Thlaspi arvensi* accessions were donated to the Brassicaceae collection in 2008 after contact and discussions with the donors. Five accessions were donated by Dr. Jim Metzger, Ohio State University. Dr. Emilie Regnier, weed scientist at Ohio State University, collected and donated seeds from a population of wild *Thlaspi arvensi* growing near Columbus, OH. Dr. Burton Johnson collected and donated seeds from a wild population growing in Fargo, ND. Dr. Marek and Dr. Bingaman collected seeds from a wild population growing at the NCRPIS, Ames. All eight accessions are available for distribution.

Collection Maintenance:
As part of a strategy to ensure that the active oil seed collection contains only viable accessions, 191 oil seed accessions were submitted for inactivation during 2008 [Brassicaceae (77), *Cuphea* (13), *Euphorbia* (13), *Helianthus* (31), flax (47), and miscellaneous asters (10)]. An accession was inactivated if it had one or no seeds or if it had fewer than 10 seeds and more than one failed germination attempt. As part of an ongoing station wide effort to convert Ames numbered accessions to PI

numbers, 289 available Ames numbered oil seed accessions were submitted for PI re-numbering.

General statistics about availability and management of the collections are presented in Tables 1 and 2 in the appendix. Fewer regenerations than average were started for the field in 2008 for all oil seed groups due to budget uncertainties. Selected details for oil seed accessions increased during 2008 are noted below.

Helianthus, Ames increases:
Cultivated *H. annuus* accessions are 94% available (90% available five years ago). Availability increases to 96% when CSR restricted accessions are removed from the calculations. We are managing our increases to maintain a high level of availability and to ensure that the core collection accessions are available. In 2008, 37 *H. annuus* cultivated accessions were regenerated. Cultivated *H. annuus* accessions requiring long seasons or short days to flower are increased in the NCRPIS greenhouse as space allows (two to four accessions per season; two during the winter of 2007-2008; three underway for 2008-2009). Wild annual *Helianthus* accessions are 93% available (77% available five years ago) and wild perennial accessions are 59% available (20% available five years ago). In 2008, we caged 12 wild annual *Helianthus* accessions and harvested seed from 10 of the accessions. We caged 68 wild perennial populations, 55 of which had been previously established in the field. Seed was harvested from 54 of the caged perennial accessions.

Helianthus, Parlier alternate grow-out site:
We continue to work with NPGS Parlier, CA personnel to increase wild taxa that require longer growing seasons than are reliably obtained in Ames. The Parlier environment also provides a valuable alternative for growing mountain and desert species such as *H. exilis* and *H. deserticola* that have not done well in the mid-western humidity and heavy soils. The Parlier location has 40 sunflower cages, purchased by NCRPIS, and can grow up to 40 sunflower accessions per year. In 2005 we implemented the increase protocol of germinating seed in Ames and shipping live seedlings to Parlier. The Parlier staff transplant seedlings and manage plant growth. As in Ames, plots are caged before flowering, pollinator insects are introduced during flowering, and plants are harvested as seed heads mature. Harvested material is shipped to Ames for threshing and processing. In 2008 we sent seedlings for 34 accessions, all of which were harvested. In addition, two accessions established in 2007 were re-caged and harvested in 2008. The 2008 harvested material arrived in Ames in November and December and is being processed.

The Parlier group records basic field data (date transplanted, dates of harvest) but does not have the staff to record standard descriptor data such as ray and disc flower color, plant height, branching characteristics nor to take images. Because some accessions represent taxa which we never see growing in Ames, it is important that these observation data be captured and their environmental context recorded. In October 2008, Dr. Marek and Mr. Larsen traveled to Parlier to record descriptor information and to take images.

Brassicaceae:
Brassicaceae accessions are 87% available (75% available five years ago). We continue to work towards having 90% or more of these accessions available. In spring 2008, field populations for 60 Brassicaceae accessions, 38 *Brassica* and 22 miscellaneous crucifers were established. Of these, 23 *Brassica* and two miscellaneous crucifer field populations were established from accessions started in December 2007 and maintained in the NCRPIS cool temperature greenhouse for vernalization before transplanting to the field. Ten Brassicaceae accessions started in December 2007 were kept in the greenhouse; seven were harvested in 2008 (all *Brassica*). The remaining three accessions started in December 2007 are being maintained in the greenhouse for 2009 harvest. Seed was harvested from 50 of the field established accessions. Plants from eleven field spring 2008 established accessions were transplanted to the winter greenhouse in fall 2008. Seven did not flower in the field; four yielded insufficient harvested material. Transplanting is a priority for accessions which have no remaining seed and/or those for which we have no useful information with which to predict winter survival. Four accessions transplanted to the winter greenhouse in fall 2007 were harvested late winter 2008. Winter greenhouse increases involve strong cooperation with the NCRPIS entomology personnel to obtain appropriate pollinators in a timely manner. Flies have been very successful pollinators in the winter greenhouse. Many of the wild Brassicaceae are of Mediterranean origin and could be expected to bloom during cool, moist, short-day winter weather. For example, *Erysimum* accessions have not flowered in the field but have done well after transfer to the winter greenhouse. Two of *Erysimum* accessions started in 2006 which did not flower in the field were transplanted to the greenhouse and maintained until they flowered and were harvested in 2008. In 2007 we implemented the protocol of starting *Erysimum* accessions in September to be maintained the cool winter greenhouse in anticipation of late winter/early spring flowering the following year. Six *Erysimum* accessions were started in September 2007, overwintered in the cool winter greenhouse, and were harvested in March and April 2008. Ten *Erysimum* accessions were started in September 2008 for 2009 harvest.

Linum:
Cultivated flax accessions are 99% available. Seeds were harvested from all eight *Linum usitatissimum* accessions planted for regeneration in 2008. Two accessions were recent collections in Tajikistan and the Republic of Georgia. Generally, cultivated flax are being prioritized for increase based on the viability of distribution lots. The six accessions increased in 2008 that were not new collections had distribution lots for which viability had decreased to 20% or less. The population collected in the Republic of Georgia was accessioned without a specific epithet. Passport data received with the accession suggested *Linum usitatissimum* as the likely species. The 2008 grow-out confirmed this suspicion, and the accession was formally re-identified.

Wild flax accessions are 70% available, a significant increase from the 47% available in 2007 (39% available five years ago). The increase in availability during 2008 was largely due to the collection maintenance process of transferring non-viable accessions to INACTIVE status. Twelve wild flax accessions were harvested in 2008, eleven from the field and one from a 2005 established population maintained

in the greenhouse. The eleven field populations are being overwintered for additional harvest in 2009.

Cuphea:
Seeds are available for 94% of the accessions of seven species (*Cuphea calophylla, C. carthegenensis, C. lanceolata, C. lutea, C. tolucana, C. viscosissima, C. wrightii)* and the *Cuphea* hybrid accessions that have been part of the PSR23 breeding efforts by members of the National *Cuphea* Consortium for the agronomic development of *Cuphea* as a domestic source of mid-chain fatty acids. Seeds were harvested from 10 of 12 accessions established in the field in 2008. One accession died in the field before flowering. Plants for the other non-flowering accession were transferred to the greenhouse before fall frost. Over all, the cuphea collection is 79% available (73% available five years ago).

Miscellaneous asters, *Vernonia:*
Overall the miscellaneous asters are 22% available; *Vernonia galamensis*, the African species within this group with the most significant current oilseed interest, is 28% available. In 2008 we attempted to increase nine *Vernonia* accessions, six of which were transplanted to the field and five of which were harvested.

Euphorbia:
In response to an indication of potential future interest in *Euphorbia lagascae* as a source of vernolic acid for the "green" building trade, we are working to increase the availability of the *Euphorbia lagascae* collection. Seven accessions were transplanted to the field and harvested, the first field increase of *Euphorbia* at the NCRPIS since 1998. *E. lagascae* accessions are 49% available; overall, the collection is 33% available.

Distributions:
General statistics about oil seed collection distributions are presented in Table 3 in the appendix. Twenty-four percent of the 2008 domestic distributions and 45% of the 2008 international distributions from the NCRPIS were oil seed accessions.

Helianthus:
A primary research focus for 2008 *Helianthus* distributions was evaluation for sclerotinia resistance. Accessions were also distributed to be evaluated for insect resistance. A large number of cultivated accessions were selected and distributed to a research group starting an NSF funded association mapping project. Other distributions were sent to support breeding work by a number of seed companies and to support research programs investigating drought tolerance, genome size, and cold resistance.

Brassicaceae:
Demand for Brassicaceae accessions continued to be strong in 2008. The largest number of orders requested material to support disease resistance evaluations and research. In addition, portions of the Brassicaceae collection were distributed for phytoremediation research, for bio-fumigant and green manure studies, and for oil composition and biofuels/oil crop evaluation. The diversity in the Brassicaceae collection (262 taxa from 21 genera) supports a wide range of research purposes.

Linum:
Linum accessions were distributed to several breeding programs working with oil and fiber characteristics as well as to an archaeo-botanical research group and to a program re-examining the potential for re-establishing flax as a crop in Texas.

Cuphea:
Cuphea accessions were distributed to ornamental breeding programs and to groups participating in the National Cuphea Consortium. The largest single distribution was sent to a researcher within the consortium group examining insect resistance.

Research Activities:
General statistics about observations and images recorded for the collections are presented in Table 4 in the appendix.

Helianthus:
Accession Diversity Analysis: During the August 2005 collection of *Helianthus pumilus* we acquired samples from 45 populations spread across the complete geographic range of this species (CO, WY). In combination with three accessions also collected in 2005 by local collaborators and two accessions previously in the NPGS collection, these 50 accessions provide an excellent resource to examine within and between accession genetic diversity and apply that diversity information to examine sampling theory. I began to assess diversity within these samples in December 2007. In January 2008, I spent two weeks working in Dr. Loren Rieseberg's Indiana University laboratory (his primary laboratory is in Vancouver, British Columbia). In Iowa and Indiana, I extracted DNA from a total of 220 individuals from 47 of the accessions. In Indiana, I used 96 markers from the EST-derived HT SSR marker library selected on the basis of polymorphisms detected by previous work in a panel of elite cultivated plus wild annual and wild perennial germplasm to screen one individual from each of 12 different accessions. Twenty-four markers that appeared to detect polymorphism between and within the twelve accessions were used to genotype 48 individuals from eight of the twelve different populations. GeneMapper analysis of these data will be completed in 2009. Future plans include a more extensive genotyping effort (100 individuals from each population) after analysis of the original results are completed.

Germination protocols: Our focus on making 90% or more of the wild Helianthus germplasm available for distribution has some challenges. Increases have never been attempted for most unavailable wild accessions; 65% of the original perennial seed and 85% of the original wild annual seed has been stored for 19 years or longer. We have found that a seven day cool water wash of seeds followed by an extended moist, cold treatment prior to transfer to germination conditions is the most consistently useful, least labor intensive strategy to promote germination of old original wild seeds. Pathogen contamination of old original seed is our biggest concern for many accessions and the cool water wash, first incorporated in to the germination protocol for 2007 Parlier increase material, seems to reduce contamination. The moist cold treatment following the water wash mimics winter conditions for seeds that might still have dormancy and helps synchronize germinations. Before exposure of the seeds to temperatures suitable for germination, any accessions showing contamination are rinsed and placed in clean germination boxes.

Photoperiod modification experiments: To complement the versatility that the NPGS Parlier alternate grow-out location provides for sunflower regenerations, we have incorporated a protocol first successfully used for sunflowers in 2007 to promote early flowering in Ames in late flowering taxa that survive the mid-western summer humidity. Photoperiod modification is accomplished by covering standard pollinator-control screened cages with black landscape cloth for 16 hours each day, mid-July until mid-August, extending the dark period by approximately seven hours. Due to the labor intensive nature of this technique, only a limited number of accessions can be increased in this manner each season. In 2008, this protocol was used to promote early flowering in two accessions of *Helianthus paradoxus* and one accession of *H. argophyllus*.

H. paradoxus has been the source of salt tolerance incorporated into cultivated *H. annuus* breeding material. The sunflower CGC has expressed interest in ensuring that a full genetic representation of this species be maintained in the NPGS collection. Wild collection and distribution of this species is restricted because it is classified as a threatened species on the USFWS Threatened and Endangered Species List. The NPGS collection has 11 accessions of *H. paradoxus*, one of which can be distributed domestically under FWS restrictions after our successful 2008 increase. Nine of the remaining accessions were collected prior to 1980 and have not been successfully increased. Increase of five of these accessions will be attempted in 2009 using the photoperiod modification protocol to determine whether fulfilling the CGC's genetic representation priority is likely to require new collection effort.

Disease resistance evaluations: Sclerotinia is the most important (economic) disease in sunflower in production fields in northern North America. The pathology group at the USDA Sunflower Research Unit, Fargo, began field evaluations in 2008 to screen all untested cultivated sunflower accessions for their response to this important disease. I identified all accessions without disease evaluation data from which an initial test group of 250 was selected. We treated the seeds with a new pesticide combination to control downy mildew before sending them to Fargo. 2008 results were incomplete due to weather related loss of two test locations. The group of 250 will be re-tested in 2009 and the best 20 accessions based on the one surviving evaluation location will be tested at additional locations. Field evaluations are labor intensive and subject to the whims of the weather. We are participating in joint effort between the Ames ARS-PIRU pathology group (Charlie Block) and the Fargo pathology group to develop a greenhouse screen that successfully predicts field response with the goal that only the most promising accessions would need to be field tested. The initial test groups for developing this screen are from wild collections. *H. resinosus* was a primary target of a 2006 wild sunflower collection trip because of potential Sclerotinia resistance; the collections have provided several accessions with close to 100% resistance in both greenhouse and field testing during 2007 and 2008. *H. resinosus* in its northern range was a primary target of the 2008 collection trip, in part because of preliminary observations of remarkable Sclerotinia resistance. The 2008 collection trip will add 11 accessions to the test groups.

Brassicaceae:
ACL study: Efficient and effective use of pollinators is an ongoing concern at the NCRPIS. Oilseeds cooperated with the entomology group in a study to compare the effectiveness of alfalfa leaf cutting bee versus honey bees as co-pollinators to *Osmia*

bees in *Brassica* as determined by several seed yield characteristics. More details about the results of this study are presented in the Entomology section of this report. Addition of pollinators increased the seed yield in *B. rapa* cages, and use of Osmia together with alfalfa leaf cutting bees seemed to result in the best yield in *B. napus* cages.

Thlaspi agronomic characteristics: *Thlaspi arvense*, a Brassicaceae species which is a common weed associated with agricultural production world-wide, has remarkable cold tolerance and interesting seed oil characteristics. *T. arvense* completes its life cycle by late spring or early summer suggesting use as a non-food or feed biodiesel component in a double cropping system. In cooperation with the USDA-ARS New Crops Research Unit in Peoria, IL, we started work to examine some of the agronomic characteristics of the *Thlaspi* germplasm in the NCRPIS collection and to provide seed for further evaluations. In August 2007, we established *Thlaspi* increase plots by direct seeding to overwinter for early spring seed production. All but two accessions bolted and flowered during October (but did not produce seed) and none of the plants that flowered survived the winter, suggesting that August is too early to start these species if the goal is to overwinter for spring seed production. All accessions had seedlings germinate in spring 2008 from the August 2007 planted seed, generally at a higher rate than fall germination, suggesting that determination of optimal germination conditions would expedite domestication of this species. Plots were harvested in July and yields ranged from 700 -17,000+ seeds per plant on stands ranging from 1 - 166 plants. In November 2008, we again established *Thlaspi* increase plots by direct seeding to overwinter. No accessions germinated in 2008. This work will be continued by ISU Agronomy graduate student Ivan Ayala.

<u>*Cuphea*</u>:
DARPA project: Ames was one of four locations in a project developed by Dr. Russ Gesch, USDA, Morris, MN, measuring a range of phenological and physiological characteristics of six cuphea germplasms from three species. In the second year of the study (2008), we planted seeds and transplanted seedlings in a replicated plot design. We maintained the plots and recorded emergence counts, flowering dates, plant heights and observations on plant stand over time as well as provided assistance in harvesting. Information was collected weekly from a HOBO soil probe and transferred to Dr. Gesch. A member of the Morris research team traveled to each of the four locations on a regular basis to record additional information and to do most harvesting.

Collection trips:
I was the PI for one targeted collection trip funded by the NPGS Plant Exchange Office (PEO), for wild *Helianthus* germplasm in 2008. In October, I met Dr. Gerald Seiler, Botanist, from the USDA Sunflower Research Group, Fargo in Atlanta, GA. We spent 13 days collecting wild sunflowers in the southeast traveling approximately 3250 miles across Georgia, South Carolina, North Carolina and Tennessee. The new collections represent the first time germplasm for *H. heterophyllus* will be available in amounts large enough to allow for standard distributions and significantly expands the genetic representation in the NPGS of the other collected species.

Training:
ISU 12+ Supervisory Leadership Training Course sponsored by Human Resource Services, September 2007 - May 2008. One session, October 2008.

Meetings and Presentations:
Helianthus:
In January 2008, I presented a talk entitled "Promoting Flowering in *Helianthus argophyllus*: Manipulating Day-length in the Field" at the annual National Sunflower Association Research Forum in Fargo, ND. I converted the talk to a document submitted and accepted as a paper to be included in the on-line forum proceedings. In addition, I presented the *Helianthus* Germplasm Status Report to the Sunflower CGC prior to the start of the forum.

In June 2008, I attended the 17th International Sunflower Association Conference in Cordoba, Spain and presented a poster and a short oral "poster explanation" entitled "2008 Update: The USDA Sunflower Collection at the North Central Regional Plant Introduction Station (NCRPIS), Ames, IA USA". An expanded version of the presentations was submitted and accepted as a paper and included in the published conference proceedings.

Cuphea:
In February, I presented an update on the status of the *Cuphea* collection at the annual meeting of the National *Cuphea* Consortium in Ames, IA.

NC7-RTAC:
In August, I presented an update on the NCRPIS Oilseeds Project to the NC7-Regional Technical Advisory Committee at their annual meeting in Fargo, ND.

New Crops:
In September, I presented a poster entitled "*Thlaspi arvense*, a Potential Biodiesel Crop: preliminary evaluation of the USDA germplasm collection" at the AAIC annual meeting in College Station, TX in addition to presenting the Cuphea, Vernonia, and Euphorbia portion of the NCRPIS New Crops Germplasm Status Report to the New Crops CGC prior to the start of the annual meeting.

Publications:
Marek, L.F., Block, C.C., and Gardner, C.A.C. 2008. 2008 update: The USDA sunflower collection at the North Central Regional Plant Introduction Station, Ames, IA, USA. Proceedings of the 17th International Sunflower Conference. 17th International Sunflower Conference, June 8-12, 2008, Cordoba, Spain. pg. 735-740.

Marek, L.F. 2008. Promoting flowering in *Helianthus argophyllus*: manipulating daylength in the field. 30th Sunflower Research Workshop, January 10-11, 2008, Fargo, ND. Available: http:// www.sunflowernsa.com/research/research-workshop/documents/Marek_Helianthus _08.pdf.

Grant applications:
FY 2009 Southern Midwest US *Helianthus* collection trip proposal submitted to the NPGS PEO office, $7,558.00. FY 2008 Southeastern US Helianthus collection trip proposal approved and funded $6,538.

FY2009 Plant Germplasm Evaluation proposal submitted, "Evaluation of *Thlaspi* and *Camelina* Accessions", $15,000.

USDA/DOE Biomass Feedstock grant proposal submitted and approved: Genomics of Wood Formation and Cellulosic biomass Traits in Sunflower; Dr. Steve Knapp, UGA, principal investigator, $1,200,00 total funding, of which ISU received $150,000 as a separate DOE contract over three years (FY 2009 - 2011).

Service Activities:
NCRPIS:
I serve on the NCRPIS Safety & Security and the Computer Committees, and contributed to the development of JSA and PPE training documentation.

Agronomy Departmental activities:
I continue to coordinate the monthly Agronomy Department Professional and Scientific staff meetings. Following an agenda pattern established in 2004-2005, the group continues to have informal monthly presentations by P&S staff from the different research/teaching/service groups within the department describing their area activities after the main agenda discussion usually led by the department assistant chair. I presented a collection trip summary to the group in January 2008.

PGOC:
I serve as a member of the *In situ* Conservation Subcommittee, the GIS and Geo-referencing Subcommittee and the Molecular Subcommittee.

H. Vegetables (K. Reitsma, L. Clark)

Collections curated by the Vegetable Project include *Cichorium* (NC7-chicory), *Cucumis sativus* (NC7-cucumis.cucs), *Cucumis melo* (NC7-cucumis.melo), *Cucumis* species (NC7-cucumis.wilds), *Cucurbita pepo* (NC7-cucurbita), *Daucus* (NC7-daucus), *Ocimum* (NC7-ocimum), and *Pastinaca* (NC7-parsnips). Statistics for accession numbers and availability for each site crop are found in the appendices in "Table 1: NCRPIS Accessions (Accs), Acquired, Available."

Acquisition:
Seventy-six new accessions were received and are listed by site crop in Table 1. The new accessions include one *Cucumis canoxyi* (from Yemen, donated by J. Gatard, France), 73 *C. melo* (from Turkmenistan, collected by McCreight et.al.), and 1 *C. sativus* accession (from NCGRP); and 1 *Cucurbita pepo* (variety no longer to be maintained by Syngenta, donated by G. Gusmini).

Maintenance:
Data for vegetable crop regenerations attempted and number of accessions harvested in 2008 are summarized in the appendices in "Table 2: NCRPIS Accessions (accs) Germinated, Regenerated, Made Available, Backed Up."

Cucumis sativus regenerations focused on accessions with low seed quantities or distribution lots 20+ years old. Of 32 accessions planted for regeneration, one failed to germinate, another with poor seed viability produced an insufficient plant population and will be regenerated again in 2009, and 30 were successfully regenerated. Two *Cucumis melo* accessions planted in December 2007 for greenhouse regeneration and harvest in 2008 failed to produced enough seeds to make them available for distribution and backup at NCGRP. Field and greenhouse regeneration of wild *Cucumis* species included accessions currently unavailable, requiring taxonomic verification, or needing a controlled-pollination increase to replace open-pollinated distribution lots. Twenty-one of 45 accessions attempted produced enough seeds for distribution and backup at NCGRP. Plants were dug and/or cuttings taken from 16 of the wild species that produced too few fruit in the field for continued regeneration in the 2008 fall greenhouse in an attempt to secure a larger seed increase. The results of these greenhouse increases will not be known until late spring 2009.

Cucurbita pepo field regenerations focused on accessions with low seed quantities or distribution lots 20+. Three accessions failed to mature fruits, and four accessions produced few fruits necessitating regeneration again in 2009. The resulting 2009 seed increases may then be bulked with the 2008 increase lots for better representation of the accessions' genetic profiles. Thirteen accessions produced a sufficient quantity of seed and will be made available after viability testing in April 2009.

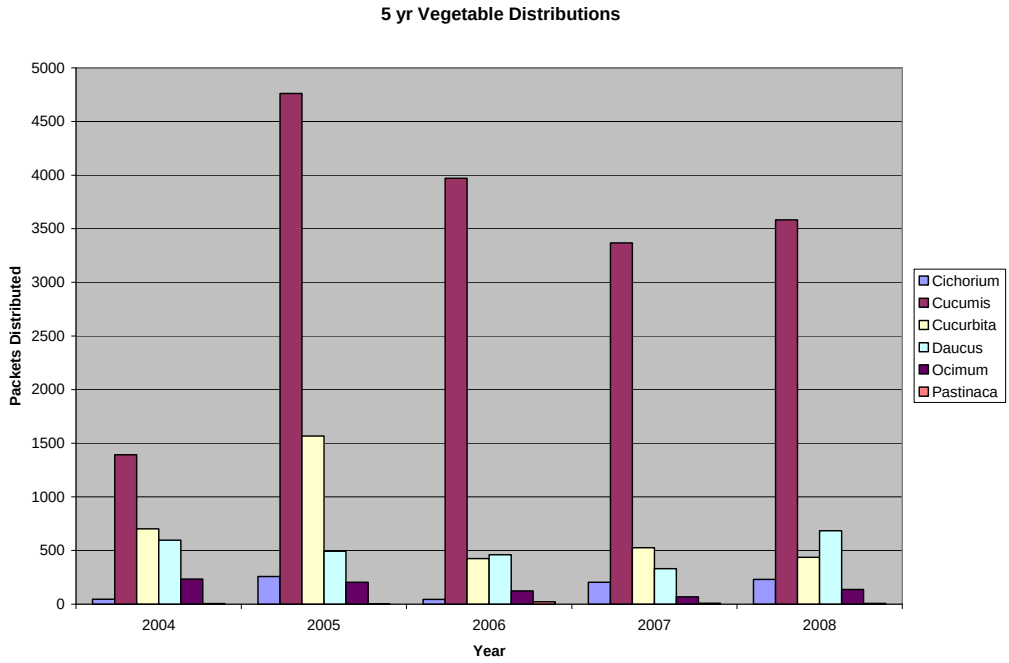
Daucus regeneration efforts included new accessions and old accessions with low seed quantity or viability. Processing of the 2008 field cage harvests is still in progress, so it is too early to determine a success rate. In addition to regenerations in Ames, we received seed increases from R. Maxwell, Seminis Vegetable Seeds, Idaho (9 accessions), and R. Freeman, Nunhems, Oregon (6 accessions). Dr. Freeman and Dr. Maxwell were sent another 5 and 6 PI-numbered accessions, respectively, for regeneration in 2009.

As NCRPIS accessions are regenerated, seed samples are sent to NCGRP for back-up. Overall, 82% of the vegetable collections are backed up, which is above the station's average of 79%. Five of eight vegetable site-crops have 81% or more of their accessions backed up at NCGRP (Table 2). In addition to the backup samples sent to NCGRP, 505 accessions from the vegetable site-crops were sent to Svalbard for backup in 2008.

One *Cucumis sativus* var. *xishuangbannanesis* and 2 *Daucus* accessions were inactivated due to poor plant performance and non-viability of the original seed lots.

In 2008, 128 germination tests (Table 2) were performed, primarily on seed increases from the 2007 regenerations.

Distribution:
Packet and accession distributions for the vegetable collections are summarized in the appendices in "Table 3A: External NCRPIS Distributions" and "Table 3B: Internal NCRPIS Distributions." In 2008, 5076 seed packets (items) involving 2999 accessions were distributed to fulfill 225 domestic and 72 foreign orders. A distribution history of the vegetable crops for the last five years can be found in the chart below and in the appendices in "Table 5: Five-Year Summary of NCRPIS Accession Orders by Crop."



There has been increased interest in wild species of *Cucumis*, primarily in *Cucumis metulifer*, for use as rootstocks for other cucurbits because of its nematode resistance. There has also been increased interest in evaluating *Cucumis melo* and wild *Cucumis* species for resistance to *Acidovorax avenae* ssp. *citrulli* (bacterial fruit blotch). All available *Ocimum* accessions were distributed to a researcher who will re-evaluate the collection chemically for natural products, profiling both aromatic oils and polyphenols. He intends to use DNA fingerprinting and chemical analyses to develop a linkage map of basil, incorporating morphological, biochemical and molecular markers.

Characterization and Taxonomy:
Digital images, along with basic notes for taxonomic identification and accession characterization, were recorded during regeneration. Data for approximately 17 descriptors, primarily fruit descriptors, were recorded at harvest for *Cucumis* and *Cucurbita* accessions. Plant habit, flowering dates, and life-cycle notes were recorded for *Daucus*.

In April, 81 *Daucus* accessions were direct seeded into an observation field to verify taxonomy, collect characterization data, and capture digital images of plants,

flowers, foliage, and roots for GRIN. Due to the wet, cool spring, seeds of many plots were washed out or had poor germination resulting in poor populations. Another two-year observation planting is planned for 2009.

With the assistance of Dr. Mark Widrlechner (NCRPIS Horticulturist), taxonomic identities are reviewed and confirmed as each accession is regenerated or grown in observation plots. The 2008 re-identifications included 23 *Cucumis* accessions to other species within *Cucumis*, and one accession to *Citrullus*, 24 *Daucus* to other *Daucus* species, subspecies, or varieties, and two *Petroselinum* to *Daucus carota*.

A general review of passport data for Ames-numbered accessions was completed for *Cichorium*, *Daucus*, *Ocimum*, and *Pastinaca* and a request for PI-number assignment was submitted in December 2007. On 4 January 2008, PI numbers were assigned for 166 *Cichorium*, 298 *Daucus*, 20 *Ocimum*, and 46 *Pastinaca*.

Dr. Widrlechner, Cindy Clark, and Kathy Reitsma (NCRPIS, Ames, IA); Dr. Joseph Kirkbride, Jr. (USDA-ARS, Beltsville, MD); and Dr. Amanuel Ghebretinsae (Monsanto, Chesterfield, MO) collaborated to describe and identify six *Cucumis* sp. accessions collected in the Northwestern Province of Zambia in 1985. Based on molecular data acquired and analyzed by Dr. Ghebretinsae, all of the accessions were found to belong to a previously un-described species. The article, "*Cucumis zambianus* (Cucurbitaceae), a New Species from Northwestern Zambia" by M. P. Widrlechner, J. H. Kirkbride, A. G. Ghebretinsae, and K. R. Reitsma was published in Systematic Botany 33(4): pp. 732-738, 2008. In addition to the six accessions mentioned in the article, two additional accessions of *Cucumis zambianus* collected from the Copperbelt Province of Zambia in 1981 were identified during our 2008 regenerations of *Cucumis* sp. germplasm.

Image of *Cucumis zambianus* fruit.

Evaluation/Utilization:
Dr. Charles Block (Pathologist) continued to screen all *Cucurbita* and *Cucumis* seedlings grown for regeneration for the presence of Squash Mosaic Virus, by using ELISA protocols before seedlings are transplanted to the field. Seedling screening has been done since 1993. He also visually inspected all cucurbit field plantings for disease during the growing season. Seed-borne diseases are of specific interest, with bacterial fruit blotch in *Cucumis melo* being of greatest concern, since phytosanitary issues have prevented the distribution of *Cucumis* germplasm to some countries. Please refer to the Plant Pathology Project section of this report for more information.

The Pollinator Program and the Vegetable Program also continued to collaborate on pollinator tests. Two *Cucurbita* accessions were each planted in eight cages as part of an insect-pollinator study to determine whether specially-made honeybee and bumble bee domicile-protection stands improved insect-pollinator performance within the large *Cucurbita* field cages. Results of the study will be analyzed after seed-viability tests are completed in April. For more information on this work, please refer to the Entomology section of the annual report.

Publications/Posters:
Cucumis zambianus (Cucurbitaceae), a New Species from Northwestern Zambia. 2008. Widrlechner, M.P., Kirkbride, J.H., Ghebretinsae, A.G., Reitsma, K.R. Systematic Botany. 33(4): pp. 732-738.

Plans for 2009:
Regenerations:
Forty accessions of *Daucus* were started in the greenhouse in October 2008 and 3 annual *Daucus* will be started in the greenhouse in March 2009 for the 2009 field cages. Sixty-five *Cucumis melo* collected from Turkmenistan in 2008 and another 15 *Cucumis* accessions will be started in the greenhouse for field-cage regeneration. Regenerations of wild *Cucumis* species will continue in the greenhouse as time, space, and other resources permit. We will continue to increase *Cucumis* and *Cucurbit* accessions where distribution quantity or viability has fallen below critical values. The *Cucumis melo* will be started in the greenhouse using the barrier system described in the 2006 NCRPIS Annual Report and NCRPIS Operations Manual to prevent the transmission of *Acidovorax avenae* ssp. *citrulli*.

Germinations:
Viability tests will be performed on the 2008 cucurbit regeneration seed lots in April 2009 and on the 2008 *Daucus* regeneration seed lots in the summer of 2009. Ten-year re-germination testing will be done as resources allow.

Characterization:
A 2-year observation planting of selected *Daucus* accessions will be direct seeded to the field in the spring of 2009 for characterization and taxonomic verification. Resulting data and images will be loaded into GRIN. We will also continue to record characterization data as regenerations occur on other vegetable accessions.

Review of accession passport data will continue on the cucurbit collections in preparation for assigning PI numbers to many of the Ames-numbered accessions in

the collections (414 *Cucumis*, 91 *Cucurbita*). Once PI numbers are assigned, labeling embedded in digital images acquired on these accessions will be updated with the new PI numbers and loaded to GRIN.

Evaluation:
Collaboration continues on improving the year-round cage and insect-pollinator program for regenerating vegetable crops. In 2009, the Vegetable Project and Entomology staff investigated ways to improve insect-pollinator effectiveness in the large *Cucurbita* cages by introducing protective structures around honey bee and *Bombus* (bumblebee) hives to prevent cucurbit vines from obstructing bee movement in and out of their domiciles. These protective structures will again be used in the regeneration cages in 2009 and additional observational data will be taken. For information on the preliminary results of the 2008 evaluation, please refer to the Entomology section of the annual report.

The Plant Pathology Project will continue to collaborate in monitoring the effectiveness of the cage program in reducing the incidence of and/or delaying the transmission of Squash Mosaic Virus and other insect-vectored diseases of cucurbits. They will also continue the greenhouse survey of the *Cucumis melo* distribution lots for the presence of *Acidovorax avenae* ssp. *citrulli*.

The Vegetable Project will start plants of six *Cucumis anguria* accessions in the greenhouse in March to evaluate pedicel length and development within this species to verify the species description as found in Dr. Kirkbride's "Biosystematic Monograph of the Genus *Cucumis* (Cucurbitaceae)".

I. Research Leader Activities (C. Gardner)

Administration and Leadership Activities:
I administer the five year project plan objectives for the USDA-ARS Plant Introduction Research Unit's two CRIS Projects, Plant Introduction Research and the Germplasm Enhancement of Maize (GEM) Project, and contribute to the coordination and execution of activities which support those objectives. I serve as the Coordinator of the Hatch-funded Multistate NC7 Project. I also serve as a member of the National Plant Germplasm Coordinating Committee, dedicated to increasing awareness and enhancing the operations of the NPGS across its components.

About 30% of my time in 2008 was devoted to assisting in the development of the GRIN-Global proposal and ensuring the project got off to a successful start. Funded in part by the Global Crop Diversity Trust via a grant from the Gates Foundation, and in part by the USDA-ARS through dedication of key personnel, the project's objective is to develop a rational genebank information management system which will be free of recurring license fees, database neutral, and can be used on either stand-alone or networked computers by any genebank in the world. Source code developed as a result of the project will be made freely available. The GRIN-Global system will replace the GRIN system in the U.S. in time.

The goals and timelines of the project are ambitious. A series of beta-prototypes of the Curator Tool have been released by the development team (sometimes daily) for testing by a limited group of U.S. and international curators and genebank personnel. A Release Candidate will be in the hands of selected genebank personnel for beta testing by the end of 2009. During the first half of 2010, a new public interface prototype will be available for testing. Bioversity will provide the expertise for translation of the interface into several languages, development of training and documentation materials, and training of international genebank personnel.

Pete Cyr, our Software Applications and Network Systems Information Specialist, serves as the project leader. Together with Mark Millard, our maize curator who serves as systems analyst for the project; Lisa Burke, our seed storage manager who serves as a primary beta tester; Brock Weaver, a contract software developer employed by Bioversity (Ames); Rachelle Little, a contract web developer employed by Bioversity (Ames); Joe Postman, pathologist with the ARS Corvallis, OR Natl. Clonal Germplasm Repository as a tester; the ARS GRIN Database Management Unit (DBMU) personnel; National Program Leader (and Project PI) Peter Bretting; and our Global Crop Diversity Trust and Bioversity partners, our development efforts will be primarily devoted to this critically important project for two more years.

Research Activities:
New graduate student Ivan Ayala-Diaz, a Fullbright Fellow from Columbia, is conducting his Ph.D. research on Thlaspi and Camelina under the guidance of Dr. Mark Westgate, ISU, and myself, and in collaboration with NCRPIS Oilseeds Curator Dr. Laura Marek.

Another new graduate student, Adam Vanous, is working on a M.S. project dealing with GEM Project germplasm and generation of dihaploid lines from introgressed maize racial materials.

Professional Interactions:
PGOC: Chair in 2008-2009. Key objectives of the PGOC during this time include the development and adoption of georeferencing standards for GRIN, facilitating feedback to contribute to development of GRIN-Global to meet system needs, and developing mechanisms to facilitate transfer of learning between sites and to increase the level of their interactions.

AAIC: President of the American Association of Industrial Crops (AAIC) in 2007-2008, and now as outgoing President responsible for society awards for 2009.

Year 2008 Table 1. NCRPIS Accessions (Accs), Acquired, Available

01/01/2008 to 12/31/2008

CURATOR	GENUS_CROP	Number Accs	Number Accs Acquired	Percent Acquired	Number Available	Percent Available	Percent Avail Last Year*
Brenner	NC7-amaranth	3342	13	0	3203	96	96
	NC7-celosia	55	3	5	27	49	52
	NC7-echinochloa	306	2	1	248	81	81
	NC7-grasses	123	1	1	76	62	63
	NC7-legumes	233	0	0	107	46	46
	NC7-melilotus	983	11	1	759	77	75
	NC7-panicum	947	0	0	905	96	96
	NC7-perilla	24	1	4	21	88	96
	NC7-quinoa	338	64	19	204	60	75
	NC7-setaria	1013	4	0	910	90	90
	NC7-spinach	405	4	1	347	86	88
	NC7-umbels	1102	0	0	610	55	50
	Total:	8871	103	1	7417	84	82
Marek	NC7-asters	352	0	0	78	22	29
	NC7-brassica	1994	0	0	1794	90	88
	NC7-crucifers	1138	8	1	943	83	76
	NC7-crucifers.pvp	1	0	0	0	0	0
	NC7-cuphea	639	0	0	508	79	78
	NC7-euphorbia	208	0	0	69	33	21
	NC7-flax	2834	0	0	2816	99	99
	NC7-flax.wilds	114	0	0	80	70	47
	NC7-sun.cults	1718	11	1	1622	94	93
	NC7-sun.wilds.ann	1361	2	0	1271	93	87
	NC7-sun.wilds.per	770	52	7	458	59	53
	NC7-sun.wilds.sp	11	0	0	5	45	50
	Total:	11140	73	1	9644	87	83
Medicinals	NC7-medicinals	452	8	1	289	64	60
	Total:	452	8	2	289	64	60
Millard	NC7-corn.kin	34	0	0	6	18	18
	NC7-maize.gems	83	0	0	83	100	0
	NC7-maize.inb	2253	17	1	1714	76	0
	NC7-maize.pop	17200	100	1	10981	64	0
	NC7-maize.pvp	174	33	19	158	91	0
	NC7-maize.wilds	347	0	0	61	18	0
	Zea.totals	20057	150	1	12997	65	64
	Total:	20091	150	1	13003	65	64
Reitsma	NC7-chicory	276	0	0	229	83	84
	NC7-cucumis.cucs	1364	1	0	1285	94	93
	NC7-cucumis.melo	3187	73	2	2281	72	74
	NC7-cucumis.wilds	327	1	0	144	44	43
	NC7-cucurbita	992	1	0	808	81	82
	NC7-daucus	1126	0	0	949	84	79
	NC7-ocimum	98	0	0	91	93	93
	NC7-parsnips	70	0	0	51	73	73
	Total:	7440	76	1	5838	78	79
Widrlechner	NC7-mints	144	3	2	103	72	70
	NC7-ornamentals	2175	151	7	988	45	45
	Total:	2319	154	7	1091	47	47
NCRPIS Total:		**50313**	**564**	**1**	**37282**	**74**	**73**

*Some Genus_Crop names are new for 2008.

Year 2008 Table 2. NCRPIS Accessions (Accs) Germinated, Regenerated, Made Available, Backed Up

01/01/2008 to 12/31/2008

CURATOR	GENUS_CROP	Number Accs	Number Accs Germed	Percent Accs Germed	Number Attempted Regen	Number Harvested Regen	Number Perm Perennial	Number Perennial Harvested (Vegetative)	Number Accs Made Available	Number Accs Growing	Number Accs Backed UP for YR	Total Number Accs Backed Up	Percent Accs Backed Up
Brenner	NC7-amaranth	3342	0	0	69	51	0	0	2	0	107	3210	96
	NC7-celosia	55	0	0	5	3	0	0	1	0	1	30	55
	NC7-echinochloa	306	1	0	9	1	0	0	1	0	31	262	86
	NC7-grasses	123	0	0	1	2	0	0	0	0	46	79	64
	NC7-legumes	233	2	1	1	1	0	0	0	0	0	174	75
	NC7-melilotus	983	32	3	1	12	0	0	31	0	204	832	85
	NC7-panicum	947	0	0	0	0	0	0	0	0	513	916	97
	NC7-perilla	24	20	83	2	2	0	0	0	0	0	22	92
	NC7-quinoa	338	6	2	9	5	0	0	1	0	1	208	62
	NC7-setaria	1013	0	0	13	11	0	0	0	0	60	951	94
	NC7-spinach	405	0	0	70	3	0	0	0	0	0	374	92
	NC7-umbels	1102	103	9	70	43	0	0	94	0	176	647	59
	Total:	8871	164	2	250	134	0	0	130	0	1139	7705	87
Marek	NC7-asters	352	0	0	7	2	0	0	5	0	5	88	25
	NC7-brassica	1994	39	2	14	34	0	0	35	1	337	1952	98
	NC7-crucifers	1138	40	4	52	50	12	0	38	44	40	979	86
	NC7-crucifers.pvp	1	0	0	0	0	0	0	0	0	0	1	100
	NC7-cuphea	639	9	1	15	4	0	0	10	0	6	582	91
	NC7-euphorbia	208	0	0	7	0	0	0	25	0	20	73	35
	NC7-flax	2834	256	9	8	1	0	0	9	0	888	2830	100
	NC7-flax.wilds	114	9	8	16	13	0	0	7	2	4	75	66
	NC7-sun.cults	1718	29	2	38	5	0	0	45	0	80	1649	96
	NC7-sun.wilds.ann	1361	34	2	39	34	0	0	84	0	732	1284	94
	NC7-sun.wilds.per	770	50	6	22	63	0	0	77	0	122	468	61
	NC7-sun.wilds.sp	11	0	0	0	0	0	0	0	0	1	5	45
	Total:	11140	466	4	218	206	12	0	335	47	2235	9986	90
Medicinals	NC7-medicinals	452	35	8	40	20	4	30	45	0	60	305	67
	Total:	452	35	8	40	20	4	30	45	0	60	305	67
Millard	NC7-corn.kin	34	0	0	3	1	0	0	0	0	0	8	24
	NC7-maize.gems	83	11	13	1	1	0	0	12	0	43	46	55
	NC7-maize.inb	2253	384	17	186	169	0	0	218	0	80	1445	64
	NC7-maize.pop	17200	966	6	402	375	0	0	128	0	204	13125	76
	NC7-maize.pvp	174	37	21	25	25	0	0	65	0	41	174	100
	NC7-maize.wilds	347	1	0	1	1	0	1	1	0	0	44	13
	Zea.totals	20057	1399	7	615	571	0	1	424	0	368	14834	74
	Total:	20091	1399	7	618	572	0	1	424	0	368	14842	74
Reitsma	NC7-chicory	276	0	0	0	0	0	0	0	0	87	243	88
	NC7-cucumis.cucs	1364	39	3	31	30	0	0	37	0	126	1286	94
	NC7-cucumis.melo	3187	15	0	3	3	0	0	15	0	13	2518	79
	NC7-cucumis.wilds	327	4	1	28	18	0	0	3	0	4	150	46
	NC7-cucurbita	992	2	0	20	19	0	0	2	0	38	801	81
	NC7-daucus	1126	67	6	64	63	0	0	26	0	262	955	85
	NC7-ocimum	98	1	1	0	0	0	0	0	0	19	91	93
	NC7-parsnips	70	0	0	0	0	0	0	0	0	0	47	67
	Total:	7440	128	2	146	133	0	0	83	0	549	6091	82
Widrlechner	NC7-mints	144	4	3	10	2	0	0	5	0	11	105	73
	NC7-ornamentals	2175	214	10	161	46	72	91	98	0	106	831	38
	Total:	2319	218	9	171	48	72	91	103	0	117	936	40
NCRPIS Total:		**50313**	**2410**	**5**	**1443**	**1113**	**88**	**122**	**1120**	**47**	**4468**	**39865**	**79**

Year 2008 Table 3A. External NCRPIS Distributions

01/01/2008 to 12/31/2008

			External Domestic Distributions				Foreign Distributions				External Domestic and Foreign Distributions			
CURATOR	GENUS_CROP	Number Accs in Collection	Number Accs	Number Orders	Number Recipients	Number Items	Number Accs	Number Orders	Number Recipients	Number Items	Number Accs	Number Orders	Number Recipients	Number Items
Brenner	NC7-amaranth	3342	185	37	36	222	164	15	15	224	291	52	51	446
	NC7-celosia	55	8	3	3	8	1	1	1	1	8	4	4	9
	NC7-echinochloa	306	3	3	2	3	10	2	2	10	12	5	4	13
	NC7-grasses	123	5	2	2	5	0	0	0	0	5	2	2	5
	NC7-legumes	233	66	6	5	67	18	5	5	19	78	11	10	86
	NC7-melilotus	983	264	18	13	406	5	2	2	5	268	20	15	411
	NC7-panicum	947	83	14	14	108	42	4	4	42	115	18	18	150
	NC7-perilla	24	18	3	3	24	19	2	2	20	19	5	5	44
	NC7-quinoa	338	92	33	31	146	84	17	14	150	132	50	45	296
	NC7-setaria	1013	83	16	16	101	205	8	8	215	249	24	24	316
	NC7-spinach	405	361	24	21	661	6	0	0	7	361	24	21	668
	NC7-umbels	1102	172	23	22	189	185	7	7	274	313	30	29	463
	Total:	8871	1340	182	168	1940	739	63	60	967	1851	245	228	2907
Marek	NC7-asters	352	20	12	11	23	7	2	2	7	20	14	13	30
	NC7-brassica	1994	609	52	43	729	937	22	21	1137	1233	74	64	1866
	NC7-crucifers	1138	216	46	37	294	353	13	13	364	520	59	50	658
	NC7-crucifers.pvp	1	0	0	0	0	0	0	0	0	0	0	0	0
	NC7-cuphea	639	81	18	15	98	0	0	0	0	81	18	15	98
	NC7-euphorbia	208	12	5	5	12	73	2	1	73	83	7	6	85
	NC7-flax	2834	62	11	11	63	174	5	5	180	230	16	16	243
	NC7-flax.wilds	114	4	3	3	4	18	3	3	20	22	6	6	24
	NC7-sun.cults	1718	772	57	48	1096	457	26	20	576	984	83	68	1672
	NC7-sun.wilds.ann	1361	459	27	23	538	166	13	13	186	521	40	36	724
	NC7-sun.wilds.per	770	96	22	21	121	170	9	9	209	229	31	30	330
	NC7-sun.wilds.sp	11	1	1	1	1	5	1	1	5	5	2	2	6
	Total:	11140	2332	254	218	2979	2360	96	88	2757	3928	350	306	5736
Medicinals	NC7-medicinals	452	157	33	30	222	10	1	1	10	161	34	31	232
	Total:	452	157	33	30	222	10	1	1	10	161	34	31	232
Millard	NC7-corn.kin	34	5	12	12	22	3	3	3	3	6	15	15	25
	NC7-maize.gems	83	81	25	21	275	54	2	2	54	81	27	23	329
	NC7-maize.inb	2253	1614	232	176	4667	348	39	33	511	1628	271	209	5178
	NC7-maize.pop	17200	1503	218	176	2205	114	16	15	133	1547	234	191	2338
	NC7-maize.pvp	174	153	177	95	1923	142	12	11	341	153	189	106	2264
	NC7-maize.wilds	347	41	48	47	172	12	12	11	29	42	60	58	201
	Zea.totals	20057	3392	540	351	9242	670	61	54	1068	3451	601	405	10310
	Total:	20091	3397	552	363	9264	673	64	57	1071	3457	616	420	10335
Reitsma	NC7-chicory	276	66	11	9	95	135	2	2	135	146	13	11	230
	NC7-cucumis.cucs	1364	324	41	38	426	407	13	12	549	583	54	50	975
	NC7-cucumis.melo	3187	1121	60	54	1689	541	25	21	642	1350	85	75	2331
	NC7-cucumis.wilds	327	77	13	11	183	61	10	7	94	100	23	18	277
	NC7-cucurbita	992	198	57	53	316	105	14	12	120	248	71	65	436
	NC7-daucus	1126	432	22	19	547	114	7	7	137	475	29	26	684
	NC7-ocimum	98	91	19	18	133	4	1	1	4	91	20	19	137
	NC7-parsnips	70	6	2	2	6	0	0	0	0	6	2	2	6
	Total:	7440	2315	225	204	3395	1367	72	62	1681	2999	297	266	5076
Widrlechner	NC7-mints	144	29	13	13	35	53	1	1	53	64	14	14	88
	NC7-ornamentals	2175	210	80	71	307	45	12	12	45	249	92	83	352
	Total:	2319	239	93	84	342	98	13	13	98	313	106	97	440
NCRPIS Total:		**50313**	**9780**	**1011**	**710**	**18142**	**5247**	**232**	**198**	**6584**	**12709**	**1243**	**908**	**24726**

Year 2008 Table 3B. Internal NCRPIS Distributions

01/01/2008 to 12/31/2008

			NC7 Related (# Accs)							Seed Storage Maintenance	
CURATOR	GENUS_CROP	Number Accs	Backed Up	Germed	Obs	Regen	Path Test	Total	# Distinct Accs for NC7 Orders	# Accs Stored	# Accs Ct Rev
Brenner	NC7-amaranth	3342	107	0	21	3	0	131	130	11	95
	NC7-celosia	55	1	0	0	5	0	6	6	1	0
	NC7-echinochloa	306	31	0	16	0	0	47	38	0	30
	NC7-grasses	123	46	1	0	0	0	47	47	0	46
	NC7-legumes	233	0	0	0	1	0	1	1	0	0
	NC7-melilotus	983	204	32	1	0	0	237	207	44	170
	NC7-panicum	947	513	0	13	0	0	526	522	0	508
	NC7-perilla	24	0	20	1	1	0	22	20	0	4
	NC7-quinoa	338	1	3	0	9	0	13	13	1	4
	NC7-setaria	1013	60	0	20	0	0	80	77	0	57
	NC7-spinach	405	0	0	0	70	0	70	70	0	5
	NC7-umbels	1102	176	89	14	66	0	345	262	100	26
	Total:	8871	1139	145	86	155	0	1525	1393	157	945
Marek	NC7-asters	352	5	73	0	6	0	84	83	5	1
	NC7-brassica	1994	337	34	504	50	0	925	755	34	605
	NC7-crucifers	1138	40	39	78	67	0	224	157	49	23
	NC7-crucifers.pvp	1	0	0	0	0	0	0	0	0	0
	NC7-cuphea	639	6	11	0	15	0	32	24	11	10
	NC7-euphorbia	208	20	0	0	7	0	27	26	0	5
	NC7-flax	2834	888	256	0	8	0	1152	1146	6	863
	NC7-flax.wilds	114	4	9	0	16	0	29	24	11	5
	NC7-sun.cults	1718	80	34	13	40	3	170	150	46	256
	NC7-sun.wilds.ann	1361	732	33	184	39	153	1141	892	104	569
	NC7-sun.wilds.per	770	122	50	2	23	0	197	157	115	58
	NC7-sun.wilds.sp	11	1	0	0	0	0	1	1	0	1
	Total:	11140	2235	539	781	271	156	3982	3415	381	2396
Medicinals	NC7-medicinals	452	60	14	1	40	0	115	101	41	61
	Total:	452	60	14	1	40	0	115	101	41	61
Millard	NC7-corn.kin	34	0	0	0	1	0	1	1	0	1
	NC7-maize.gems	83	43	11	5	1	16	76	44	11	10
	NC7-maize.inb	2253	80	401	623	167	60	1331	1055	305	401
	NC7-maize.pop	17200	204	762	3887	240	36	5129	4561	230	890
	NC7-maize.pvp	174	41	40	105	25	23	234	123	85	61
	NC7-maize.wilds	347	0	1	1	0	0	2	2	4	9
	Zea.totals	20057	368	1215	4621	433	135	6772	5785	635	1371
	Total:	20091	368	1215	4621	434	135	6773	5786	635	1372
Reitsma	NC7-chicory	276	87	0	0	0	0	87	87	0	4
	NC7-cucumis.cucs	1364	126	37	0	33	0	196	162	39	309
	NC7-cucumis.melo	3187	13	15	3	6	497	534	520	90	740
	NC7-cucumis.wilds	327	4	4	1	39	0	48	44	4	4
	NC7-cucurbita	992	38	17	4	20	0	79	77	3	10
	NC7-daucus	1126	262	67	85	122	1	537	466	41	285
	NC7-ocimum	98	19	1	3	0	0	23	23	0	1
	NC7-parsnips	70	0	17	0	0	0	17	17	0	0
	Total:	7440	549	158	96	220	498	1521	1396	177	1353
Widrlechner	NC7-mints	144	11	4	0	10	0	25	21	7	15
	NC7-ornamentals	2175	89	124	8	150	0	371	338	233	131
	Total:	2319	100	128	8	160	0	396	359	240	146
NCRPIS Total:		**50313**	**4451**	**2199**	**5593**	**1280**	**789**	**14312**	**12450**	**1631**	**6273**

Year 2008 Table 4. NCRPIS Accessions (Accs) Observations (Obs) in GRIN, Images in GRIN

01/01/2008 to 12/31/2008

CURATOR	GENUS_CROP	Number Accs	Number Accs Obs Trials	Number Obs in GRIN for Year	Number Acc Obs in GRIN for Year	Number Acc Obs in GRIN Last Year	Number Acc Obs in GRIN (all years)	Number Accs Imaged	Number Acc Images in GRIN for Year	Number Acc Images in GRIN (all years)
Brenner	NC7-amaranth	3342	21	42	33	3323	3324	130	32	397
	NC7-celosia	55	0	4	3	0	9	3	3	8
	NC7-echinochloa	306	16	0	0	23	294	8	0	23
	NC7-grasses	123	0	0	0	10	11	3	0	10
	NC7-legumes	233	0	0	0	3	88	1	0	4
	NC7-melilotus	983	1	3400	973	17	973	16	20	37
	NC7-panicum	947	13	9	9	20	939	12	9	27
	NC7-perilla	24	1	0	0	0	0	2	0	1
	NC7-quinoa	338	0	14	14	25	245	6	14	39
	NC7-setaria	1013	20	6	6	38	995	40	6	30
	NC7-spinach	405	0	2	1	0	401	3	1	1
	NC7-umbels	1102	14	1225	65	218	226	28	5	5
	Total:	8871	86	4702	1104	3677	7505	252	90	582
Marek	NC7-asters	352	0	0	0	0	4	0	0	0
	NC7-brassica	1994	504	116	69	1654	1901	0	0	332
	NC7-crucifers	1138	78	114	57	672	822	9	0	330
	NC7-crucifers.pvp	1	0	0	0	0	1	0	0	0
	NC7-cuphea	639	0	11	10	29	367	1	0	8
	NC7-euphorbia	208	0	0	0	0	0	0	0	0
	NC7-flax	2834	0	28	6	0	2824	5	0	0
	NC7-flax.wilds	114	0	135	21	24	82	0	0	2
	NC7-sun.cults	1718	13	837	35	100	1657	12	0	25
	NC7-sun.wilds.ann	1361	184	689	52	73	1263	64	0	22
	NC7-sun.wilds.per	770	2	1641	149	168	551	31	1	72
	NC7-sun.wilds.sp	11	0	0	0	0	6	0	0	0
	Total:	11140	781	3571	399	2720	9478	122	1	791
Medicinals	NC7-medicinals	452	1	577	263	0	291	44	264	266
	Total:	452	1	577	263	0	291	44	264	266
Millard	NC7-corn.kin	34	0	0	0	0	0	0	0	0
	NC7-maize.gems	83	5	23	9	26	83	2	0	73
	NC7-maize.inb	2253	623	5790	846	119	2071	375	4	574
	NC7-maize.pop	17200	3887	8841	1053	2211	14442	937	27	4144
	NC7-maize.pvp	174	105	987	118	90	172	64	3	132
	NC7-maize.wilds	347	1	0	0	0	235	0	0	107
	Zea.totals	20057	4621	15641	2026	2446	17003	1378	34	5030
	Total:	20091	4621	15641	2026	2446	17003	1378	34	5030
Reitsma	NC7-chicory	276	0	284	204	0	274	0	204	204
	NC7-cucumis.cucs	1364	0	176	165	814	1363	32	55	861
	NC7-cucumis.melo	3187	3	226	160	40	3106	77	25	435
	NC7-cucumis.wilds	327	1	0	0	0	292	18	0	1
	NC7-cucurbita	992	3	2783	987	0	987	4	27	69
	NC7-daucus	1126	85	398	304	0	1124	41	0	0
	NC7-ocimum	98	3	21	19	0	98	1	0	0
	NC7-parsnips	70	0	152	70	0	70	0	0	0
	Total:	7440	95	4040	1909	854	7314	173	311	1570
Widrlechner	NC7-mints	144	0	13	7	19	26	4	7	27
	NC7-ornamentals	2175	13	4369	255	106	479	174	256	448
	Total:	2319	13	4382	262	125	505	178	263	475
NCRPIS Total:		**50313**	**5597**	**32913**	**5963**	**9822**	**42096**	**2147**	**963**	**8714**

Year 2008 Table 5. Five-Year Summary of NCRPIS Accession Orders by Crop

CURATOR	GENUS_CROP	TIME_PERIOD	Number Orders	Number Recipients	Number Items Distributed	Number Accessions Distributed
Brenner	NC7-amaranth	01/01/2004 - 12/31/2004	39	37	470	350
		01/01/2005 - 12/31/2005	59	53	539	228
		01/01/2006 - 12/31/2006	59	53	3230	2630
		01/01/2007 - 12/31/2007	56	50	532	310
		01/01/2008 - 12/31/2008	52	51	446	291
	Total:		265	244	5217	3809
	NC7-celosia	01/01/2004 - 12/31/2004	4	4	5	4
		01/01/2005 - 12/31/2005	5	5	7	6
		01/01/2006 - 12/31/2006	9	8	31	21
		01/01/2007 - 12/31/2007	8	8	35	21
		01/01/2008 - 12/31/2008	4	4	9	8
	Total:		30	29	87	60
	NC7-echinochloa	01/01/2004 - 12/31/2004	7	7	31	27
		01/01/2005 - 12/31/2005	5	5	58	56
		01/01/2006 - 12/31/2006	19	16	49	24
		01/01/2007 - 12/31/2007	5	5	15	14
		01/01/2008 - 12/31/2008	5	4	13	12
	Total:		41	37	166	133
	NC7-grasses	01/01/2004 - 12/31/2004	0	0	0	0
		01/01/2005 - 12/31/2005	1	1	3	3
		01/01/2006 - 12/31/2006	7	6	9	7
		01/01/2007 - 12/31/2007	2	2	6	5
		01/01/2008 - 12/31/2008	2	2	5	5
	Total:		12	11	23	20
	NC7-legumes	01/01/2004 - 12/31/2004	3	3	83	75
		01/01/2005 - 12/31/2005	7	6	28	24
		01/01/2006 - 12/31/2006	6	6	15	11
		01/01/2007 - 12/31/2007	2	2	9	9
		01/01/2008 - 12/31/2008	11	10	86	78
	Total:		29	27	221	197
	NC7-melilotus	01/01/2004 - 12/31/2004	9	7	68	58
		01/01/2005 - 12/31/2005	16	14	83	73
		01/01/2006 - 12/31/2006	12	10	56	49
		01/01/2007 - 12/31/2007	12	11	41	27
		01/01/2008 - 12/31/2008	20	15	411	268
	Total:		69	57	659	475
	NC7-panicum	01/01/2004 - 12/31/2004	9	8	920	877
		01/01/2005 - 12/31/2005	11	11	80	68
		01/01/2006 - 12/31/2006	22	21	77	42
		01/01/2007 - 12/31/2007	11	10	21	20
		01/01/2008 - 12/31/2008	18	18	150	115
	Total:		71	68	1248	1122
	NC7-perilla	01/01/2004 - 12/31/2004	3	3	21	14
		01/01/2005 - 12/31/2005	11	11	74	22
		01/01/2006 - 12/31/2006	14	14	102	22
		01/01/2007 - 12/31/2007	6	6	21	14
		01/01/2008 - 12/31/2008	5	5	44	19
	Total:		39	39	262	91
	NC7-quinoa	01/01/2004 - 12/31/2004	19	18	98	58
		01/01/2005 - 12/31/2005	32	30	302	138
		01/01/2006 - 12/31/2006	37	31	401	196
		01/01/2007 - 12/31/2007	40	37	307	128
		01/01/2008 - 12/31/2008	50	45	296	132
	Total:		178	161	1404	652

	NC7-setaria	01/01/2004 - 12/31/2004	12	12	131	116
		01/01/2005 - 12/31/2005	10	9	150	125
		01/01/2006 - 12/31/2006	23	21	227	177
		01/01/2007 - 12/31/2007	16	16	317	225
		01/01/2008 - 12/31/2008	24	24	316	249
	Total:		85	82	1141	892
	NC7-spinach	01/01/2004 - 12/31/2004	15	14	80	71
		01/01/2005 - 12/31/2005	12	12	399	370
		01/01/2006 - 12/31/2006	26	26	1619	377
		01/01/2007 - 12/31/2007	19	18	1196	374
		01/01/2008 - 12/31/2008	26	23	668	361
	Total:		98	93	3962	1553
	NC7-umbels	01/01/2004 - 12/31/2004	33	32	353	193
		01/01/2005 - 12/31/2005	27	25	239	215
		01/01/2006 - 12/31/2006	36	33	189	136
		01/01/2007 - 12/31/2007	30	29	199	164
		01/01/2008 - 12/31/2008	30	29	463	313
	Total:		156	148	1443	1021
	Brenner Total:		1073	996	15833	10025
Marek	NC7-asters	01/01/2004 - 12/31/2004	4	4	7	6
		01/01/2005 - 12/31/2005	9	9	73	70
		01/01/2006 - 12/31/2006	14	12	61	54
		01/01/2007 - 12/31/2007	7	6	16	16
		01/01/2008 - 12/31/2008	14	13	30	20
	Total:		48	44	187	166
	NC7-brassica	01/01/2004 - 12/31/2004	57	50	4347	1735
		01/01/2005 - 12/31/2005	56	54	1688	1286
		01/01/2006 - 12/31/2006	70	56	2532	1421
		01/01/2007 - 12/31/2007	64	49	1754	1047
		01/01/2008 - 12/31/2008	74	64	1866	1233
	Total:		321	273	12187	6722
	NC7-crucifers	01/01/2004 - 12/31/2004	31	27	1403	793
		01/01/2005 - 12/31/2005	52	48	1486	497
		01/01/2006 - 12/31/2006	34	32	358	208
		01/01/2007 - 12/31/2007	48	43	840	413
		01/01/2008 - 12/31/2008	59	50	658	520
	Total:		224	200	4745	2431
	NC7-crucifers.pvp	01/01/2004 - 12/31/2004	0	0	0	0
		01/01/2005 - 12/31/2005	0	0	0	0
		01/01/2006 - 12/31/2006	0	0	0	0
		01/01/2007 - 12/31/2007	0	0	0	0
		01/01/2008 - 12/31/2008	0	0	0	0
	Total:		0	0	0	0
	NC7-cuphea	01/01/2004 - 12/31/2004	14	10	229	180
		01/01/2005 - 12/31/2005	20	13	451	277
		01/01/2006 - 12/31/2006	21	16	337	254
		01/01/2007 - 12/31/2007	19	10	720	507
		01/01/2008 - 12/31/2008	18	15	98	81
	Total:		92	64	1835	1299
	NC7-euphorbia	01/01/2004 - 12/31/2004	1	1	3	2
		01/01/2005 - 12/31/2005	1	1	1	1
		01/01/2006 - 12/31/2006	4	4	15	13
		01/01/2007 - 12/31/2007	4	3	10	8
		01/01/2008 - 12/31/2008	7	6	85	83
	Total:		17	15	114	107
	NC7-flax	01/01/2004 - 12/31/2004	16	15	211	201
		01/01/2005 - 12/31/2005	14	14	1677	1441
		01/01/2006 - 12/31/2006	19	18	1284	1199
		01/01/2007 - 12/31/2007	8	8	60	56
		01/01/2008 - 12/31/2008	16	16	243	230
	Total:		73	71	3475	3127

	NC7-flax.wilds	01/01/2004 - 12/31/2004	6	6	69	32
		01/01/2005 - 12/31/2005	6	6	34	30
		01/01/2006 - 12/31/2006	8	8	138	65
		01/01/2007 - 12/31/2007	4	3	19	19
		01/01/2008 - 12/31/2008	6	6	24	22
	Total:		30	29	284	168
	NC7-sun.cults	01/01/2004 - 12/31/2004	38	31	309	209
		01/01/2005 - 12/31/2005	62	46	1633	788
		01/01/2006 - 12/31/2006	56	44	468	346
		01/01/2007 - 12/31/2007	64	47	754	541
		01/01/2008 - 12/31/2008	83	68	1672	984
	Total:		303	236	4836	2868
	NC7-sun.wilds	01/01/2004 - 12/31/2004	44	35	550	387
		01/01/2005 - 12/31/2005	54	39	1058	784
		01/01/2006 - 12/31/2006	45	40	1072	648
		01/01/2007 - 12/31/2007	43	39	1303	1107
		01/01/2008 - 12/31/2008	58	52	1060	755
	Total:		244	205	5043	3681
	Marek Total:		1352	1137	32706	20569
McCoy	NC7-medicinals	01/01/2004 - 12/31/2004	31	29	221	112
		01/01/2005 - 12/31/2005	58	49	378	185
		01/01/2006 - 12/31/2006	44	35	323	163
		01/01/2007 - 12/31/2007	58	48	358	181
		01/01/2008 - 12/31/2008	34	31	232	161
	McCoy Total:		225	192	1512	802
Millard	NC7-corn.kin	01/01/2004 - 12/31/2004	8	8	11	6
		01/01/2005 - 12/31/2005	7	7	11	6
		01/01/2006 - 12/31/2006	16	14	34	6
		01/01/2007 - 12/31/2007	14	14	28	6
		01/01/2008 - 12/31/2008	15	15	25	6
	Total:		60	58	109	30
	NC7-maize.gems	01/01/2004 - 12/31/2004	24	21	310	66
		01/01/2005 - 12/31/2005	13	12	142	66
		01/01/2006 - 12/31/2006	28	25	334	66
		01/01/2007 - 12/31/2007	23	22	381	67
		01/01/2008 - 12/31/2008	27	23	329	81
	Total:		115	103	1496	346
	NC7-maize.inb	01/01/2004 - 12/31/2004	160	124	1892	961
		01/01/2005 - 12/31/2005	161	132	1633	604
		01/01/2006 - 12/31/2006	265	197	2956	760
		01/01/2007 - 12/31/2007	259	203	3314	919
		01/01/2008 - 12/31/2008	271	209	5178	1628
	Total:		1116	865	14973	4872
	NC7-maize.pop	01/01/2004 - 12/31/2004	149	127	1438	1055
		01/01/2005 - 12/31/2005	149	135	1302	1005
		01/01/2006 - 12/31/2006	195	163	2132	1463
		01/01/2007 - 12/31/2007	207	174	1722	1016
		01/01/2008 - 12/31/2008	234	191	2338	1547
	Total:		934	790	8932	6086
	NC7-maize.pvp	01/01/2004 - 12/31/2004	69	39	608	43
		01/01/2005 - 12/31/2005	103	51	1095	76
		01/01/2006 - 12/31/2006	214	95	2202	111
		01/01/2007 - 12/31/2007	188	106	3181	130
		01/01/2008 - 12/31/2008	189	106	2264	153
	Total:		763	397	9350	513
	NC7-maize.wilds	01/01/2004 - 12/31/2004	46	43	225	82
		01/01/2005 - 12/31/2005	46	43	253	77
		01/01/2006 - 12/31/2006	59	49	303	77
		01/01/2007 - 12/31/2007	67	62	272	43
		01/01/2008 - 12/31/2008	60	58	201	42
	Total:		278	255	1254	321

	Zea.totals	01/01/2004 - 12/31/2004	334	241	4473	2207
		01/01/2005 - 12/31/2005	381	275	4425	1828
		01/01/2006 - 12/31/2006	585	356	7927	2477
		01/01/2007 - 12/31/2007	553	376	8870	2175
		01/01/2008 - 12/31/2008	601	405	10310	3451
		Total:	2454	1653	36005	12138
		Millard Total:	2514	1711	36114	12168
Reitsma	NC7-chicory	01/01/2004 - 12/31/2004	5	4	45	43
		01/01/2005 - 12/31/2005	9	9	257	118
		01/01/2006 - 12/31/2006	10	9	44	38
		01/01/2007 - 12/31/2007	5	5	203	162
		01/01/2008 - 12/31/2008	13	11	230	146
		Total:	42	38	779	507
	NC7-cucumis	01/01/2004 - 12/31/2004	73	64	1394	1106
		01/01/2005 - 12/31/2005	102	91	4761	2140
		01/01/2006 - 12/31/2006	126	108	3970	2096
		01/01/2007 - 12/31/2007	115	94	3368	1866
		01/01/2008 - 12/31/2008	121	106	3583	2033
		Total:	537	463	17076	9241
	NC7-cucurbita	01/01/2004 - 12/31/2004	38	35	702	490
		01/01/2005 - 12/31/2005	51	49	1567	828
		01/01/2006 - 12/31/2006	58	52	424	300
		01/01/2007 - 12/31/2007	41	36	525	323
		01/01/2008 - 12/31/2008	71	65	436	248
		Total:	259	237	3654	2189
	NC7-daucus	01/01/2004 - 12/31/2004	21	21	596	378
		01/01/2005 - 12/31/2005	24	24	493	375
		01/01/2006 - 12/31/2006	33	32	460	356
		01/01/2007 - 12/31/2007	24	21	330	284
		01/01/2008 - 12/31/2008	29	26	684	475
		Total:	131	124	2563	1868
	NC7-ocimum	01/01/2004 - 12/31/2004	22	22	235	84
		01/01/2005 - 12/31/2005	23	21	204	85
		01/01/2006 - 12/31/2006	21	21	123	69
		01/01/2007 - 12/31/2007	11	10	68	51
		01/01/2008 - 12/31/2008	20	19	137	91
		Total:	97	93	767	380
	NC7-parsnips	01/01/2004 - 12/31/2004	3	3	5	4
		01/01/2005 - 12/31/2005	1	1	1	1
		01/01/2006 - 12/31/2006	3	3	22	15
		01/01/2007 - 12/31/2007	3	3	8	8
		01/01/2008 - 12/31/2008	2	2	6	6
		Total:	12	12	42	34
		Reitsma Total:	1078	967	24881	14219
Widrlechner	NC7-mints	01/01/2004 - 12/31/2004	17	16	45	28
		01/01/2005 - 12/31/2005	18	17	61	38
		01/01/2006 - 12/31/2006	19	19	55	37
		01/01/2007 - 12/31/2007	10	10	54	47
		01/01/2008 - 12/31/2008	14	14	88	64
		Total:	78	76	303	214
	NC7-ornamentals	01/01/2004 - 12/31/2004	66	64	289	212
		01/01/2005 - 12/31/2005	67	61	262	187
		01/01/2006 - 12/31/2006	89	76	431	318
		01/01/2007 - 12/31/2007	75	71	267	195
		01/01/2008 - 12/31/2008	92	83	352	249
		Total:	389	355	1601	1161
		Widrlechner Total:	467	431	1904	1375
NCRPIS Total:			**6709**	**5434**	**112950**	**59158**

Year 2008 Table 6. **NC7 CSREES Regional Order History**

Time Period	Total Number of Orders	Number of Orders (DI)	Foreign Orders (DI)	Domestic Orders (DI)	Domestic Orders (DI) CSREES Regions NC7	NE9	S9	W6
01/01/2008 to 12/31/2008	1569	1243	232	1011	488	114	201	208
01/01/2007 to 12/31/2007	1495	1138	240	898	455	113	181	149
01/01/2006 to 12/31/2006	1510	1184	249	935	507	111	184	133
01/01/2005 to 12/31/2005	1226	930	175	755	348	77	198	132
01/01/2004 to 12/31/2004	1045	787	164	623	287	71	159	106
01/01/2003 to 12/31/2003	871	614	158	456	204	49	100	103
01/01/2002 to 12/31/2002	1031	779	170	609	304	71	133	101

Note: Total Number of Orders includes all orders handled, including NC7 orders.

Year 2008 Figure 1.