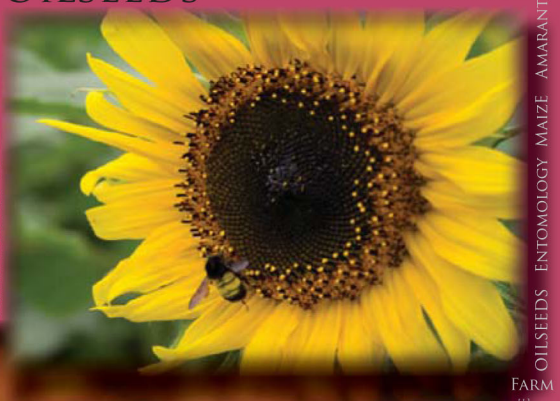
North Central Regional Plant Introduction Station

NCRPIS

AMES, IOWA



USDA/ARS
NC7 Annual Report
January 1- December 31, 2013

NCRPIS ANNUAL REPORT - 2013

TABLE OF CONTENTS

NORTH CENTRAL REGIONAL PLANT INTRODUCTION STATION
NC-7 ANNUAL REPORT, JANUARY 1 - DECEMBER 31, 2013

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, USDA-ARS, Iowa

C. State Experiment Stations Representatives

Voting members:

1. Illinois	E. Sacks	7. Missouri	J. Shannon
2. Indiana	J. Janick	8. Nebraska	D. Santra
3. Iowa	T. Lübberstedt	9. N. Dakota	B. Johnson
4. Kansas	M. Stamm	10. Ohio	P. Jourdan
5. Michigan	A. Iezzoni	11. S. Dakota	Vacant
6. Minnesota	Vacant	12. Wisconsin	W. Tracy

Non-voting participants:

13. California-Davis	R. Karban	24. Missouri	S. Flint Garcia
14. Connecticut	M. Brand	25. Missouri	S. Jose
15. Delaware	R. Wisser	26. Nebraska	C. Urea
16. Illinois	J. Juvick	27. New Jersey	S. Handel
17. Illinois	G. Kling	28. New Jersey	T. Molnar
18. Illinois	S. Korban	29. New York	P. Griffiths
19. Illinois	D. Lee	30. New York	M. Smith
20. Iowa	K. Lamkey	31. Texas	D. Baltensperger
21. Kansas	A. Fritz	32. Wisconsin	N. de Leon
22. Kentucky	T. Phillips	33. Wisconsin	S. Kaeppler
23. Michigan	J. Hancock		

D. U. S. Department of Agriculture (*Voting members)

1. ARS National Program Staff, Plant Germplasm	*P. Bretting
2. ARS Plant Exchange Office	*G. Kinard
3. ARS Area Director, Midwest Area	R. Matteri
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	*S. Greene

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 - July, 2013 – June, 2014:

Departures:

- Dr. Michael Blanco, GEM Coordinator/Maize Geneticist, retired June, 2014
- Bill Van Roekel, Pathology Agri. Research Science Technician, January, 2014

Promotion:

- Jeff Carstens, from Horticulture Agri. Research Science Technician to Category III Horticulturist, Woody Ornamentals

New Hires:

- Vivian Bernau, Temporary Research Technician, GEM, January, 2014
- Michael Peters, Agri. Research Science Technician, GEM, February, 2014

Transitions:

- Jesse Perrett, IT Specialist Network Administration / Security, February 2014 (converted from a Pathways Trainee position following completion of M.S.)

Vacant Positions:

- Pathology Agri. Research Science Technician
- GEM Project Coordinator / Maize Geneticist Entomology Agri. Research Science Technician
- Two Biological Science Technicians, support for germination and seed storage; one restored since sequestration
- Entomology Agri. Research Science Technician (vacant since 2010)

Management of Federal and ISU Student Temporary Employees:

USDA-ARS resources provided for 19 student part-time temporary positions in FY 2013. The temporary 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 or ARS technicians. Marci Bushman and Susan Siev managed the administrative aspects of all federal student hires, with support and guidance from Ames ARS HR Specialist Kim Grandon and Admin. Officer Carol Moran.

Budget:

As a result of federal sequestration in FY 2012, support for the two ARS CRIS projects was decreased by 7.38%. The CRIS funding that supports plant genetic resource conservation activities decreased from $2,288,999 to $2,120,271, or $168,928, which held throughout FY2013. The CRIS Project that supports the Germplasm Enhancement of Maize Project (GEM) decreased from $1,118,053 to $1,036,282, or $82,571. We are grateful that Hatch funding resources were maintained during this difficult time.

Sequestration at the start of FY 2014 had serious impacts on our ability to accomplish timely harvest. Only three federal 'essential' designated employees were allowed to work. NCRPIS state employees continued to work, but could not use any equipment purchased with federal funds, including all of the station's computers.

They were able to use an old small tractor and flatbed trailer owned by ISU to move harvested material from the field.

Fortunately, we received additional FY2014 USDA-ARS allocations which restored FY2011 funding levels for both projects and about $60,000 more, with implementation instructions to support maize curation and GRIN-Global System development. Student hiring for summer 2014 is at full capacity. We have received approval to hire additional technical staff for seed storage and germination, and to fill the vacant pathology technician and GEM Coordinator positions. Hopefully by next year's report these positions will be filled.

Further reductions in funding will force reduction in student hiring, necessary for executing our genebank's mission. Like many other research units, our ability to cover all aspects of our mission is challenged; our personnel strive to cover all functions and serve the collections entrusted to us and our stakeholders to the best of our ability.

We appreciate the support of the Agricultural Experiment Stations of the North Central Region, which have maintained their annual support and continued to provide $522,980 in Hatch funds. These funds support the salaries of our nine ISU staff members, their professional travel, and some expenses. In addition, Iowa State University's Agricultural Experiment Station provides support valued at over $400,000 annually that supports infrastructure, administration, and benefits for current NCRPIS-ISU staff members and retirees.

Dr. Charles Block's Sclerotinia Initiative funding supports student labor and supplies used for this research.

Construction and Facilities:
In fall of 2012, fire destroyed one of two gas-fired dryer burners and a plenum on the outside of the building; the drying bins on the inside of the building and the building itself were not damaged, fortunately. In 2013 both units were replaced including the undamaged unit with newer technology that provides better safety controls at a cost of $82,000.

In cooperation with ISU, the telecommunications infrastructure within the station was upgraded to10 gigabit capability in FY2012, and the servers were relocated to an environmentally controlled room, remodeled and upgraded for this use. In FY2013 ISU completed needed improvements to the air conditioning equipment to provide for consistent temperature control in the server rooms.

Equipment:
All telephones at the station were upgraded to new internet protocol (ip) phones in order to be compatible with new campus VOIP hardware, which also reduced monthly costs. All NCRPIS workstations were upgraded to Windows 7 except for two with legacy software or connected lab equipment; the latter are not connected to the internet. Surplus servers were acquired from the Natl. Center for Animal Health in Ames. Changes directed towards energy savings and improving plant growth conditions include design and installation of on-demand tankless water

heaters to three greenhouses to temper the water used for watering the plants; design and installation of a new greenhouse watering and fertilizer injection system in Greenhouse #3 to improve efficiency of the water and nutrient delivery; and replacement of T-12 light fixtures.

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

(Part IV. summarizes the accomplishments and progress for calendar year 2013 presented in greater detail in the individual staff reports in the document.)

Acquisition and Documentation Highlights:
In 2013, (Appendix Table 1) 192 new accessions were acquired. Of these, 119 were a result of NPGS exploration and transfers and include *Daucus* and miscellaneous umbels from Morocco; wild *Helianthus* and woody species from the U.S.; ornamentals from China, Albania and Russia, and an Amaranth cultivar donated by Seeds of Change. The remaining 78 include Germplasm Enhancement of Maize (GEM) Project lines and *H. annuus* from Texas A&M University. This compares with 470 new accessions in 2012, 485 in 2011, 516 in 2010, and 521 in 2009.

In 2013 our staff participated in collection expeditions that acquired *Fraxinus quadrangulata, Quercus muehlenbergii,* and other ornamentals from Iowa, Illinois, Indiana, Kansas, Kentucky, and Missouri; and *Helianthus* from California and southwestern Oregon, including a newly reported wild perennial sunflower species.

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. Excellent quantities of seed provided by collectors of many new accessions have made a significant proportion available and distributable immediately.

Permanent PI numbers were assigned to 169 accessions in 2013. Taxonomic re-identification was completed for 33 accessions; nine accessions were nominated for inactivation. 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 in order to provide useful visual references for comparison of regeneration lots with original samples.

Regeneration and Maintenance Highlights:
In 2013, 1,184 accessions were newly grown for regeneration and 1,048 were harvested in 2013, as compared to 759 accessions grown for regeneration and 954 harvested in 2012, and 1,069 grown and 1,017 harvested in 2008 (Appendix Table 2). The entire UGA-SAM1 *Helianthus* association mapping population (288 cultivated lines) was regenerated. 2013 growing conditions can be summarized as too wet early, dry in June-July, and generally cooler than normal during flowering time. An additional 422 perennials are grown in permanent plantings. About 780 accessions

were made available to the public. Accessions backed up at the NCGRP in Ft. Collins in 2013 numbered 781, compared with 799 in 2012, 792 in 2011, 2,388 in 2010 and 1,848 in 2009. Eighty percent of NCRPIS collection holdings are backed up at the NCGRP (Appendix Table 2). Overall collection availability is 76%, an increase of 2% since 2012, despite 6% growth in collection size since 2006. Additional accessions (351) were sent to Ft. Collins for assembly with accessions from other NPGS sites for deposit to the Svalbard Global Germplasm Vault.

Horticulturist D. Barney's report details significant efforts to analyze and prioritize ornamental collection holdings.

Assistance in regeneration was provided by USDA-ARS staff of Parlier, CA for increase of wild *Helianthus* taxa. *Daucus* regeneration efforts were supported by seed increases from Seminis Vegetable Seeds (R. Yzquierdo) and Nunhems (R. Freeman). Maize regeneration and observation assistance for 50 tropical maize populations was provided by Monsanto (D. Butruille) in Hawaii. T. Foley regenerated 14 expired maize PVPs at various locations. USDA-ARS staff of Mayaguez, PR and the St. Croix quarantine nursery staff supported regeneration of 86 maize accessions. Ames GEM Project Coordinator M. Blanco provided increase seed of 10 newly released GEM lines. Raleigh GEM Project Coordinator Matt Krakowsky provided increases of 12 GEM lines. USDA-ARS staff in Puerto Rico increased 20 tropical accessions. Spinach regenerations continue to be supported by cooperative efforts between the USDA-ARS and Sakata Seed America, Inc. in Salinas, CA.

Distribution:
2013 external distributions included 40,409 items of 17,788 unique accessions to fulfill 1,523 orders from 1,204 requestors. This compares with the record 2012 distribution of 45,115 items of 18,811 unique accessions to fulfill 1,632 orders from 1,344 requestors; 2011 distributions of 38,402 items of 18,634 unique accessions to fulfill 1,501 orders from 1,180 requestors; 2010 distributions of 26,651 items of 13,226 accessions; and 2009 distributions of 26,904 items of 13,515 accessions to fulfill 1,487 orders from 1,081 requestors. Approximately 36% were distributed internationally and 64% to domestic researchers, (Appendix Table 3A). The relative numbers of distributions generally correlate well with the proportional makeup of the collections and vary from year to year, although demand for maize is usually greater than for other crops.

Curator	Collection Size 2013	% of Total Collections	% of 2013 Distributions	Collection Size 2013	% of Total Collections	% of 2013 Distributions
Barney	1508	3	1	1507	3	1
Brenner	9013	17	14	8985	17	9
Carstens	1765	3	<1	1709	3	
Marek	11885	23	27	11548	22	28
Millard	20724	39	33	20679	40	44
Reitsma	7710	15	24	7695	15	18
Totals	**52605**	**100**	**100**	**52123**	**100**	**100**

Research demand for our plant genetic resource collections continues to be very high; requests for diversity and relationship analyses, disease resistance, biofuel, and health and nutrition contribute increasingly to these increases, as well as for basic research applications such as photoperiod response, and an array of performance traits. Demand for *Zea mays* inbred lines, vegetables, *Helianthus*, Brassicaceae, flax, *Daucus,* quinoa and the culinary umbels for evaluation and characterization were particularly high. Maize inbred requests were driven by the continuing publication of information from genomic (genotyping by sequencing) and phenotypic analyses projects. The maize curator collaborated with MaizeGDB personnel toprovide a tool, the TYPSimSelector, at http://alpha.maizedb.org. This application allows genotypic comparison of 2,500 inbred accessions using 680,000 SNP markers to establish identity by sequence (IBS) relationships.

NPGS curators at all sites continue to receive many requests from individuals not affiliated with research institutions, generally for home gardening (Table 3B). 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 inform these requestors about plant genetic resource conservation and encourage interested individuals to save seeds, conserve them, and share germplasm and associated information. The proliferation of websites instructing non-research requestors how to deceive curators at various germplasm sites in order to get free germplasm continues to be problematic. 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.

Evaluation and Characterization:
In 2013, the NCRPIS utilized 1,026 accessions for internal observation, evaluation and characterization for a wide array of descriptor information, viability testing, pathology tests and back up. About 14,150 observations associated with 1,685 accessions were entered in the GRIN database (http://www.ars.grin.gov/npgs/). About 12,000 images were added to GRIN (Appendix Table 4).

Information technology and telecommunications:
The NCRPIS staff continues to provide expertise and leadership for the development of GRIN-Global (GG), the successor to the GRIN system; this has become the primary focus of two NCRPIS staff members, with substantial time by additional personnel. This project was undertaken as a partnership between USDA-ARS, Bioversity International 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 301 Leader, Peter Bretting, was the PI for this agreement. With the release of GRIN-Global V1.8 to the international community at the start of 2013, efforts were re-focused on gap analysis and programming to address implementation needs of the National Plant Germplasm System (NPGS). Release of V2.0 to the global community is anticipated in 2013.

The Database Management Unit (DBMU) in Beltsville, MD hosts the GRIN system and has the lead responsibility for NPGS implementation of GRIN-Global. Ames-based development team members include P. Cyr, our Applications Software

Development IT Specialist, Project Manager; M. Millard, Maize Curator and Business Analyst; L. Burke, Seed Storage Manager and beta tester; and C. Gardner, RL. In 2012 several Ames curators also devoted considerable time to system testing. A number of other NPGS genebank site personnel are involved in testing and gap analysis, and provide valuable input on NPGS germplasm community needs.

Please see the IT section for technical details of NCRPIS support activities.

Germplasm's Viability and Health:
Over 1,122 or 2% of the NCRPIS collections, were tested for viability in 2013, significantly fewer than in prior years due to a vacant technical position, budget challenges, and the need to direct student labor resources to other projects and the consequent labor constraints (Appendix Table 2). A germination technical position has been restored and the hiring process initiated. Our storage conditions (4 C, 25-35% relative humidity) are very good, and the efforts devoted to seed cleaning ensure storage of very clean seed lots, important to longevity of viability. We also need to add a field in the new GRIN-Global System that differentiates simple viability from 'pure live seed.' Dormant seeds that do not readily germinate should be considered in the context of accession viability.

Horticulturalist D. Barney's section reports research results for germination protocols for *Hypericum* and *Actaea*.

Pathology team research (C. Block) focused on combining greenhouse and field resistance screening methods for Sclerotinia stalk rot in wild sunflowers; screening of 3,312 *Cucumis* seedlings grown for presence of Squash Mosaic Virus via ELISA; regular disease monitoring of cucurbit plantings from transplant to harvest and of *Helianthus* plantings for downy mildew, viruses and phytoplasmas; screening of maize for Stewart's wilt resistance and northern corn leaf blight; and testing maize inbreds of known Stewart's wilt response for Goss's wilt resistance. Increased incidence and severity of Goss' wilt of maize has led to intensified research on the biology and epidemiology of this disease. Field observations were made in the increase plots, and accessions were monitored in particular for diseases for which seed-borne transmission is of concern. A collaborative study of seed infection and transmission of the Goss' wilt pathogen is a high priority, as seed transmission is a rare but possible event, and this information has an impact on phytosanitary considerations and criteria for seed movement. Thirty five maize inbreds were screened a second year, in order to assess potential correlations for resistance response to Stewart's wilt and Goss' wilt disease.

Dr. Block and collaborators continued evaluation of published PCR primer sets for specificity in detection of *Pantoea stewartii* subsp. *stewartii* in maize seeds. This research has important implications for standardization of phytosanitary testing methods authorized for laboratories to use in determining whether maize seed meets criteria for importation in various countries.

Insect management:
The Entomology staff provided five insect pollinator species to control pollinate 617 accessions. Honeybees continue to be the primary pollinator used in the NCRPIS regeneration program, followed by the Alfalfa Leafcutter Bee (ALC).

Detailed, interesting observations and interpretative information regarding their field pollinator research activities can be found in their extensive section of the annual report for information on their continuing efforts to enhance the pollination program's effectiveness and efficiency. Substantial reporting is devoted to this team's activities because of the uniqueness of this project, limited sources of such information, and relevance to the broader germplasm conservation world. Feedback and suggestions on experimental approaches are welcomed.

We continue to consider the impact of the effectiveness of insect pollinators on cross-fertilization of caged plantings, and whether the genetic profile of the accession is maintained during regeneration.

Enhancement:
The Germplasm Enhancement of Maize Project (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. Research and breeding are designed to improve exotic germplasm introgression methods, to provide unique sources of allelic diversity, and 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.

The Ames and Raleigh, NC GEM Projects and public collaborators have released 265 lines from 2001-2013, representing over 60 maize races. An important goal is development of a set of inbred lines representative of the diversity inherent to all of the races of maize. In addition to traditional introgression methods, the project is generating doubled-haploid maize lines in partnership with the ISU Doubled Haploid Facility to accomplish this objective, and also with collaboration of private sector partners to accomplish the initial increase of doubled-haploid seeds in Hawaii and Chile winter nurseries. Of the 252 DH lines considered for joint released by USDA-ARS and ISU, 204 are suitable for 2013 release.

Photoperiod sensitive tropical maize often does not flower until September in Ames. GEM and maize curatorial 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. The sunflower project has used photoperiod control very effectively to induce flowering in certain wild sunflower accessions. Photoperiod-control environment capacity on the order of one to three acres would be very useful in maintaining and providing unique genetic resources.

Outreach and Scholarship:
Approximately 500 visitors toured the NCRPIS during 2013. Our staff participated in teaching students from grade K to postgraduate level, and 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. 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 continue to evaluate activities that can be reasonably reduced without sacrificing collection health and quality, and to improve efficiency.

Continued emphasis will be placed on communicating with research stakeholders to identify and address development of comprehensive, genetically diverse collections to meet research and development needs. Climate change is forcing researchers to renew efforts to identify superior forage cultivars as well, and interest has increased in collections of suitable species. A 'gap analysis' process is utilized to examine distribution of crops and their wild relatives; information sources include herbarium records, floras of various countries and ecoregions, predictive analyses bases on GIS layers and habitat information, and scholarly publications that cite plant sources, traits, and performance attributes. Wise selection of targets is important to managing collection growth and effective use of resources. Horticulturist D. Barney's report details analyses of the herbaceous ornamental collection holdings.

2014 collecting efforts will be targeted to expand the *Fraxinus quadrangulata* collection from its native range, in advance of the destructive Emerald Ash Borer, continuing to preserve individual mother trees from the populations to support genetic research; and *Gymnocladus* to enable selection of superior Kentucky coffee tree individuals for managed landscapes. A planned collection trip to Spain for *Daucus* relatives will not be possible in 2014 due to imposition of additional IPR restrictions beyond the standard SMTA that are not accepted for NPGS collections.

Better characterization information is essential to enable well-targeted use of the collections, especially given the increasing constraints of limited research and conservation resources. Availability of PGR significantly impacts research applications, including taxonomy. A recent example is the research of Brigham Young University scientists, who have determined the contributions of two wild species held in NCRPIS collections to the *Chenopodium quinoa* genome.

Pathologist Charles Block's efforts to assess response of wild and cultivated *Helianthus* to Sclerotinia, the most important disease in sunflower production fields in North America, will continue, as will his efforts to develop superior methods to detect seed-borne disease. Curator David Brenner is evaluating *Melilotus* accessions adapted to late-season planting that will over-winter well.

Software development efforts continue to center on the development and deployment of the successor to the GRIN system, GRIN-Global - its schema, internal and public interfaces, and applications for data capture and transfer. These efforts are 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. NC7 Region researchers typically account for nearly half of domestic plant germplasm distributions from the NCRPIS. 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, thus sharing of findings resulting from use of NPGS germplasm, linked with the germplasm's identity and source, is critically important.

The linkage of the GEM Project, the maize curation project, and public and private collaborators throughout the U.S. 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 19 NPGS sites; 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 the 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 2013 Annual Meeting in Ames, IA include the following: (from the meeting minutes):

- The 2013 RTAC meeting was hosted by Amy Iezzoni and the staff of Michigan State University, and highlighted the extensive research applications using plant genetic resources, including extensive outreach efforts. The opportunities afforded by the meeting and field tours are key to establishing the types of collaborative relationships that lead to long-term partnerships for major research and development efforts.
- The warm welcome and information shared by Doug Buhler, Director of MSU's AgBioResearch and Senior Associate Dean for Research for College of Agriculture and Natural Resources (CANR) is much appreciated. He reiterated the value and importance of multistate committees for regional work and strongly endorsed the work of NC7-RTAC, and provided an excellent overview of MSU and of MI agriculture.
- The NC7 Committee Members are encouraged by continued increase in demand for accessions by the genetic improvement community, but are concerned over increasing cost for distribution of seed especially for overseas requests and request by the general public some of whom are not research oriented. We proposed that this issue be considered by a select committee composed of RTAC, NCRPIS, CGCs, and USDA program staff.
- The importance of communicating impact of use of plant genetic resources, and the outcomes of NC7 Project participant research, education and outreach activities was emphasized. This is to be a focus of the 2014 RTAC meeting.
- Crop vulnerability statements need to be updated, using the new template provided by National Program Staff, and appropriately communicated.
- Consideration should be given to increase internal (within each state) outreach for the Plant Introduction Station.
- The committee thanks Amy Iezoni for hosting the 2013 meeting; we look forward to the meeting at Purdue University in West Layfayette, IN in August, 2014.

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 conducted all 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 19.0 FTE's. We coordinated and completed facility construction and upgrades.

Labor:
During 2013, 45 applications for hourly employment were received and reviewed. There were 29 interviews, resulting in 25 new or returning hourly employees hired. Currently there are 16.1 (FTE) Biological Science Aides 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. He works half-time for the farm support group and half-time for the oilseeds project.
Brian Buzzell (Farm Mechanic) joined the staff in May 2002.

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

1. Continued replacing old T-12 light fixtures with energy efficient T-8 units. Approximately 75 percent of the old fixtures have now been replaced. The focus in 2013 was to upgrade the ballasts in the seed storage rooms as the old lamps failed.
2. Rearranged the shelving in the Amaranth storage section of seed storage to create additional shelving space.
3. Designed a new drying cart for the dryers to allow additional small sample bags to be dried in the same amount of space.
4. Replaced old dryer units with upgraded burners, blowers and safety systems.
5. Added loft area to headhouse to facilitate additional storage area for harvest baskets and conetainer racks.
6. Designed and installed on-demand tankless water heaters to three greenhouses to temper the water used for watering the plants.
7. Designed and installed new greenhouse watering and fertilizer injection system in Greenhouse #3 to improve efficiency of the water and nutrient delivery.
8. Added material storage rack to shop to increase area available for storage of parts and tools.

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

Tours:
This past year, we organized and conducted 19 tours. There were approximately 500 visitors to the NCRPIS during 2013.

Staff Training:
We conducted Tractor and Utility Vehicle Safety, Worker Right-to-Know and Worker Protection Standard training sessions for the new staff and student employees as well as updates for existing staff.

B. Information Technology and Telecommunications (P. Cyr and J. Perrett)

Jesse Perrett has been acting as the first-line of support for NCRPIS during 2013. Jesse was supervised by Pete Cyr who is on assignment with the GRIN-Global project (designed to replace the GRIN Germplasm Management System currently in use). The following list outlines the progress made by the IT team during 2013 at NCRPIS.

Equipment
As of December 2013, NCRPIS has 57 desktop and 19 laptop workstations installed for use by permanent staff members and part-time temporary student help. The centralized functions required by the station were supported by 18 physical servers and a number of virtual servers including those used for file storage, intranet, backups, and door security systems.

In 2013, 32 computers were upgraded with Solid State drives, increased memory, and quad core processors. Over 100 new batteries were installed in the Server UPS systems. A new DHCP/DNS server was installed to provide a more cohesive network structure for IP addresses and domain names. The processors, memory, and hard drives were upgraded on five servers. All three server racks were rewired for cleanliness and functionality. A new Windows 2012 R2 Hyper V server was installed with an attached hard drive array for virtual machine infrastructure. The station continues to implement virtual servers wherever possible in order to better utilize server capabilities. The server room had a dehumidifier installed because the air conditioner was being under-utilized, resulting in a high humidity problem.

All telephones at the station were upgraded to new IP phones in order to be compatible with new campus VOIP hardware. One benefit of the new phone system is reduced cost per month for each phone. A wireless repeater was added to the Davis weather station to enhance reliability.

Four new Optiplex 3010 workstations were purchased and three were deployed for life cycle replacement. Three Dell Latitude 10 slate PC's were purchased in order to enhance field data collection capabilities. Two surplus servers were received from NCAH. Two physical and numerous virtual servers were installed and configured for use with GRIN-Global.

Software:
All workstations at NCRPIS were upgraded to Windows 7 except for two workstations which have legacy software or connected lab equipment. The remaining two workstations have Windows XP with service pack 3 installed and are not connected to the internet. Microsoft Office 2010 was installed on 25 computers. Acrobat version was upgraded to 10 on all relevant computers.

Frequent updates to anti-virus and anti-spy-ware definitions in conjunction with regular full system scans help to ensure that these workstations remain vulnerability free. During 2013 all workstations and servers at NCRPIS received security updates from Microsoft every month via the Iowa State University software update servers. BigFix/Tivoli Endpoint Management is the new ARS patch management software and is in the testing phase for campus locations.

All computer systems on campus and at the farm (servers and workstations) use Symantec Endpoint Protection for enhanced security against virus and spyware threats. A new antivirus solution from Microsoft called System Center Endpoint Protection will be implemented over the course of the next year. This system will require a new server and Active Directory integration. Symantec will be supported for the current installations until the new system is in place.

In order to comply with ARS policy, all compatible laptops were re-encrypted using bit locker which is built into Windows in order to cut costs. This system uses active directory to store recovery keys and should make encrypted laptop management easier. Users who need to load images to the GRIN database as well as remote users facilitate connectivity to ARSNet through the use of Cisco Any Connect VPN software. Active Directory group policies are used to implement the necessary security policies on all machines.

All servers were upgraded to Windows Server 2012 R2/2008 R2 with the exception of the pocket applications web server.

Documentation:
IT support videos and training documents, and information about farm operation, safety, and health was posted to the NCRPIS intranet website. Input was provided to the area IT office regarding system/component information for data calls.

Plans for 2014:
- Install Microsoft Office 2013 on critical computers.
- Continue upgrading servers to Windows Server 2012 R2 and implement Windows 8 where applicable.
- Implement new System Center Endpoint Protection antivirus system.
- Implement new ARS VPN software solution.
- Continue to replace NCRPIS workstations on an as needed basis (targeting a 3-5 year lifespan for daily use workstations).
- Identify and surplus excess hardware.

GRIN-Global:
The GRIN-Global project is a joint partnership between the USDA-ARS NPGS, the Global Crop Diversity Trust and Bioversity International. The goal of the project is to re-develop 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 and cost. The new Germplasm Management System (dubbed GRIN-Global) will support five different languages, four database systems and install on a single desktop computer or a network. In 2014 the NCRPIS team enhanced the curator desktop applications (Curator Tool) for easier editing accession data (via the Accession Wizard), easier processing of order (via the Order Wizard), loading of attachments to accessions, inventory, and orders (via the Attachment Wizard). Enhancements to the database schema to fully support viability testing data will be provided, and continued enhancements of the curator search tool, the search engine and the web services (middle tier) for improved speed and reliability of curator searches.

C. Information Management-Germplasm Collections (R. Stebbins)

Acquisition:
The North Central Regional Plant Introduction Station (NCRPIS) acquired 197 new accessions in 2013. Of these new accessions, 119 were received from within the National Plant Germplasm System (NPGS) through exploration and transfer. This included 28 accessions of *Daucus* and miscellaneous umbels collected in Morocco by Philipp Simon, and 26 accessions of wild *Helianthus* and 30 accessions of woody species from collection trips conducted by NCRPIS personnel.

The remaining 78 accessions received from outside the NPGS included 22 accessions of *Zea mays* subsp. *mays* from the Germplasm Enhancement of Maize project and 14 accessions of *Helianthus annuus* from Texas A&M University.

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

Maintenance:
Curatorial assistance was provided by processing requests for taxonomic re-identifications and nominations of accessions to the inactive file. In total, 33 accessions received taxonomic re-identifications. Among these were 10 accessions of *Cucurbita*. Also, nine accessions were nominated for inactivation, including seven accessions of woody species, one accession of *Amaranthus* and one accession of *Melilotus* were inactivated due to duplication. The inventory lots of these accessions were integrated together with lots of their respective duplicates.

Additionally, 169 accessions were assigned PI numbers. Included in this group were 130 accessions of *Amaranthus* and 24 accessions of miscellaneous umbels.

Conclusions:
Compared to 2012, 285 fewer new accessions were received at the NCRPIS in 2013. Among the maintenance areas, eight fewer re-identifications were made, 60 fewer nominations to the inactive file, PI-number assignments were 279 lower, and seven fewer duplications were resolved than in the previous year. The number of new accessions acquired and the totals for re-identifications, nominations to the inactive file, and PI-number assignments were below their 18-year averages. Resolved duplications were also below its 15-year average.

D. Order processing (R. Stebbins)

During 2013, 2,290 orders were entered into GRIN, the highest number of orders ever initiated in one year. These orders led to the external distribution of 40,409 items (primarily seed packets, but also vegetative samples). Of these, 26,808 items (64%) were distributed within the United States, and 14,844 (36%) were sent to foreign requestors. Additionally, 1,988 items were distributed within the NCRPIS, for observation and disease testing.

The number of orders entered into GRIN in 2013 was 77 more than that of 2012 (a new record for the NCRPIS); however, the number of items distributed was down by 3,463. This is largely due to a new NCRPIS policy regarding non-research requests (implemented in May, 2013). The number of requests received electronically this year was 2,061, an increase of 101 from 2012.

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

Two full-time, permanent federal employees (Lisa Burke and Lisa Pfiffner), and two part-time students staffed the seed storage area. Lisa Pfiffner continued to serve as the federal supervisor for several of the crews guided and directed by state employees.

In 2013, we stored 2130 inventory lots, including 1128 original seed lots. Of the original lots stored, 364 were woody landscape accessions, along with 463 *Helianthus*. Of the increase lots, 669 Ames increases and 333 non-Ames increases were stored. Of all stored lots, 650 lots had sufficient seed quantities to be made available for distribution. We split 33 original lots to make them available for distribution in limited quantities. We reviewed 5274 inventory lots for seed quantity, and any discrepancies were corrected in the GRIN database. Five hundred and ninety-four samples were prepared and transferred to the -20C freezer for long-term storage.

We filled 1553 seed orders in 2013, including those for distribution, observation, germination, transfer and backup. NCRPIS distributed 41,331 packets to meet distribution and observation requests. There were 590 lots sent to the National Center for Genetic Resources Preservation (NCGRP) for backup, involving both accessions new to NCGRP and additional seed quantities for previously deposited accessions. We transferred 18 inventory lots to other NPGS sites.

2013 saw the continuation of the prepacking program. With the aid of our student workers, we prepacked 22,964 packets of 2298 inventory lots. Prepacking impacts seed storage operations by keeping the on-hand inventories more accurate and speeding up seed order fulfillment.

NCRPIS continued to participate in sending seed to the Svalbard Global Seed Vault in 2013, by preparing 351 accessions for backup there. Sample amounts ranged from 200 to 800 seeds depending on the amount of seed needed for two regenerations. For inventory tracking purposes, an inventory action code (SVALBARD) was added to GRIN for all lots shipped. Packets were filled and orders sent to NCGRP for preparation and shipment to Svalbard.

Seed storage personnel continued to maintain the germplasm distribution display in the farm headquarters hallway. New maps were printed at the start of 2013, and destinations for both domestic and international shipments were marked. The maps are a stop on tours of the station and show visitors both national and international destinations of our germplasm orders.

Scanning of original seed samples continues. In 2013, 130 scans were taken, mostly of original samples. 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 an important tool to allow future comparisons with the increase lots by curators and storage personnel.

Lisa Burke continued to participate in the development of GRIN-Global, serving as one of the principal testers and training Ames curatorial personnel. She provides weekly subject matter to the GRIN-Global documentation specialist for use in training webinars for NPGS personnel.

Lisa Pfiffner completed the Purity Analysis certification. With the departure of Maria Erickson, the station's germination technician, Lisa Pfiffner has assumed responsibility for aspects of the seed germination program. She handles testing of newly regenerated seed lots and special testing for regeneration purposes. Both activities are key in storing regeneration seed lots and aiding curators in regenerating seed lots. She spends approximately half of her work time in the germination area.

Lisa Burke continued as the station's CPR/AED/First Aid instructor. She provided three-year First Aid certification for 15 NCRPIS student workers and two-year CPR/AED/First Aid certification for 21 staff members. Included in the First Aid classes were two interns and two student workers from campus. Each session was entered into the National Safety Council database and certificates of completion provided for each participant. Cooperative work with campus staff on improving the CPR/AED/First Aid training was continued.

In 2010 a new order type designation was added to GRIN. 'NR' was created to indicate non-research orders. The majority of NR orders come from home gardeners who are better served by seeds obtained from commercial sources, not material from a genebank which includes crop plants but also the wild and weedy relatives of crop

plants. In spring of 2013 the NCRPIS updated our NR policy with the following effects on distributions.

Figure 1. NR Orders

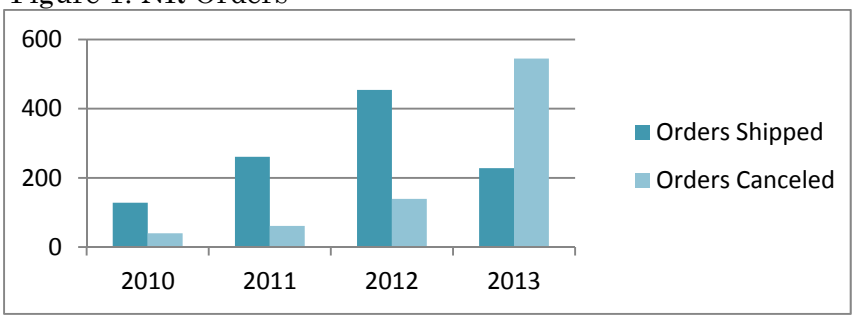
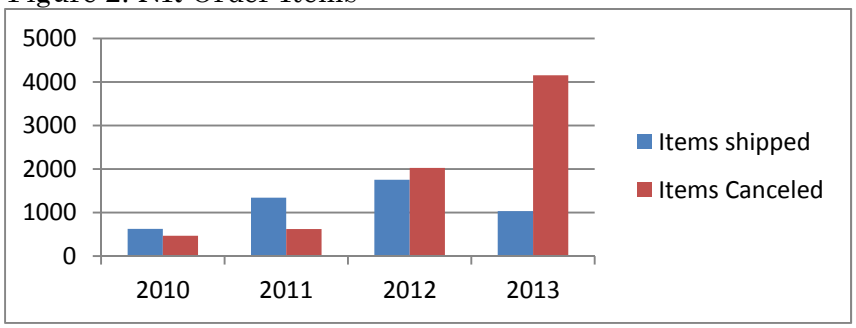


Figure 2. NR Order Items

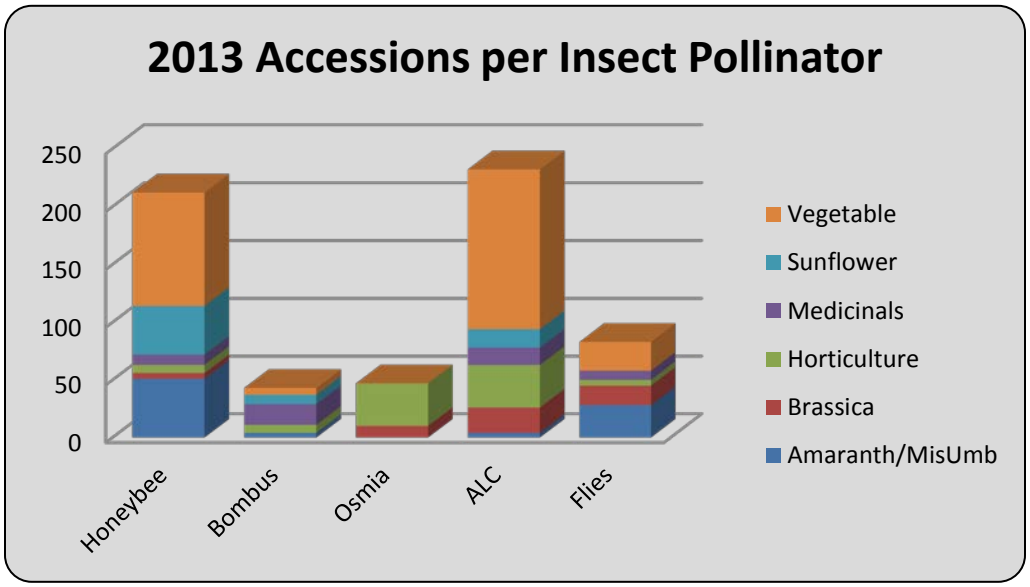


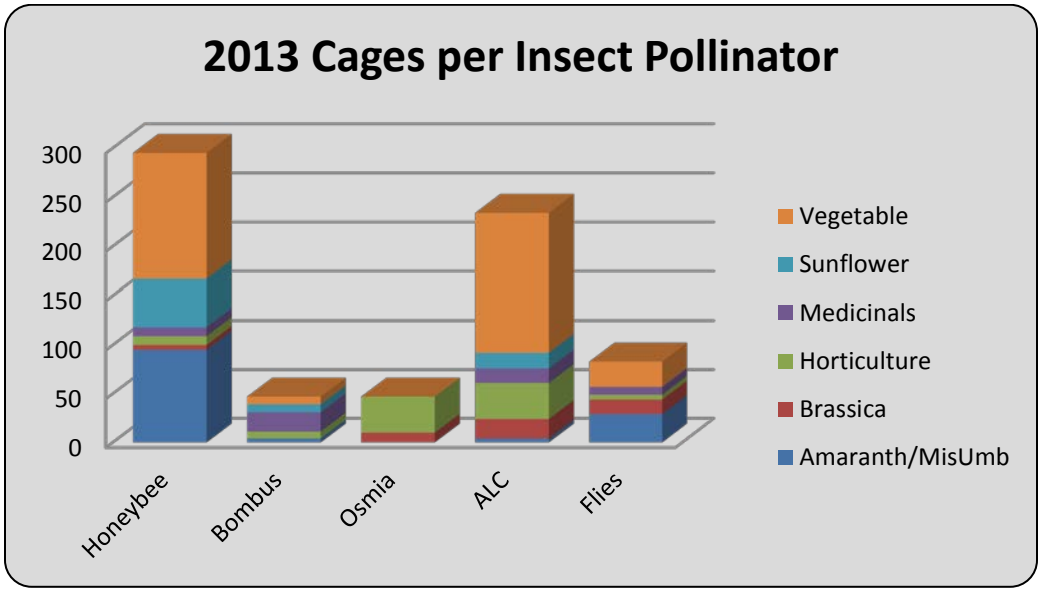
VII. CURATORIAL AND SCIENTIFIC TEAM REPORTS:

A. Controlled Insect Pollination Service Program (S. Hanlin)

Summary of Pollinators supplied to 2013 regeneration cages

Number of Unique ACCESSIONS per pollinator						
	Honeybee	**Bombus**	**Osmia**	**ALC**	**Flies**	**TOTAL**
Amaranth/MisUmb	51	4	0	4	28	87
Brassica	5	0	10	22	17	54
Horticulture	7	7	37	37	5	93
Medicinals	9	18	0	15	8	50
Sunflower	42	8	0	16	0	66
Vegetable	98	6	0	138	25	267
OVERALL	212	43	47	232	83	617
Number of TOTAL CAGES per pollinator						
	Honeybee	**Bombus**	**Osmia**	**ALC**	**Flies**	**TOTAL**
Amaranth/MisUmb	95	4	0	4	29	132
Brassica	5	0	10	20	15	50
Horticulture	9	7	37	37	5	95
Medicinals	9	20	0	15	8	52
Sunflower	49	8	0	16	0	73
Vegetable	128	8	0	142	26	304
OVERALL	295	47	47	234	83	706





Progress:

Caged pollination:

Bee pollinators (minus the alfalfa leafcutting bee) were supplied a single time to 389 cages for controlled pollination of 302 accessions. Alfalfa leafcutting bee and fly-pollinated cages are tabulated and reported separately due to multiple distributions of those insects to the same cages over the pollination season.

Honey bee pollination:

Honey bees were used to pollinate 212 accessions in the field.

2013 Honeybee Pollinator Deliveries to Regeneration Cages

Crop Group	Total # of Accessions	# of Genera	# Accessions/Genera
Misc.Umbels	51	10	31 *Melilotus*, 8 Torilis, 4 Anethum, 1 Angelica, 1 *Eryngium*, 1 *Foeniculum*, 1 *Kundmannia*, 1 *Levisticum*, 1 *Orlaya*, 1 *Trachyspermum*
Oilseeds	47	4	39 *Helianthus*, 3 *Centrapalus*, 3 *Brassica*, 2 *Crambe*
Horticulture/ Medicinals	7/9	5	8 *Baptisia*, 4 *Cornus*, 2 *Physocarpus*, 1 *Euonymus*, 1 *Potentilla*
Vegetable	98	2	95 *Cucumis*, 3 *Cucurbita*
Total	**212**	**21**	

Overwintering success: 94% of the 51 three story parent colonies, 91% of the 32 two story parent colonies and 40% of the 108 double-story and 13 single-story nucleus colonies stored in the 2012 indoor wintering facility survived, comparable to the 100%, 73% and 26% from 2011.

No colonies were left outside during the winter 2012, all colonies and nucleus hives were placed into the over-wintering room. We removed all colonies and nucs from the overwintering facility starting on March 14, 2013. In the winter of 2013, we placed in the overwintering facility 33 three story parent colonies, 69 two story parent colonies and 29 double story nucleus hives,.

We purchased 20 "Buckfast" 3-pound packages to supplement over-winter losses and 50 "Buckfast" queens to supply spring nucs used for cage pollinations. The packages were placed into full size hives and given four feedings of high fructose corn syrup and two pollen treatments. The queens were placed into nucleus boxes with two frames of brood and three frames of adhering bees.

In Early-May we selected queens from resilient, over-wintered parent colonies to produce queens for nucleus hives during summer 2013 and set them up in cell builder colonies. We started grafting queens in Mid-May and produced an average of 32 queens per week. Nucleus hives were produced until late July; nucs not used in cages for pollination were fed, an additional super placed on top, and strengthened for over-wintering.

In August, 23 strong double story and one single story nucleus hives were made into colonies. In September, all medium-strength single story nucleus hives containing three to four frames of bees had an additional super placed on top to prepare them for over-wintering. In many of the parent colonies, the bee clusters remained dispersed throughout the boxes and did not combine in a tighter cluster, so they were over-wintered in 2013 as three story colonies.

In June and July, 18 colonies at three locations were sampled weekly using the powdered sugar roll method for a "screen bottom board comparison study" done by Joaneette Oliveras Rivira, a summer intern from Puerto Rico. The purpose of the study was to determine whether treatments resulted in significant differences in Varroa mite infestation. The highest observed mite population during this period was 30 mites/100 bees with the majority of the colonies having less than 10 mites/100 bees (see ARS Photo by Scott Bauer). Because HopGuard® (a soft chemical control) was used last year, 90% of all hives were treated with Apivar® (a single treatment) in August. The remaining 10% had to be treated with HopGuard® (twice in a six week period) because we ran out of Apivar. After the treatment was removed, 50% of all colonies in the field were sampled using the powdered sugar roll method. Mite counts were less than five mites/100 bees.

All parent colonies and nucleus hives were given three treatments of Fumagilin – B® in April 2013 for the prevention of dysentery (nosema). In October, all hives being prepared for over-wintering were given three medicated feedings of Fumagilin – B®. In September all hives received two fall treatments of Tylan for prevention of American Foul Brood (AFB). There were no signs of AFB in the summer of 2013.

For wax moth control during the summer, a combination of methods was employed. Supers with frames were stacked at right angles to each other to prevent adult moth migration. Starting in July, the lights in the equipment room were left on during

working hours (8 hours; five days). In July, adult moths were observed flying around lights and pupa were found in several supers. In years past, these non-chemical control methods kept the moths at low populations. However, during the summer of 2013 these methods appeared to have limited control of wax moth and approximately 20 supers of comb out of 120 supers were damaged. In winter, temperatures in the unheated storage room limit serious moth problems.

We continue to use our syrup feeding system of a 1,050 gallon polypropylene tank, a 30 gallon poly "mixing" tank and a dish washer for cleaning feeding containers. To prevent crystallizing of the high fructose corn syrup (HFCS) in the large interior storage tank, the contents were circulated for at least five minutes daily. Additional HFCS was purchased to supplement feeding of bees during the summer and into the spring of 2014. Starting in September, fermented syrup was fed to stronger colonies and nucleus hives. Feeding fermented syrup when a honey flow was occurring prevented the bees from storing the "bad" syrup and feeding on it during the winter months, which could contribute to N*osema* infection, and we did not have to discard several barrels of syrup. Once feeders or feed containers were placed on hives, syrup was transported using five gallon buckets and containers were refilled in the field. This prevented container and syrup loss while transporting.

All bee locations were re-registered with the Iowa Department of Agriculture and Land Stewardship (IDALS). The IDALS registry assists pesticide applicators in locating bee-yards and in obtaining contact information of appropriate beekeepers prior to spraying.

In May, all hives were removed from two locations because of rising water and chance of flooding. Neither of these locations flooded, however water did get several feet from overflowing the banks.

Bombus pollination:
Eighteen "mini-research" colonies of *Bombus impatiens* were purchased from a commercial supplier and used to pollinate 47 field cages with 43 accessions. A single *Bombus* hive can be used for pollinating more than one cage with a minimum lapse of 48 hours between sites to prevent pollen contamination.

2013 *Bombus* Pollinator Deliveries to Regeneration Cages

Crop Group	Total # of Accessions	# of Genera	# Accessions/Genera
Misc.Umbels	4	1	4 *Melilotus*
Sunflower/Oilseeds	8	1	8 *Helianthus*
Horticulture/Medicinals	7/18	3	17 *Baptisia*, 7 Staphylea, 1 *Potentilla*
Vegetable	6	1	6 *Cucurbita* (2 hives/cage)
Total	**43**	**6**	

We continued to use 60-quart protective plastic containers or affixed two full supers to house the cardboard *Bombus* hives while in field cages. The protective shelter and hive are placed on a honey bee hive body and lid for a stand and, with the

plastic container, two water-filled quart containers are placed inside as weights to prevent the wind from blowing the container and hive off of the stand.

Osmia cornifrons/*O. lignaria* pollination:
Osmia were used to pollinate a total of 47 field cages with 47 accessions.

2013 *Osmia* Bee Pollinator Deliveries to Regeneration Cages

Crop Group	# of Cages	Total # of Accessions	# of Genera	# Accessions/ Genera
Brassica/Oilseeds	10	10	3	7 *Brassica*, 2 *Crambe*, 1 *Camelina*
Horticulture	17 (*O. aglaia*) 20 (*O. lignaria*)	37	1	37 *Aronia*
Total	**47**	**47**	**4**	

In the 2012 growing season, we only obtained an increase of ca. 18 *Osmia* pupae which could be used for pollination and increase during the 2013 pollination season. The lower increase rate of bees possibly is due to dryer/cooler spring 2012 conditions, or declining increase stock because of unavailability of commercial bees in the past two years. We were able to purchase commercial cells in the spring of 2013 from two suppliers. One of the suppliers recommended a new species of Osmia, *O. aglaia* which is reported to fly at warmer temperatures than *O. lignaria* and was reported to pollinate many of the crops which are pollinated by *O. lignaria*.

The pupae were used to fill 72 two-inch domiciles (14 contained *O. aglaia*) and 24 three-inch domiciles; of these, 47 two-inch domiciles were used in pollination cages and 25 two-inch and 24 three-inch were used at "increase" sites. A new Precision® incubator was used for storage of all straws and domiciles in 2013.

We collected ca. 719 pupae from domiciles in 2013 for use in the spring of 2014. We will also try to obtain an additional 1000 pupae for cage requests and increase.

Through the use of a GPS unit and Google-Earth, we tracked and plotted the 24 three-inch domicile placed at two locations for retrieval later in the summer. The 25 two-inch domiciles were placed on the boundaries of our outlying honey bee yards and the GPS was not used.

We did not see any difference in seed production between the use of *O. lignaria* and *O. aglaia* as a pollinator. A possible reason for the lack of establishment of *O. aglaia* is that the domiciles straw size was not the preferred size for the bee and it was not able to propagate. In the future, we will not use *O. aglaia* for our pollination uses and continue to use *O. lignaria*.

Alfalfa leafcutting bee (ALC) *Megachile rotundata*:

ALC bees were purchased as larvae in leaf cells from a single supplier for use in 2013, arriving in Ames, IA on January 10, 2013. The bee cells were held in refrigerated storage until scheduled for placement in warm incubation and bee emergence boxes. Bees were available weekly throughout the year for use in plant regeneration cages in the field and greenhouse from Mid-September 2012 through Mid-November 2013.

In 2013, 1940 total ALC deliveries were made to a total of nine fields and four greenhouses with 234 cages containing 232 accessions. Two greenhouse cages of *Cucumis* and *Daucus* are still undergoing pollination at the transition from 2013 into 2014.

2013 Alfalfa Leafcutter Pollinator Deliveries to Regeneration Cages

Crop Group	# of Deliveries	# of Cages	# of Locations	# of Accessions	# of Genera	Time Period
Misc.Umbels	47	4	3	4	3	Feb. – Sept.
Brassica/ Oilseeds	171	20	2	22	6	Nov. – Nov.
Horticulture	143	37	2	37	2	May - July
Medicinal	158	15	2	15	2	July – Oct.
Sunflower	94	16	2	16	1	Sept. – Oct.
Vegetables	1327	142	4	138	3	Sept. – Oct.
Total	**1940**	**234**	**15**	**232**	**17**	**Sept. – Nov.**

Numbers of active ALC-supplied cages and frequency of bee delivery vary seasonally and by cage structure/location and individual accession characteristics. In normal pollination situations, ALC bees/cells are only provided to crops in the summertime. However at the station, ALC are used outside of the normal time frame. From September 2012 through October 2013, greenhouse cages were supplied weekly with bees. 2013 field requests for ALC bees started in early-May and the number of weekly active cage increased rapidly through mid-August.

In 2013 we received U.S. sourced cells, which are known to have more parasites and parasitoids than found in Canadian cells. Based on the need for additional storage trays and refrigerated storage, the supplier did ship an additional amount of pupae for pollination use. The new Precision® incubator was used for storage of screen trays of cocoons from February to October.

Because of the government furlough in early October, field cage requests did not end until Mid-October. Bees continued to emerge and were placed into field cages of *Helianthus* into late-October.

Flies (Blue Bottle Flies and Houseflies):

Fly pupae of two species (Calliphoridae and *Musca domestica*) were purchased from two suppliers and incubated for weekly use from August 2012 through October 2013 for caged plant pollinations in the

greenhouse and field. From June through August, twenty-six orders of 10,000 house fly pupae were purchased and form December 2012 through September 2013 268 cups of blue bottle fly pupae was purchased. In 2013, 757 fly deliveries were made to five fields and five greenhouses with 83 cages containing 83 accessions representing 23 genera.

An average of 6 greenhouse cages received flies weekly from August 2012 through the end of October 2013.

2013 Fly Pollinator Deliveries to Regeneration Cages

Crop Group	# of Deliveries	# of Cages	# of Locations	# of Accessions	# of Genera	Time Period
Misc.Umbels	200	29	3	28	13	Dec. – Oct.
Brassica/Oilseeds	120	15	1	17	5	Oct. - May
Horticulture	19	5	2	5	2	May - July
Medicinal	71	8	1	8	1	July – Oct.
Vegetables	347	26	3	25	2	Aug. – Sept.
Total	**757**	**83**	**10**	**83**	**23**	**Aug. – Oct.**

Only blue bottle flies were distributed weekly in winter and spring greenhouse cages due to blue bottle flies working at cooler temperatures and a large number of cage requests in the cooler greenhouse. Both blue bottle flies and houseflies were distributed weekly to summer field cages. Re-supplying flies weekly to cages ensures continued pollinator presence. If appropriate and available, bee pollinators may be present in the same cages receiving flies.

Tests (Hanlin):

Screened Bottom Board Comparison Study:

Literature states that screen bottom boards are a good mechanical control for varroa mites. The mites once dislodged from the adult honey bee fall through the screen to the ground beneath the hive and are unable to crawl back and reattach to a bee and parish. A comparison study using 9 screened bottom boards on three colonies of bees at three different bee yards were compared to nine colonies on solid bottom boards. This work was done by Joanette Oliveras, a George Washington Carver intern. Beginning on June 10 through July 17 weekly bee samples were taken of each colony using a sugar roll method to determine if there was a difference in mite numbers based on the screen bottom board or not. The results showed that for this limited period of time no difference in mite numbers was observed between colonies on a screened bottom board and colonies on a solid bottom board at any of the three locations.

Preventing infestation of hives by summer wax moth:

In past summers all "dead" hives were taken apart and the equipment was stored in the back equipment room in the entomology building with stored equipment. This was thought to be a source of infestation of wax moth to the stored supers containing frames. During the summer of 2013 all "dead" or removed equipment from the field was placed at right angles into the over-winter room which was kept at 55° F, without disassembly. The premise for this was if the equipment contained wax

moth eggs/larva, the temperature would slow down the moth development and the exclusion of the "used" equipment from clean, non-infested equipment should prevent wax moth damage from occurring in the back equipment room. When the equipment was removed from the over-winter room in November 2013, some damage was observed and both dead adults and larva were found on frames and boxes, however the damage and observation of adult moths that occurred in the equipment room was reduced when compared to 2012.

Safety Training for S. Hanlin:

First Aid/CPR:

February 7, First Aid/CPR training, required of all permanent staff every 3 years.

Chemical Inventory:

February 8, updated the Entomology chemical inventory including obtaining updated MSDS for new mite treatment chemicals.

Defensive Driving:

March 1, "Basic Defensive Driving" on AgLearn; April 5, "Advanced Defensive Driving" on AgLearn; April 18, Webinar "Distractive Driving Training" for ARS employees. Because of the amount of time and distance that the bee crew is off the station, the AgLearn training is considered an annual training requirement.

Epi-pens:

April, S. Hanlin arranged for internet training and with the assistance of S. Siev created certification of permanent staff for recognizing the signs of anaphylactic shock and correct use of epi-pens based on recommendations from ISU Occupational Medicine. Replacement pens were obtained in August and expired pens were returned to Occupational Medicine. The Epi-pens are available at NCRPIS as prevention of anaphylactic shock caused by bee stings.

Presentations and Outreach:

On May 9, S. Hanlin spoke to seven groups of sixth grade students on honey bees and beekeeping at the Squirrel Hollow Outdoor Classroom held in Jefferson IA.

On several occasions during 2013, S. Hanlin was contacted by Dean Peterson of the North Central Soil Conservation Research Lab in Morris MN about the benefits of canola for honey bees and other native pollinators and the use of honey bees as pollinators of other ground cover plants. On March 5, S. Hanlin sent D. Peterson the NCRPIS pollination power point to use at a beekeeping field day to in Morris.

On June 26 & 27, S. Hanlin, K. Tow (Biological Science Aid) and D. Helm (Biological Science Aid) assisted with the "4-H Youth Conference Workshop", hosting two groups of approximately 12 participants and providing them the opportunity to put on bee equipment and work with a nucleus hive of honey bees. The groups were also given information on the other pollinators used at the station.

In April, S. Hanlin collected pollen for Drs. Adam Dolezal and Amy Toth (ISU researchers) for use in nutritional testing of honey bees. In May, on two occasions Dr. Dolezal and Arvin Foell (on-site beekeeper for Toth project) participated in training on colony setup and grafting procedures for production of queens.

From June 10 to August 2, S. Hanlin mentored Joaneette Oliveras Rovira (George Washington Carver intern). She was directed and assisted with a study determining if use of screened bottom boards are a satisfactory method for controlling varroa mites. Weekly samples were taken using the sugar roll method from June through July. Ms. Rovira was assisted by S. Hanlin and Dr. Gardner in creating a poster and power-point presentation of her research for a GWC seminar.

S. Hanlin continued as in 2012, emerging and distributing ALC and flies in addition to the duties caring for and distributing honey bee, *Bombus* and *osmia* bees. In 2013 S. Hanlin assisted curatorial staff with Pocket Pollinator issues including setting up 2013 imbedded workbooks for several curators and end of the year curator workbooks for total pollinators used per project.

Plans for 2014:
Test screen bottom boards for mite control:
A documented, non-chemical control for varroa mites is to place a hive on top of a bottom board in which the bottom is "open" with only a piece of 1/8" screen rather than solid boards. The control of mites occurs when the mites become detached from adult bees while they enter the hive rub against the screen, the mite falls to the bottom through the screen, and expires. This continues the comparison study done by J. Oliveras Rovira in 2013 with an increased sample size (number of screen bottom boards being used) and increased, scheduled sampling periods rather than the approximate month. The comparison study will use 20 screen bottom boards and an additional 9 screen sampling bottom boards, and compared to the remaining colonies which are all placed on traditional solid bottom boards. The screen bottom boards will be distributed through all bee yards rather than just one location as in 2013. Mite sampling will be done using both the sticky board method and the powdered sugar roll method. The sugar rolls will be done every two weeks to prevent colony interruption which occurred in 2013 with weekly samplings.

Personnel resources:
The Agricultural Science Res. Technician position has been vacant since October, 2011, and Mr. Hanlin has been assisted since then exclusively by temporary student employees. The position has been held open because of impending closures at other locations and the need to hold vacant positions for technicians who may want to accept a relocation assignment. We hope to refill this position in 2014.

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

Disease Resistance Evaluations:
Sclerotinia wilt resistance in wild sunflower (Helianthus):
We conducted disease resistance evaluations of wild perennial sunflowers for Sclerotinia stalk rot resistance, caused by *Sclerotinia sclerotiorum*, with co-investigators Thomas Gulya (USDA-ARS, Fargo, ND) and Laura Marek (NCRPIS). Plants were tested in the greenhouse under high disease pressure, with the goal of identifying accessions that showed significantly better survival percentages than the most resistant hybrid check, Croplan 305. In 2013, nine perennial species were

evaluated (168 accessions overall), including *Helianthus strumosus* (18 entries), *H. gracilentus* (6 entries), *H. microcephalus* (11 entries), *H. angustifolius* (17 entries), *H. heterophyllus* (15 entries), *H.divaricatus* (12 entries), *H. hirsutus* (6 entries), *H. nuttallii* (39 entries), and *H. pumilus* (44 entries). All species showed very good resistance. Sixty percent plant survival after 20 days is used as an indicator of a high level of resistance for an accession in our tests. Overall, 167 of 168 accessions had survival percentages above 60% and 120 had $\geq$ 90% plant survival.

In a separate study, we tested 51 entries consisting of crosses and backcrosses of several perennial species with the cultivated inbreds HA 410 or HA 441. The crosses were made by Dr. C.C. Jan (USDA-ARS, Fargo, ND). Many entries wilted quickly, with the top of the plant collapsing and falling over 4 to 5 days after inoculation (Fig. 1). The original resistance of the perennial parent was lost after multiple backcrosses. Plant showing this quick collapse reaction, which we called a floppy wilt, never recovered. An interesting reaction type was observed in several entries. The second reaction type, essentially a stiff stalk, was characterized by a slow loss of lower leaves, progressive yellowing and slow death of the plant, but no top wilt or plant collapse (Fig. 2). These plants seem to display a type of resistance with recovery potential if the plant has an opportunity to grow new roots. Fifteen plants were transplanted from the small cells to one gallon pots 9 to 10 days after the initial inoculation. All plants showed a significant degree of lower leaf loss at the time of transplanting, but 10 of the 15 grew new roots and recovered.

Figure 1. Floppy wilt reaction type observed in entries 234, 235, and 245.

Figure 1. Stiff stalk reaction type observed in entries 12, 24 and 57.

2013 Stewart's wilt resistance screening in maize:

Stewart's wilt (*Pantoea stewartii*) disease resistance evaluations were conducted on 210 maize inbreds. Accessions were rated on a 1-9 scale with 1.0 being nearly immune and 9.0 being highly susceptible. Disease development was good and we identified several highly-resistant accessions (Table 1). The most resistant accessions were Ames 27185 (Pa875), PI 601689 (WIL500), Ames 27110 (E2558W) and PI 542955 (Va4), all with ratings of 1.0. The most susceptible accession was a check inbred, Ames 23507 (C42) which rated 8.4.

Table 1. Stewart's wilt resistance of top-performing maize accessions in 2013.

Entry	**Alternate ID**	**Other notes**	**2012 SW average score (1-9 scale of R to S)**
Ames 27185	PA875	Developed 1983, Pennsylvania	1.0
PI 601689	WIL500	Developed by Wilson Hybrids from tropical germplasm population.	1.0
Ames 27110	E2558W		1.0
PI 542955	VA4	Developed in Virginia	1.0
Ames 25372	Pa91HT1	Developed in Pennsylvania	1.1
Ames 31537	CI28A Goodman-Buckler	Recovered blight resistant strain of B2	1.1
CIze 45	CI45	Pedigree: (Mo21A x R4) x (NC34 x R4)	1.1
CIze 82	CI 82A	Pedigree: Pd2287-1 x R39	1.1
CIze 7	CI7	Pedigree: (L317 x 33-16) 33-16 ^2	1.1

2013 Goss's wilt resistance screening in maize:

Thirty-five inbreds were screened for resistance to Goss's wilt in a second year field trial. The objective was to assess the correlation between resistance to Stewart's wilt and Goss's wilt. The pool of inbreds represented a broad sample of known Stewart's wilt disease reactions ranging from highly resistant to highly susceptible, essentially spanning the 1-9 rating scale. As a group, inbreds showing good resistance to Stewart's wilt, with mean scores ranging from 1.3 to 3.0, also showed good resistance to Goss's wilt, with mean scores ranging from 1.0 to 3.0. Inbreds that were systemically infected (>5.0) by *Pantoea stewartii* were systemically infected by *Clavibacter michiganensis* ssp. *nebraskensis*. The Pearson correlation coefficient, calculated from mean disease severity ratings, was 0.92 indicating a linear relationship between Goss's wilt ratings and Stewart's wilt ratings.

Disease observations on seed increase crops:
Plant health monitoring continued with field inspections of seed parent plants for maize (curation and GEM), sunflowers, and cucurbits:

Maize:
The pathology team inspected 195 seed increase plots (maize curation) for disease presence and severity. Plots were inspected for 12 diseases – gray leaf spot, Stewart's wilt, Goss's wilt, northern and southern corn leaf blight, eyespot, crazy top, common rust, common smut, head smut, sorghum downy mildew and wheat streak mosaic virus. Similarly, 400 entries of GEM lines were inspected for the same diseases. In terms of typical diseases of phytosanitary concern for export, none were found – no Stewart's wilt, Goss's wilt, crazy top or other downy mildew diseases, head smut, or southern corn leaf blight were observed.

Sunflower:
Multiple field inspections of sunflower were carried out for downy mildew, viruses, and phytoplasmas. No downy mildew (the main phytosanitary issue) was present and no unusual disease problems were noted.

Cucurbits:
Routine disease testing for squash mosaic virus was conducted on all seedlings prior to transplanting. One hundred and five accessions with 3,312 plants were sampled. Two SqMV-infected plants were identified by ELISA from one *Cucumis melo* (melon) accession, grown from original seed collected in Turkmenistan. These plants were eliminated before transplanting. The seedling screening combined with cage screening was successful in keeping SqMV out of the field planting. The SqMV test results are summarized in Table 3. Field plantings were scouted every 2-3 weeks to monitor disease development. Powdery mildew continues to be a frequent problem in the field and regular fungicide spraying is required to manage mildew.

Table 3: Squash mosaic virus testing results for 2013.

Species	**Accessions tested**	**Accessions with infected plants**	**Plants tested**	**# of SqMV infected plants**
Cucumis spp. (melo, sativus)	99	1	3219	2
Cucurbita pepo	5	0	93	0
Total	**104**	**1**		**2**

Seed Health Testing/Seed Treatment:
We carry out a seed health testing and fungicide seed treatment program to support international seed shipments – 587 laboratory tests were run, 398 for maize and 189 for sunflower. The volume of lab testing was considerably higher than in recent years, compared to 218 tests in 2011 and 249 tests in 2012. Between 200 and 300 seed packets (primarily sunflower) were treated with fungicides for international seed orders.

Laboratory research activities:
We are collaborating with A. Robertson (ISU Plant Pathology Dept.) and L. Shepherd (ISU Seed Science Center) to study Goss's wilt (*Clavibacter michiganensis* subsp. *nebraskensis*) seed infection and seed transmission. Seed from infected field plots in 2012 was harvested for analysis in 2013. The seed lots ranged from 3.6% to 37% infected seed, as estimated by plating corn seeds directly onto semi-selective agar. Suspect bacterial colonies were injected into corn seedlings in a growth chamber to confirm pathogenicity. In field plantings, seed transmission was confirmed as a rare, but possible event, occurring about one time per 2000 infected seeds planted.

Publications:
Dutta, B., **Block, C.C.**, Stevenson, K.L., Hunt Sanders, F., Walcott, R.R., and Gitaitis, R.D. 2013. Distribution of phytopathogenic bacteria in infested seeds. Seed Sci. & Tech. 41:383-397.

Block, C.C. and Shepherd, L.M. 2013. Relationship between resistance to Stewart's wilt and Goss's wilt in dent corn inbreds. (Abstract) Phytopathology. 103 (Suppl. 2):S2.17.

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

Acquisition and inactivation:
Twenty-eight accessions were acquired (Table 1), including 1 *Amaranthus,*, 19 *Apiaceae,* 4 Chenopodiaceae, 3 *Melilotus,* and 1 *Portulaca.* Seven accessions were inactivated due to duplication.

A commercial grain amaranth cultivar 'Burgundy' (Ames 31991) was donated by the Seeds of Change company.

Eighteen Apiaceae were donated by Phil Simon and David Spooner from their plant exploration in Morocco (Ames 32041 through 32049, and Ames 32061 through 32066). They include: Three *Ammi*, two *Anethum*, two *Coriandrum*, three *Cuminium*, two *Petroselinum*, three *Pimpinella*, and one *Torilis* (Ames 32068). An aditional Apiaceae, *Zizia aptera* Ames 32015 was donated by the Missouri Botanical Garden. Two accessions of *Tordylium* (PI 325874 and PI 325876) were transferred from Pullman, Washington.

We added one of the obscure Chenopodiaceae-Amaranthaceae genera needed for systematics research with two accessions of *Micromonolepis pusila* (Ames 32087 and Ames 32088). They were collected by David Brenner and Reid Palmer on a USDA-ARS Plant Explorations Office funded exploration in Wyoming. On the same trip we also collected two *Blitum nuttallianum* accessions (Ames 32085 and Ames 32086).

Reid Palmer collecting germplasm in Wyoming

Three *Melilotus* (Ames 32036 to Ames 32038) collected in the far east of the Russian Federation during 2012 were donated by Dr. Douglas A. Johnson of Utah State University.

David Brenner collected a *Portulaca pilosa* accession (Ames 32099) in Tampa, Florida during the annual Agronomy Conference.

Maintenance and distribution:
The overall availability for these crops improved slightly from 86% to 87% (Table 1). By the spring of 2014 our seed cleaning and processing activities were essentially up-to-date through the summer 2013 harvest. The fall 2013 seed harvests are still in the cleaning process.

New PI numbers were assigned to 168 accessions including 96 amaranth accessions donated from the University of California, Davis in 1996, but assembled in the 1970s by S.K. Jain's research group.

Improving passport data continued in 2013 with the addition of 1,098 latitude-longitude coordinates. Five-hundred-nine secondary identifiers were entered in GRIN, many of them Bioversity expedition numbers that allow click-on access from accessions in GRIN to PDFs of the original collectors' reports. The collectors' reports are archived at Bioversity's web site (PI 482046 is an example). Samuel Flomo loaded 324 accession images into GRIN.

In 2013, 586 accession citations of 27 publications were loaded in GRIN. This information is available to the public in a GRIN format that allows toggling between citation title and accessions listed in the publication.

The number of accessions of our crops tested for germination (Table 2), 251 (3%) is an improvement from 1% in 2012. Numbers fluctuate depending on station priorities, labor availability, and scheduling variations.

We continue to receive many requests for non-research seed uses. Most of these requests are from home gardeners and the requestors are often referred to commercial seed sources. The process is much more efficient than before, thanks to Robert Stebbins vetting the orders.

Amaranthus:
Eighty-eight *Amaranthus* seed lots from 2011 and 2012 were stored in 2013.

Chenopodium:
The only seed of this group stored in 2013 was a 2012 lot of *Suckleya suckelyana* (PI 667181). This is probably the only accession of the genus available world-wide. It is expected to become useful in systematics studies.

Millets and other grasses:
Accessions of two grass species *Glyceria striata* (Ames 29899) and *Setaria palmifolia* (PI 271196) grew in our field but did not flower or over-winter there. We will need to find another environment for seed production.

Melilotus:
Thirty-two *Melilotus* accessions were harvested in 2013 and 30 accessions were planted in the Farm Greenhouse #2 in October 2013 for spring transplanting into the field. They will be pollinated with caged bees and harvested in mid-2014. *Melilotus* availability improved from 76% to 83% because of storing 76 harvests that accumulated from 2010, 2011 and 2012.

Miscellaneous Apiaceae:
Our colleagues at the National Arid Land Plant Genetic resources Unit in Parlier, California regenerated 15 cumin (*Cuminum cyminum*) accessions by seeding directly in field soil on October 25, 2012. Cumin is much better adapted as a winter-crop there, than in the environments we have tried in Iowa. The new seed lots from Parlier are far superior to the seed lots we grow. Seven additional cumin accessions germinated in Parlier, and then failed to thrive, so they appear to be un-adapted there.

Our 2003 greenhouse increase of samphire (*Crithmum maritimum*, Ames 25254) had 0% viability in 2005 and 82% in 2013. We attribute the improved viability to after-ripening. This is good news since this is the only accession of the species that we can make available, and it is of interest as a minor European vegetable.

Six Apiaceae seed lots from as long ago as 2008 were stored in 2013.

Perilla:
The viability of some *Perilla* distribution seed lots deteriorated after 20 years of storage as determined by viability testing in 2012. *Perilla* seeds generally have poor life spans in storage. Four fresh seed lots were stored in 2013, and two replacement lots were regenerated for storing in 2014. We will regenerate approximately four seed lots per year until the old seed lots are replaced.

Leaf of an oddly serrated *Perilla* accession PI 664495

Spinacia:
Seed lots of 30 accessions were regenerated in 2013-2014 by cooperators in Salinas, California, Sakata Seed and the USDA-ARS. We regenerated two accessions of wild *Spinacia* germplasm in greenhouses at the NCRPIS and we made second harvests for two accessions to bulk with the harvests of 2012. Thirty-four seed lots were stored in 2013 including thirty regenerated in Salinas during 2011-2012.

Characterization/evaluation/taxonomy:
Amaranthus:
A planting of the 150 accession African Vegetable type *Amaranthus cruentus* collection and other black seeded *A. cruentus* is in progress. The intent is to resolve issues of duplication, characterization, taxonomy, purity and mostly to characterize the morphological group (MORPHOLOG).

Blitum nuttallianum can grow as a winter-annual:
Blitum nuttallianum is an obscure and little-studied native relative of spinach. Seeds that volunteered from a 2012 field planting of PI 662303 surprised us by germinating in our field in late September 2013, and the plants survived over winter and were growing in April 2014. Another winter-annual, *Lamium amplexicaule* germinated at about the same time. This demonstrates that *B. nuttallianum* is adapted for a winter-annual life cycle. We have previously only grown it as a spring-germinating species. We do not know how important winter-annual growth is across the enormous range of this species in the wild, extending from Mexico into Canada. Additionally the over-wintered plants had fleshy roots which are consistent with a report of Native Americans eating the roots.

Blitum nuttallianum (PI 662303) imaged on
April 8, 2014 after over-wintering in the field.

Chenopodium quinoa:
The United Nations International Year of Quinoa, 2013, was celebrated with conferences and continuing interest in the crop. David Brenner attended the Quinoa Conference at Washington State University organized by Professor Kevin Murphy, and attended by many long-term germplasm clients. One of the germplasm clients, Dr. Hassan Munir of the University of Agriculture in Faisalabad, Pakistan has an especially successful quinoa project based on NPGS germplasm. Since access to much of the world's quinoa germplasm is restricted by national policies, the NPGS germplasm is generally the most accessible, even within South America. Our collection is valued nationally and internationally by many supportive researchers.

In 2013 there was a surprising benefit from collecting the wild *Chenopodium* species. Researchers at Brigham Young University announced (before publishing in a peer-reviewed journal) that the two wild species making up the genome of cultivated (allotetraploid) *Chenopodium quinoa* are both in our collection and one is native in the United States. The evidence is based partly on PI 666323 *C. standleyanum* collected in Ames, Iowa, and one of the parent species, the other species is *C. ficifolium*. This finding could result in a long-term need to work with wild germplasm in quinoa improvement.

Chenopodium panicle form:
A new quinoa panicle form descriptor (PANICLE) was added to GRIN that is equivalent to one of Bioversity's 2013 international quinoa descriptors (Bioversity International, FAO, PROINPA, INIAF and IFAD 2013). This was aided by observation of the rare "amaranth" form in PI 614002, and consultation via email with experts in Argentina and Pullman, Washington. We plan to add more of Bioversity's quinoa descriptors to GRIN, especially the descriptor for pericarp color.

Portulaca:
We are imaging *Portulaca* and confirming taxonomy as we gain experience with this recently acquired genus.

Portulaca flowers of PI 532152 and Ames 31288. *Portulaca* is an important vegetable in much of the world. PI 532152 is an erect-growing, large seeded, cultivated accession from Oman.

Spinach:
Sun Zhaofa of the Qingdao Academy of Agricultural Science in China provided 346 spinach observations on five traits including monoecious frequency, and leaf shape of 69 accessions. The observations are loaded in GRIN.

Taxonomy:
In 2012, David Brenner made 13 taxonomic re-identifications, involving eight genera. In addition, six existing taxonomic determinations were confirmed with entries in GRIN's annotation area.

Publications and presentations:
David Brenner presented a lecture in the ISU Sustainable Agriculture Colloquium on March 13, 2013 titled: Seed saving in the tropics: Yucatan, Mexico. The presentation was repeated for a Unitarian Universalist church group on March 26.

David presented an oral talk: Status of the Amaranthus Seed Collection, at the Amaranth Institute Conference in Chicago, IL 19 to 21 September, 2014

David also provided a public hands-on seed cleaning demonstration in Ames, Iowa for a September 7 edible garden tour.

David is the lead author on a 2013 paper in Genetic Resources and Crop Evolution (cited below). This paper proposes a genetic-resources approach to the economic problem of black seeds in commercial amaranth grain harvests. The paper documents that grain amaranth lines have dramatically different frequencies of crop-weed hybrids bearing black seeds. Plant breeders have the option of selecting cultivars that outcross at low frequencies resulting in low frequencies of crop-weed hybrids.

Crop Germplasm Committee reports:
Written progress reports were prepared for the Clover and Special Purpose Legumes, Forage and Turf Grass, Leafy Vegetable, and New Crops, Medicinal and Essential Oils Crop Germplasm Committees (CGCs). David was the recording secretary for both the grass and clover CGCs.

Manuscript Reviews:
David Brenner reviewed one scientific journal article and one grant proposal for external organizations.

GRIN-Global development:
We actively participated in the development of GRIN Global. David Brenner and Samuel Flomo participated in the spring 2013 GRIN-Global training. David made suggestions, and also reviewed the public GRIN trial version in early autumn 2013.

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

Akond, M., Islam, S., and Wang, X. 2013. Characterization of biomass traits and cell wall components among diverse accessions of *Amaranthaceae*. Journal of Applied Phytotechnology in Environmental Sanitation. 2:37-45.

Andini, R., Yoshida, S., Yoshida, Y., and Ohsawa, R. 2013. *Amaranthus* genetic resources in Indonesia: morphological and protein content assessment in comparison with worldwide amaranths. Genetic Resources and Crop Evolution. 60:2115-2128.

Bell, M.S., Hagar, A.G., and Tranel, P.J. 2013. Multiple resistance to herbicides from four site-of-action groups in waterhemp (*Amaranthus tuberculatus*). Weed Science. 61:460-468.

Bhargava, A. and Srivastava, S. 2013. Quinoa: botany, production and uses. CAB International. Wallingford, UK. 247 pages.

Brenner, D.M., Johnson, W.G., Sprague, C.L., Tranel, P.J., and Young, B.G. 2013. Crop-weed hybrids are more frequent for the grain amaranth 'Plainsman' than for 'D136-1'. Genetic Resources and Crop Evolution. 60:2201-2205.

Hlinkova, A., Bednarova, A., Havrlentova, M., Supova, J., and Cicova, I. 2013. Evaluation of fatty acid composition among selected amaranth grains grown in two consecutive years. Biologia. 68:641-650.

Khaing, A.A., Moe, K.T., Chung, Jun-Wook, Baek, Hyung-Jin, and Park, Young-Jin. 2013. Genetic diversity and population structure of the selected core set in *Amaranthus* using SSR markers. Plant Breeding. 123:165-173.

Kietlinski, K.D., Jimenez, F., Jellen, E.N., Maughan, P.J., Smith, S.M., and Pratt, D.B. 2014. Relationships between the weedy *Amaranthus hybridus* (Amaranthaceae) and the grain amaranths. Crop Science. 54:220-228.

Kolano, B., Saracka, K., Broda-Cnota, A., Maluszynska, J. 2013. Localization of ribosomal DNA and CMA3/DAPI heterochromatin in cultivated and wild *Amaranthus* species. Scientia Horticulturae. 164:249-255.

Kolano, B., Siwinska, D., Szymanowska Pulka, J., Maluszynska, J. 2012. Genome Size Variation in Chenopodium quinoa (Chenopodiaceae). Plant Systematics and Evolution. 298: 251-255.

Kuwaharaa, K., Suzukia, R., and Itoa, Y. 2013. An analysis of genetic and geographical variation of spinach germplasm using SSR markers. Plant Genetic Resources. DOI:10.1017/S1479262113000464.

Li, N., Li, Z., Fu, Q., Zhuang, P., Guo, B., and Li, Hua. 2013. Agricultural technologies for enhancing the phytoremediation of cadmium-contaminated soil by *Amaranthus hypochondriacus* L. Water Air and Soil Pollution. 224:1-8.

LoPresti, E.F. 2014. Chenopod salt bladders deter insect herbivores. Oecologia. 174:921-930.

Murakami, T., Yutani, A., Yamano, T., Iyota, H., and Konishi, Y. 2013. Effects of popping on nutrient contents of amaranth seed. Plant Foods for Human Nutrition. 69:25-29.

Park, Young-Jun and Nishikawa, T. 2012. Rapid identification of *Amaranthus caudatus* and *Amaranthus hypochondriacus* by sequencing and PCR-RFLP analysis of two starch synthase genes. Genome. 55:623-628.

Seguin, P., Mustafa, A.F., Donnelly, D.J., and Gelinas, B. 2013. Chemical composition and ruminal nutrient degradability of fresh and ensiled amaranth forage. Journal of the Science of Food and Agriculture. 93:3730-3736.

Link to online conference presentation:
International Quinoa Research Symposium Broadcast Webinar 2013
http://www.extension.org/pages/68467/international-quinoa-research-symposium-broadcast-webinar.

Research indirectly related to our germplasm:

Bioversity International, FAO, PROINPA, INIAF and IFAD. 2013. Descriptors for quinoa (*Chenopodium quinoa* Willd.) and wild relatives. Bioversity International, Rome, Italy; Fundación PROINPA, La Paz, Bolivia; Instituto Nacional de Innovación Agropecuaria y Forestal, La Paz, Bolivia; International Fund for Agricultural Development, Food and Agriculture Organization of the United Nations, Rome, Italy. 52 pages.

Bonasora, M.G., Poggio, L., and Greizerstein, E.J. 2013. Cytogenetic studies in four cultivated *Amaranthus* (Amaranthaceae) species. Comparative Cytogenetics. 7:53-61.

Green, A.J., Frisch, D., Michot, T.C., Allain, L.K., Barrow, W.C. 2013. Endozoochory of seeds and invertebrates by migratory waterbirds in Oklahoma, USA. Limnetica. 32:39-46.

Jimenez, F.R., Maughn, P.J., Alvarez, A., Kietlinski, K.D., Smith, S.M., Pratt, D.B., Elzinga, D.B., and Jellen, E.N. 2013. Assessment of genetic diversity in Peruvian Amaranth (*Amaranthus caudatus* and *A. hybridus*) germplasm using single nucleotide polymorphism markers. Crop Science. 53:532-541.

Kehinde, T.O., Ajala, M.O., Daniel, I.O., and Oyelakin, O.O. 2013. Physiological and genetic integrity of amaranth (*Amaranthus* spp.) seeds during storage. International Journal of Plant Breeding and Genetics. 7:35-46.

Lata, C., Gupta, S., and Prasad, M. 2013. Foxtail millet: a model crop for genetic and genomic studies in bioenergy grasses. Critical Reviews in Biotechnology. 33:328-343.

Mondoni, A., Tazzari, E.R., Zubani, L., Orsenigo, S., and Rossi, G. 2013. Percussion as an effective seed treatment for herbaceous legumes (*Fabaceae*): implications for habitat restoration and agriculture. Seed Science and Technology. 41:175-187.

Munusamy, U., Abdullah, S.N.A., Aziz, M.A., and Khazaai, H. 2013. Female reproductive system of *Amaranthus* as the target for *Agrobacterium*-mediated transformation. Advances in Bioscience and Biotechnology. 4:188-192.

Maruthachalam, K., Klosterman, S.J., Anchieta, A., Mou, B., and Subbarao, K.V. 2013. Colonization of spinach by *Verticillium dahliae* and effects of pathogen localization on the efficacy of seed treatments. Phytopathology. 103:268-280.

Palombini, S.V., Claus, T., Maruyama, S.A., Gohara, A.K., Souza, A.H.P., de Souza, N.E., Visentainer, J.V., Gomes, S.T.M., and Matsushita, M. 2013. Evaluation of nutritional compounds in new amaranth and quinoa cultivars. Food Science and Technology. 33:339-344.

Ribeiro, D.N., Pan, Z., Duke, S.O., Nandula, V.K, Baldwin, B.S., Shaw, D.R., and Dayan, F.E. 2014. Involvement of facultative apomixes in inheritance of EPSPS gene amplification in glyphosate-resistant *Amaranthus palmeri*. Planta. 239:199-212.

Sato, K., Mukainaria, Y., Naito, K., and Fukunaga, K. 2013. Construction of a foxtail millet linkage map and mapping of spikelet-tipped bristles 1(stb1) by using transposon display markers and simple sequence repeat markers with genome sequence information. Molecular Breeding. 31:675-684.

Stroescu, M., Stoica-Guzun, A., Ghergu, S., Chira, N., and Jipa, I. 2013. Optimization of fatty acids extraction from *Portulaca oleracea* seed using response surface methodology. Industrial Crops and Products. 43:405-411.

Venskutonis, P.R., and Kraujalis, P. 2013. Nutritional components of amaranth seeds and vegetables: A review on composition, properties, and uses. Comprehensive Reviews in Food Science and Food Safety. 12:381-412.

D. Horticulture (D. Barney, J. Carstens)

The horticulture program had two main foci during 2013. Jeff Carstens continued as curator working with the NC7-woody landscape collection with an emphasis on *Aronia* regeneration and evaluation, and *Fraxinus* and *Gymnocladus* acquisition. Dan Barney continued as curator of the NC7-medicinals, mints, and herbaceous ornamentals collections. His emphasis was to conduct an in-depth gap analysis of

these collections in order to prioritize taxa and develop long term acquisition, regeneration, and maintenance plans and protocols.

Table 1. Taxa with active accessions maintained in the NC7 horticulture collections as of December 31, 2013.

	Genera	**Subgeneric taxa**	**Accessions**
NC7-medicinals	10	92	499
NC7-mints	16	46	174
NC7-ornamentals	65	306	835
NC7-woody landscape	91	380	1765
Total	**182**	**824**	**3273**

Acquisitions:
During 2013, we added one herbaceous ornamental and added or re-obtained 74 woody landscape accessions to the horticulture collections.

One collection trip, funded by the USDA-ARS Plant Exploration/Exchange Office, targeted the collection of *Gymnocladus dioicus* throughout Iowa, Kansas, Missouri, Illinois, Indiana, and Kentucky. This trip resulted in the addition of 19 new *Gymnocladus* accessions. Collection efforts by Dr. Joseph Zeleznik, also funded through the USDA-ARS Plant Exploration/Exchange Office, resulted in the collection of 8 *Fraxinus* accessions (93 mother tree samples). Additional trips were executed by Jeff Carstens resulting in the collection of 7 *Fraxinus quadrangulata* accessions. Foreign accessions received at NC7 were collected in China by Kang Wang and Huiming Pei; Albania by Endrit Kullaj; and Russian Federation by Alexander Taran.

Maintenance:
No new field plantings were made for the medicinals, mints, or herbaceous ornamentals collections during 2013, although *Actaea*, *Baptisia*, *Dasiphora*, *Potentilla*, and *Symphytum* remained in the fields for seed increase purposes.

Maintenance efforts for woody-landscape accessions continued in 2013 with the addition of 22 accessions established for regeneration, including *Spiraea*, *Physocarpus*, *Diervilla*, and *Symphoricarpos*.

Phase one of a gap analysis of the NC7-medicinals, mints, and herbaceous ornamentals collection began in 2012 and was completed in 2013. The objectives were to:

- Prioritize the taxa for management, evaluation, and in-house research.
- Reorganize taxa within maintenance groups, if needed, based on primary stakeholder usage of the crops (medicinal, culinary, or ornamental).
- Identify gaps in taxa and populations that should be filled.
- Identify new taxa, and populations that should be added to the NC7 collections.
- Prioritize acquisition of needed germplasm.

Phase one involved collecting general information on genera and subgeneric taxa and estimating historical and current germplasm demand, research interest, and commercial interest. Data collected included the total number of NPGS germplasm

requests per taxon for selected periods. Research interest was estimated by the numbers of National Agricultural Library AGRICOLA database citations for the same periods as the germplasm requests.

By far the most challenging and time-consuming activity during phase one was determining commercial interest. Data collection required multiple Internet searchers for each taxon. For some taxa, little or no information was available. Data were usually piecemeal and often not from authoritative sources. Because all of the taxa within these collections are either wild or represent minor, recently commercialized crops, production and marketing statistics were limited or nonexistent. Market size was a subjective determination based on the number of products and vendors found in online searchers.

For each of the three criteria of germplasm demand, research interest, and commercial interest, each taxon received a rank of low, medium, or high priority. Those three ranking were used to develop an overall priority for each taxa.

Several challenges arose during the analysis. The number of germplasm requests and AGRICOLA citations were collected for the periods pre-1994, 1994-2003, and 2004-2013. Because not all taxa have been maintained the same length of time by NPGS and the number of accessions for each taxon varies widely and has shifted over time, the request demand was an estimate, only. Due to changes in taxonomy over time, the number of AGRICOLA citations may not always have been accurate due to changes in the scientific names of plants. Questions on taxonomy were frequent, but generally easily resolved. The genera *Alcea*, *Althaea*, *Lavatera*, *Malva*, and *Sphaeralcea* created, perhaps, the greatest challenge because of their close phylogenetic relationships and relatively recent reassignment of taxa within the genera. The GRIN Taxonomy for Plants database was the final authority used for this gap analysis.

General information on plant life forms, improvement status, threatened status, and designation as invasive or noxious weeds was generally easily obtained and reasonably objective. The status of rare, endangered, or threatened was the most difficult to determine in this group because there is no central organization that assigns risk values to plant taxa worldwide. For our purposes, the designations rare, threatened, and endangered were used in the practical, not legal, meaning.

The number of accessions maintained by the various NPGS units, the activity status of the taxa, and numbers of germplasm requests were the easiest data to obtain and the most objective. Although the data was cumbersome to obtain using GRIN Classic, the search engine in GRIN Global allowed fairly rapid collection and sorting of NPGS accession data.

The numbers and topics of research citations were relatively easy to obtain using the AGRICOLA database and reasonably objective, despite changes in plant nomenclature. That database worked well for the medicinal, mint, and ornamental germplasm that was the focus of this gap analysis. For other crops, different or additional publication databases may prove useful in gauging research interest.

Table 2. Subgeneric taxa maintained in the NC7-medicinal, NC7-mint, and NC7-ornamentals collections.

Collections	**Number of subgeneric taxa**			
	High priority	**Medium priority**	**Low priority**	**Total**
NC7-medicinals	10	18	64	92
NC7-mints	7	8	32	47
NC7-ornamentals	7	37	261	305
Total	**24**	**63**	**357**	**444**

Table 3. High priority NC7-medicinals, NC7-mints, and NC7-ornamentals taxa.

Taxon	**Maint group**	**Active NC7 accs**	**Common name**
Actaea racemosa	med.	39	black cohosh
Echinacea angustifolia	med.	8	blacksamson echinacea
Echinacea angustifolia var. *angustifolia*	med.	41	blacksamson echinacea
Echinacea angustifolia var. *strigosa*	med.	2	strigose blacksamson
Echinacea pallida	med.	47	pale purple coneflower
Echinacea purpurea	med.	22	purple coneflower
Hypericum perforatum	med.	78	St. Johnswort
Prunella vulgaris	med.	45	selfheal
Prunella vulgaris subsp. *asiatica*	med.	4	selfheal
Prunella vulgaris subsp. *lanceolata*	med.	2	lance selfheal
Hyssopus officinalis	mints	6	hyssop
Monarda fistulosa	mints	37	wild bergamot, bee balm
Origanum vulgare	mints	14	oregano
Origanum vulgare subsp. *gracile*	mints	2	oregano
Origanum vulgare subsp. *hirtum*	mints	1	oregano
Origanum vulgare subsp. *virens*	mints	1	oregano
Origanum vulgare subsp. *vulgare*	mints	5	oregano
Alcea rosea	orn.	12	hollyhock
Calendula officinalis	orn.	37	pot marigold
Hyoscyamus niger	orn.	12	henbane
Malva sylvestris	orn.	12	high mallow
Matricaria chamomilla	orn.	3	chamomile
Rumex acetosella	orn.	1	sheep's sorrel
Tanacetum parthenium	orn.	8	feverfew
Total accessions		**439**	

Table 4. Medium priority NC7-medicinals, NC7-mints, and NC7-ornamentals taxa.

Taxon	Maint group	Active NC7 accs	Common name
Echinacea hybrid	med.	2	coneflower
Echinacea laevigata	med.	9	smooth purple coneflower
Echinacea paradoxa var. *neglecta*	med.	4	Bush's purple coneflower
Echinacea paradoxa var. *paradoxa*	med.	5	Bush's purple coneflower
Echinacea sanguinea	med.	9	sanguine purple coneflower
Echinacea simulata	med.	10	wavyleaf purple coneflower
Echinacea tennesseensis	med.	4	Tennessee purple coneflower
Hypericum androsaemum	med.	6	sweet-amber
Hypericum ascyron subsp. *pyramidatum*	med.	5	great St. John's wort
Hypericum gentianoides	med.	8	orangegrass
Hypericum hirsutum	med.	5	hairy St Johnswort
Hypericum hypericoides	med.	9	St. Andrew's cross
Hypericum maculatum	med.	1	spotted St. Johnswort
Hypericum patulum	med.	1	none
Hypericum prolificum	med.	10	shrubby St. Johnswort
Hypericum punctatum	med.	11	spotted St. Johnswort
Hypericum scabrum	med.	5	none
Silybum marianum	med.	2	milk thistle
Agastache foeniculum	mints	15	blue giant hyssop
Agastache nepetoides	mints	8	yellow giant hyssop
Agastache rugosa	mints	16	purple giant hyssop
Monarda citriodora var. *austromontana*	mints	1	lemon beebalm or lemon mint
Monarda didyma	mints	2	scarlet beebalm
Monarda hybrid	mints	5	beebalm
Monarda punctata	mints	5	spotted beebalm
Stachys byzantina	mints	1	woolly hedgenettle
Acorus calamus	orn.	1	calamus
Alcea rugosa	orn.	9	rugose hollyhock
Althaea officinalis	orn.	3	common marshmallow
Anemone nemorosa	orn.	3	European thimbleweed
Calendula arvensis	orn.	17	field marigold
Calendula hybrid	orn.	6	marigold
Duchesnea indica	orn.	5	Indian strawberry
Glebionis coronaria	orn.	21	crown daisy
Glebionis segetum	orn.	5	corndaisy
Hyoscyamus muticus	orn.	2	henbane

Lavatera thuringiaca	orn.	13	tree lavatera
Lavatera trimestris	orn.	4	annual mallow
Lythrum salicaria	orn.	1	purple loosestrife
Malva alcea	orn.	4	vervain mallow
Malva moschata	orn.	5	musk mallow
Malva neglecta	orn.	3	common mallow
Malva parviflora	orn.	8	cheeseweed mallow
Malva verticillata var. *crispa*	orn.	4	curly mallow
Malva verticillata var. *verticillata*	orn.	6	curly mallow
Peganum harmala	orn.	4	wild rue or Syrian rue
Phacelia tanacetifolia	orn.	1	lacy phacelia
Plectranthus barbatus	orn.	1	forskohlii
Plectranthus scutellarioides	orn.	21	common coleus
Potentilla argentea	orn.	11	silver cinquefoil
Potentilla gracilis	orn.	6	slender cinquefoil
Potentilla recta	orn.	11	sulphur cinquefoil
Rumex acetosa	orn.	4	common sorrel or garden sorrel
Rumex crispus	orn.	2	curly dock
Sanvitalia procumbens	orn.	13	Mexican creeping zinnia
Spergula arvensis	orn.	8	corn spurry
Sphaeralcea ambigua	orn.	1	desert globemallow
Sphaeralcea coccinea	orn.	3	scarlet globemallow
Sphaeralcea munroana	orn.	2	Munro's globemallow
Sphaeralcea parvifolia	orn.	3	smallflower globemallow
Symphytum officinale	orn.	1	common comfrey
Tanacetum cinerariifolium	orn.	8	dalmatian pyrethrum
Tanacetum vulgare	orn.	9	common tansy
Total accessions		**388**	

Availability and Backup:
During 2013, approximately 73% of the medicinals and mints collections were available, essentially unchanged from last year. For 2013, 63% of the herbaceous ornamentals and 49% of the woody landscape accessions were available; an increase of approximately 4% availability of the woody landscape accessions.

For the medicinals and mints accessions, 77% and 82%, respectively, were backed up as of the end of 2013, similar to 2012. Sixty-four percent of the ornamentals and 40% of the woody landscape accessions were backed up, with an increase in backup status for the woody landscape accessions of 2% from last year. Data on the NC7 horticulture collections accessions, and their availability and backup status are shown in Table 5 and Appendix Tables 1 and 2.

Table 5. Availability and backup status of NC7 horticulture collections for 2013.

	Accessions			
	High priority	**Medium priority**	**Low priority**	**Total**
NC7-medicinals				
No. of accs	288	106	102	499
backed up	250 (86.8%)	89 (84.0%)	45 (44.1%)	384 (77.0%)
available	250 (86.8%)	69 (65.1%)	46 (45.1%)	365 (73.1%)
NC7-mints				
No. of accs	64	53	57	174
backed up	52 (81.3%)	52 (98.1%)	39 (68.4%)	143 (82.2%)
available	47 (73.4%)	51 (96.2%)	29 (50.9%)	127 (73.0%)
NC7-ornamentals				
No. of accs	120	230	485	835
backed up	85 (70.8%)	188 (81.7%)	262 (54.0%)	535 (64.1%)
available	82 (68.3%)	190 (82.6%)	258 (53.2%)	530 (63.5%)
Total	**472**	**389**	**647**	**1508**
backed up	387 (82.0%)	329 (84.6%)	354 (54.7%)	1062 (70.4%)
available	379 (80.3%)	310 (79.7%)	333 (51.5%)	1022 (67.8%)
NC7-woody landscape				
No. of accs	1765	n/a	n/a	n/a
backed up	706 (40.0%)			
available	865 (49.0%)			

Regeneration:
Regeneration efforts in 2013 focused primarily on seed production from established, caged shrubs and herbaceous ornamentals, as they did in 2012. The largest number of seed harvests came from woody landscape accessions.

For the NC7 woody landscape collection, we made a total of 67 harvests from *Aronia*, *Cornus*, *Staphylea*, and other miscellaneous taxa. We attempted to establish 37 accessions including *Betula*, *Cornus*, *Diervilla*, *Spiraea*, *Viburnum*, and other miscellaneous taxa.

For the NC7 ornamentals collection, we made a total of 13 harvests from *Baptisia*, *Matricaria*, and *Potentilla*. A total of seven *Actaea* seed harvests were made for medicinals accessions. We established perennial accessions of *Anemone*, *Hypericum*, and *Thalictrum* for seed harvests in 2014 and beyond. Regeneration of NC7-mints accessions is scheduled for 2014 and 2016, with an emphasis on *Monarda* and *Agastache*.

A regeneration schedule through 2020 was developed, with the goal of backing up and making available all high- and medium-priority NC7 medicinals, mints, and herbaceous ornamentals accessions. That effort will involve regenerating approximately 180 of 861 total high- and medium-priority accessions during those 7 years. Approximately 332 of 631 total low-priority accessions are not presently backed up and/or are not available. Acquisitions through a planned Seeds of Success

(SOS) distribution are not included in these figures, but should have minimal impact on regenerations during the next five years. Most of the SOS accessions requested are, reportedly, already backed up.

Regeneration decisions for medicinals, mints, and herbaceous ornamentals accessions are based on: 1) each accession's management priority and 2) the regeneration priority of the accession's primary seed lot. The primary seed lot may be the original seed lot or a seed lot from an increase, depending on the quantity of the seed in each seed lot, seed age, viability, and other factors. Management priority is based on the gap analysis discussed above.

Regeneration priority is based on several factors, including quantity of seed on hand, age of the seed lots, viability test results, backup status, and availability status. Regeneration priority uses a scale of "1" to "5" with "1" being very high priority, such as a seed lot 30 years old, with less than 100 seeds on hand, an estimated viability less than 25%, and that is not available or backed up. A rating of "5" is low priority and indicates a seed lot less than 10 years old, with greater than 75% estimated viability, more than 10,000 seeds on hand, and that is both backed up and available. Regeneration priorities for 2014-2016 are discussed in the work plan at the end of this Horticulture section.

Viability Testing:
With the NC7 seed viability technician position vacant throughout 2013, seed viability testing remained at low levels. A total of 127 seed viability assessments were made for the woody landscape accessions. Research on seed dormancy, germination, and viability testing was a high priority for Dan Barney during 2013 and is discussed below.

Distribution:
Distribution figures for the horticulture collections are summarized in Table 6 and Appendix Tables 3A and 3B. For the combined horticulture program, we distributed 162 external domestic and foreign orders to 141 requestors totaling 755 items from 521 accessions. We cancelled 214 orders from 209 requestors representing 609 items. Most of the orders were cancelled because they were requested for home gardening or other non-research use.

The numbers of orders, requestors, and items shipped were generally similar for the NC7-medicinals and NC7-mints collections for 2010-2013, although the number of accessions and items shipped increased somewhat for the mints collection in 2013. Demand for NC7-ornamentals was down, with the fewest numbers of orders and requestors and the second lowest numbers of accessions and items since 2009.

The taxa most requested in 2013, in terms of individual packets shipped, were: medicinals – *Echinacea angustifolia* var. *angustifolia*; mints – *Origanum vulgare* and *Origanum vulgare* subsp. *gracile*; herbaceous ornamentals – *Calendula officinalis*; and woody landscape plants *Fraxinus*, *Aronia*, *Spiraea*, *Gymnocladus*, and *Caragana* (listed in decreasing order of most requested.

Table 6. External domestic and foreign germplasm distributions for the NCRPIS horticulture program during 2013.

Crop	Year	No. of Orders	No. of Recipients	No. of Items Distributed	No. of Accs Distributed
Medicinals	2009	64	52	267	154
	2010	35	31	165	129
	2011	47	45	125	91
	2012	32	29	166	97
	2013	31	30	150	94
	Average	**41.8**	**37.4**	**174.6**	**113**
Mints	2009	33	31	179	92
	2010	22	22	54	34
	2011	34	32	125	79
	2012	29	29	81	58
	2013	30	30	150	87
	Average	**29.6**	**28.8**	**117.8**	**70**
Ornamentals *	2009	110	95	607	390
	2010	82	73	301	248
	2011	114	95	599	405
	2012	49	48	106	86
	2013	45	41	190	154
	Average	80.0	70.4	360.6	256.6
Woody Landscape	2012	47	43	166	131
	2013	76	63	265	186
	Average	**61.5**	**53**	**215.5**	**158.5**

* For 2009-2011, herbaceous ornamental and woody landscape plants were reported as a single group. Beginning in 2012, the two crops were split into separate maintenance groups.

Characterization/taxonomy:
No characterization or taxonomic work was conducted on the NC7-medicinals, NC7-mints, or NC7-ornamentals collections during 2013. A total of three accessions were reidentified. During 2013, horticulture staff captured seed images of 78 horticulture accessions, and an additional 304 plant, flower, fruit, and bark images. Images were named following the NCRPIS imaging standard protocol and loaded to GRIN.

Evaluation:
No evaluations were made of NC7-medicinals, mints, or ornamentals during 2013. *Actaea*, *Hypericum*, and *Prunella* accessions to be used for phenotyping and evaluation were established in containers for phenotyping in 2014 and beyond, and efforts to develop descriptors lists for these genera began.

In 2013, a total of 440 observations were collected on woody landscape accessions and were loaded into GRIN. Observations focused on *Aronia*, *Fraxinus*, and *Gymnocladus*, and included total soluble solids, fruit diameters, fruit weights, USDA

Cold Hardiness Ratings, Omernik Ecoregions, seed widths, seed lengths, peak flowering, and ploidy level.

Enhancement:
No enhancement activities were conducted on the NC7-medicinals, mints, or ornamentals collections in 2013.

A small, long-term project to conduct recurrent selection on *Fraxinus ornus* (flowering ash) for improved winter survival continued with the cultivation of a seedling population (Ames 29231) produced from the inter-mated progeny of trees selected in Urbana, IL continues.

New in 2013, a population of *Quercus prinoides*, Ames 23752, was utilized to select for individuals with extreme prostrate growth habits and superior fall color. Out of 65 specimens represented in this population, 22 individuals were selected for regeneration in 2014.

Coordination of the NC-7 Regional Ornamental Trials:
In 2013, Jeff Carstens distributed 124 plants of four accessions to 12 sites for long-term evaluation. A brief paragraph with an overview of the NC-7 Regional Ornamental Trials Program has been added to GRIN database records for the four accessions distributed in 2013. 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:
Dan Barney continued collaboration with researchers at the USDA-ARS National Clonal Germplasm Repository – Corvallis on manuscripts describing genetic profiling of *Paeonia* and *Rheum*, which research began when he was stationed in Alaska and curated those genera.

Research products:
The effectiveness, or lack thereof, of two standard germination protocols were determined for 47 *Hypericum* subgeneric taxa maintained at NC7. As discussed below, one or both of the protocols provided 50% or greater cumulative germination for 7 taxa and 10% to 49% cumulative germination for 15 additional genera.

Although surface sterilization proved ineffective as a means of reducing microbial growth in germination dishes for *Actaea* and *Hypericum*, a protocol using finely screened peat moss to conduct germination tests on *Actaea racemosa* seeds was developed. That protocol is described below.

A rapid viability assay for *Actaea racemosa* was developed using 2,3,5-triphenyl tetrazolium chloride.

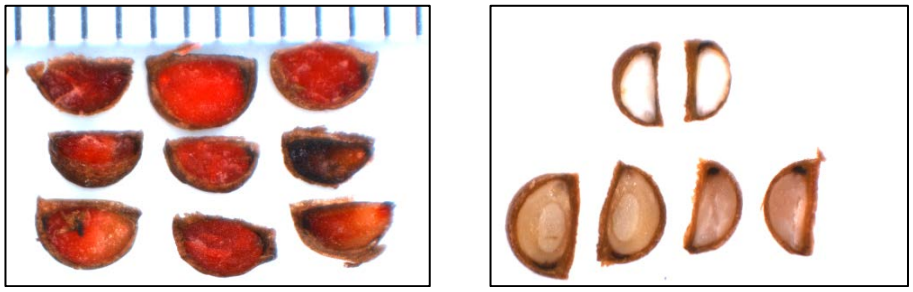
Dan Barney's other research and training activities:
Research continued on seed viability assessments, dormancy, and seed development as it relates to dormancy and viability. The focus was on *Actaea*, *Fraxinus*, and *Hypericum*.

For *Actaea racemosa*, vital staining with 2,3,5-triphenyltetrazolium chloride (TTC) proved effective in predicting seed viability quickly. Protocols tested included varying the TTC concentration from 0.1% to 1.0%, with seed immersion for 30 minutes to 24 hours. The optimal protocol for using TTC to evaluate *Actaea racemosa* seed viability appears to be splitting the seeds longitudinally for three-fourths of their lengths and immersing the seeds in 1.0% TTC in deionized or distilled water for 24 hours with constant agitation on a tube rotator. The immersion vials should be wrapped in aluminum foil to exclude light. Images of intact, unstained seeds are shown in Figure - Horticulture 1. and TTC-stained viable and non-viable seeds are shown in Figure - Horticulture 2.

Figure 1. Actaea racemosa PI 649023 seeds. One division = 1.0 mm.

A problem with using germination as a means of determining seed viability for *Actaea racemosa* is rapid fungal and/or bacterial growth on the seeds when they are placed onto sterile blotter paper in plastic germination boxes. Attempts to reduce or eliminate microbial growth in the germination boxes by surface sterilization were unsuccessful. In repeated trials, sodium hypochlorite bleach, sodium dichloro diisocyanurate (NADDC), chlorine gas, and hydrogen peroxide all killed the *Actaea* seeds and were ineffective in reducing microbial growth. Staining with TTC before and after surface sterilization treatments revealed that the treatments damaged the seeds, as shown by the lack of staining. Examples are shown in Figure 2.

Figure 2. Viability evaluations of *Actaea racemosa* seeds using 2,3,5-triphenyltetrazolium chloride. Untreated seeds on the left were stained by immersing them in 1.0% aqueous TTC solution for 4 hours. Eight of the nine untreated seeds appear to be viable. Seeds on the right were incubated in TTC following immersion in 3.0% hydrogen peroxide for 30 minutes and reveal little or no staining, indicating that the embryonic and other seed cells were not viable. One division = 1.0 mm.



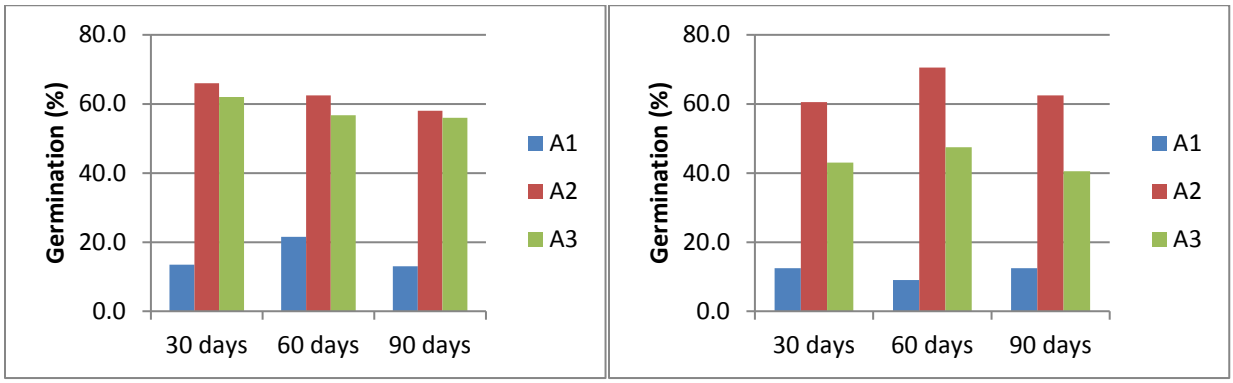
Warm and cold stratification of *Actaea racemosa* seeds in moist, finely-ground sphagnum peat moss screened to pass an 850 µm sieve eliminated almost all mold on seeds that were completely surrounded by the peat moss. This strategy allows

warm and cold stratification of the seeds in the germination dishes, followed by germination testing in the laboratory (Figure 3). The mechanism by which the peat moss reduced microbial growth remains to be determined.

Figure 3. *Actaea racemosa* PI 649023 seedlings in a germination dish filled with peat moss-based potting soil following 30 days of warm and 90 days of cold stratification and incubation for 49 days at 25/10 °C with 12-hour photoperiod.

Warm stratification trials demonstrated that stratifying *Actaea racemosa* seeds at 15 or 20 °C for 30, 60, or 90 days, followed by 90 days of stratification at 5 °C effectively met dormancy requirements and stimulated germination. The optimal protocol appears to be 30 days of warm stratification at 15 °C. Trials continue to determine the effectiveness of cold stratification for 30, 60, and 90 days. Results of warm stratification trials appear in Figure 4.

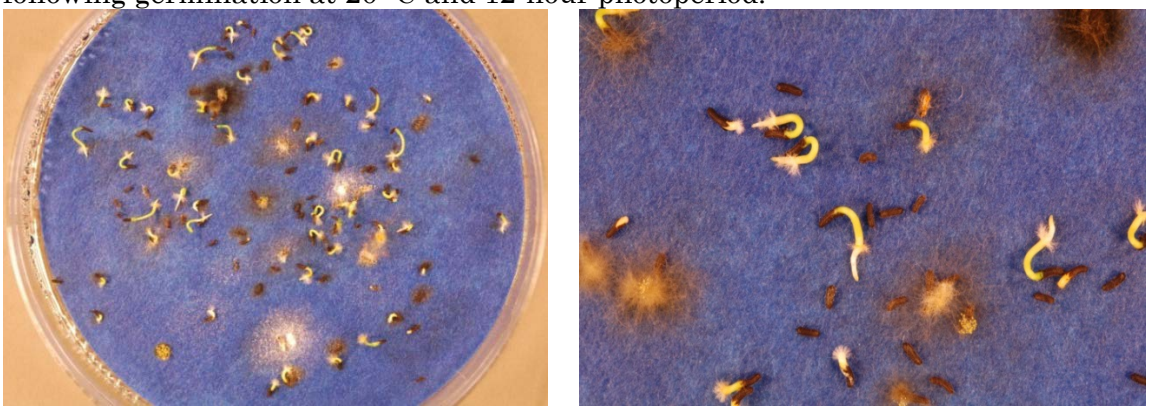
Figure 4. Results of *Actaea racemosa* warm stratification trials at 15 °C (left) or 20 °C (right) for 30, 60, or 90 days. Accessions used: A1 = Ames 27630, A2 = PI 649023 and A3 = PI 649024.



Fungal and, occasionally bacterial, growth often develops in *Hypericum* germination dishes. Due to the small seed size and aggressive nature of some common pathogens, such contamination can make collecting accurate viability data difficult and can mask the effects of seed pregermination treatments. Further work is planned to identify the pathogens commonly seen in *Hypericum* germination dishes.

As they did for *Actaea*, attempts to reduce germination dish contamination using seed surface sterilization proved ineffective for *Hypericum gentianoides*, *H. perforatum*, *H. prolificum*, and *H. punctatum*. While it was possible to reduce or eliminate microbial growth, seed germination was inhibited or eliminated for all of the treatments described above for *Actaea*. A typically microbe-contaminated *Hypericum prolificum* germination dish is shown in Figure 5.

Figure 5. Fungal growth in a germination dish of *Hypericum prolificum* PI 664868 following germination at 20 °C and 12-hour photoperiod.



Seed germination trials using *Hypericum* examined the effects of temperatures on seed germination, without scarification, stratification, or other pre-germination treatments. Results are summarized in Table 7. We have effective germination protocols (50% to 100% germination) for seven taxa and moderately effective protocols (10% to 49% germination) for 15 taxa. Twenty-four *Hypericum* taxa maintained at NC7 produced less than 10% germination at constant 20 or 30 °C with 12-hour photoperiods and no pregermination treatments. Because only one or a very few accessions were available for testing for most of the accessions, we cannot yet conclude to what degree the low germination responses were due to ineffective germination protocols and/or poor seed viability. Research planned for 2014 is described at the end of this Horticulture section.

Table 7. Responses of *Hypericum* taxa to germination at constant 20 °C or 30 °C with 12-hour photoperiod and no stratification, scarification, or other pregermination treatments. none = no germination, low = 1% to 9% germination, moderate = 10% to 49% germination, high = 50% to 100 % germination, nt = not tested.

Species	20C	30-20C
H. beanii	high	nt
H. forrestii	high	nt
H. graveolens	high	nt
H. oblongifolium	high	nt
H. perforatum	high	high
H. undulatum	high	nt
H. x inodorum	high	nt

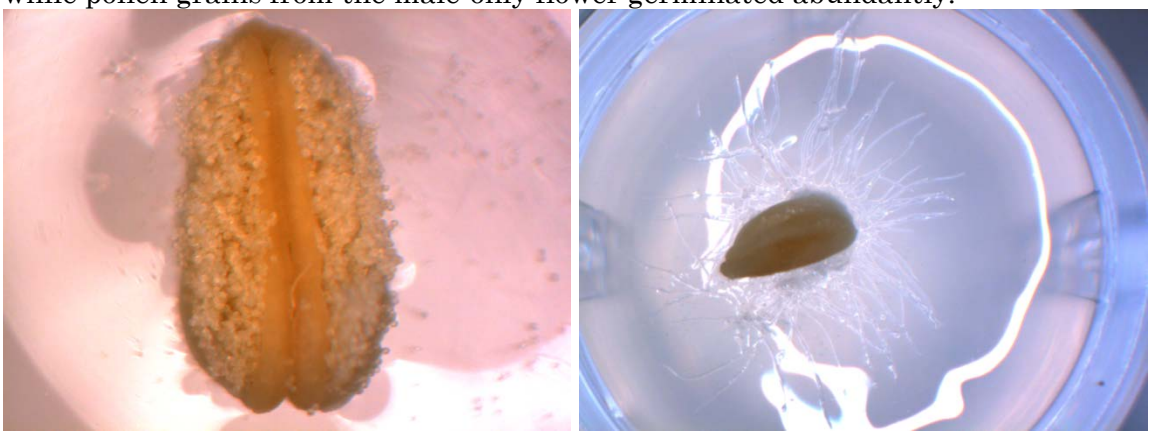
Species	20C	30-20C
H. androsaemum	moderate	moderate
H. balearicum	moderate	nt
H. bellum	moderate	nt
H. bithynicum	moderate	moderate
H. hakonense	moderate	nt
H. hirsutum	moderate	moderate
H. maculatum	moderate	nt
H. mitchellianum	moderate	nt
H. monogynum	moderate	nt
H. orientale	moderate	nt
H. patulum	moderate	nt
H. prolificum	moderate	moderate
H. pseudomaculatum	moderate	nt
H. punctatum	moderate	moderate
H. tetrapterum	moderate	nt

Species	20C	30-20C
H. canadense	low	nt
H. denticulatum	low	nt
H. gentianoides	low	low
H. humifusum	low	nt
H. hypericoides	low	low
H. hypericoides subsp. multicaule	low	nt
H. hyssopifolium	low	nt
H. linarioides	low	nt
H. myrtifolium	low	nt
H. scabrum	low	nt
H. setosum	low	nt
H. tenuifolium	low	nt
H. uralum	low	nt
H. adpressum	none	nt
H. ascyron	none	nt
H. ascyron subsp. pyramidatum	none	nt
H. cistifolium	none	nt
H. crux-andrea	none	nt
H. densiflorum	none	nt
H. drummondii	none	nt
H. fasciculatum	none	nt
H. majus	none	nt
H. pulchrum	none	nt
H. tetrapetalum	none	nt

In a preliminary study, Jeff Carstens and Dan Barney investigated floral morphology, pollen viability, and the effects of self- and cross-pollination in *Gymnocladus dioicus* (Kentucky coffeetree). We observed that, while some flowers developed both male and female reproductive structures, viable pollen was only produced in the anthers of male-only flowers. Images of pollen tube growth, or lack thereof, from anthers plated on pollen germination medium appear in Figure 6. The pollen germination medium was prepared as follows:

Compound	**Concentration**	**To make 50 mL, add:**
Agar	1%	500 mg
H3BO3	100 mg/L	5.0 mg
MgSO4	100 mg/L	5.0 mg
Sucrose	15%	7.5 g
Water		50 mL

Figure 6. Anthers from *Gymnocladus dioicus* hermaphroditic (left) and male (right) flowers plated on a germination medium containing agar, boric acid, magnesium sulfate, sucrose, and deionized water and incubated at room temperature overnight. Note that no pollen tubes formed on anthers collected from hermaphroditic flowers, while pollen grains from the male-only flower germinated abundantly.



From May 22 through June 10, 2013, inflorescences were bagged on two accessions (Ames 13775 and Ames 22090) of *Gymnocladus dioicus*. A total of 20 inflorescences were randomly selected and bagged prior to anthesis or simply marked (control) with flagging tape to compare seed set between bagged and marked (control/open pollinated) inflorescences. None (0%) of the bagged inflorescences resulted in the formation of seeds. A total of 33% and 50% of the open pollinated inflorescences set at least one fruit for accessions Ames 13775 and Ames 22090, respectively. Both the preliminary bagging study and also the pollen germination study, indicates that hermaphroditic flowers are not self-compatible. However, additional research utilizing other accessions/genotypes is highly recommended.

Observation data captured for *Aronia* continued in 2013, with a total of 63 images captured, peak flowering for 40 accessions documented, and the ploidy level (diploid, triploid, or tetraploid) for 69 accessions determined by Dr. Mark Brand (University of Connecticut). Observation data was loaded to GRIN.

Other Horticultural project-training and staff-development activities:
Dan Barney completed six AgLearn courses on safety, diversity, and communications, as well as three laboratory safety courses from Iowa State University. He also completed first aid and CPR training and related safety training at the NCRPIS.

Jeffrey Carstens completed seven AgLearn courses on safety, diversity, and communications as well as respirator recertification from Iowa State University. He also completed first aid and CPR training and related safety training at NCRPIS.

Manuscript and Proposal Review:
Dan Barney reviewed research journal manuscripts on *Citrullus colocynthis* and cotton.

Posters, Presentations, and Seminars:
Jeff Carstens presented information on the NC7 Regional Ornamental Trials Program at the 2013 Indiana Green Expo (Indianapolis, Indiana). Jeff also provided a workshop at the Iowa Arboretum (Luther, Iowa) on 'Nut Trees for the Landscape.' Dan Barney did not make any oral or poster presentations during 2013.

Publications which appeared in print (or online) in 2012:
Barney, D.L., Bauer, M., and Jensen, J. 2013. Survival, frost susceptibility, growth, and disease resistance of corkbark and subalpine fir grown for landscape and Christmas trees. HortTechnology. 23:194-200.

Gilmore, S., Bassil, N.V., Barney, D.L., Knaus, B.J., and Hummer, K.E. 2014. Short-read DNA Sequencing Yields Microsatellite Markers for Rheum. J. Amer. Soc. Hort. Sci. 139(1):22–29.

Gilmore, B.S., Bassil, N.V, Nyberg, A., Knaus, B.J., Smith, D., Barney, D.L, and Hummer, K.E. 2013. Microsatellite marker development in peony using next-generation sequencing. J. Amer. Soc. Hort. Sci. 138(1):1–11.

Jensen, J., Barney, D.L., and Bauer, M. 2013. Growing corkbark fir and subalpine fir for nursery production. PNW 645. University of Idaho.

Mickelbart, M., Carstens, J., Daniel, K., and Gosney, M. 2013. Evaluation of Native U.S. Trees at Purdue. Indiana Nursery & Landscape Association. January/February 2013. p. 22-25.

Conclusions and Plans for 2014:
Unusually rainy weather interfered with planned field plot establishment for *Baptisia* and *Hypericum*. Otherwise, 2013 was productive in terms of overall regeneration of the horticulture collections. Much progress was made in the acquisition and curation of *Fraxinus* and *Gymnocladus* germplasm. Completion of the first phase of a gap analysis on the NC7-medicinals, mints, and ornamentals collections makes it possible to develop a focused, long-term plan for collection management and expansion.

Curation:
For 2014, we will attempt to regenerate 80 medicinals, mints, and herbaceous ornamentals accessions. With two exceptions, regeneration involves accessions with high or medium management priority and with "1" or "2" regeneration priority. The exceptions are *Symphytum asperum* and *Dasiphora fruticosa subsp. fruticosa*, which are already established in fields at NCRPIS and can be harvested easily following caging. They are low-priority accessions but have moderate to high regeneration priorities.

Many of the accessions planned for establishment in 2014 are perennial and will not be harvested until 2015 or later. There should be approximately 46 harvests in 2014 for the NC7-medicinals, NC7-mints, and NC7-ornamentals. Part of the expected harvests will come from *Actaea*, *Baptisia*, *Dasiphora*, and *Symphytum* accessions already established in NC7 fields, and established, containerized *Prunella* accessions. Seven *Actaea racemosa* and two *A. rubra* accessions are now being propagated in containers for field planting adjacent to already established *Actaea* in Field G in late 2014 or early 2015.

Other genera scheduled for regeneration during 2014 include *Anemone*, *Glebionis*, *Calendula, Echinacea*, *Hyoscyamus, Lavatera, Matricaria, Monarda, Origanum*, *Peganum,* and *Thalictrum*. The *Hyoscyamus* and *Peganum* accessions will be grown in the Agronomy greenhouse on the Iowa State University campus for secure seed production due to risks involved with toxicity and psychoactive properties of the plants.

With the pending transfer of *Baptisia* to the Ornamental Plant Germplasm Center in Ohio in late 2014 or early 2015, plans to establish new field plantings of *Baptisia* have been discontinued. The *Baptisia* and *Symphytum* accessions in Field G can be removed at the end of the 2014 or beginning of the 2015 growing season.

Medicinal, mint, and herbaceous ornamental genera scheduled for regeneration in 2015 include *Alcea*, *Hypericum*, *Malva*, *Plectranthus*, *Silybum*, and *Tanacetum*. Genera tentatively scheduled for regeneration in 2016 include *Acorus*, *Agastache*, *Duchesnea*, *Potentilla*, *Rumex*, and *Sphaeraclea*.

In 2014, we will attempt to regenerate 33 woody landscape accessions. All of the accessions planned for establishment in 2014 are shrubs and will not be harvested until 2016 or later. Taxa attempted for regeneration include *Cornus, Prinsepia, Ampelopsis, Diervilla,* and *Viburnum*. There should be approximately 48 harvests in 2014 for the NC7-woody.landscape collection. Part of the expected harvests will come from *Spiraea, Staphylea, Euonymus, Aronia*, and *Caragana.* Regeneration plans for 2015 will likely focus on established accessions of NC7-medicinals, NC7-mints, NC7-ornamentals, and NC7-woody.landscape. Efforts will also be placed on propagating clonal selections of *Ulmus* in order to establish a new field block. Many of the PI *Ulmus* accessions established in the 1980's are starting to decline.

Evaluation:
Phenotyping observations are planned for *Actaea racemosa* and *Prunella vulgaris* during 2014. *Baptisia* presently established in field G will also be observed with a goal to confirm taxonomy and issue PI identification numbers prior to transferring

the *Baptisia* collection to the Ornamental Plant Germplasm Center in Columbus, Ohio.

Observations are planned for *Aronia* fruit in 2014. Fruits of *Aronia* accessions currently established at NCRPIS will be harvested throughout the growing season from the beginning of fruit coloration through the point at which fruits begin to desiccate. In collaboration with the USDA-ARS National Center for Agricultural Utilization Research Station (Bio-Oils Research Unit) located in Peoria, IL selected *Gymnocladus* accessions will be assessed for total oil and fatty acid contents. Evaluations will also include capturing digital imagery of *Ulmus* fruits of all fruiting accessions at NCRPIS for future use in taxonomic verification and possible revisions to current taxonomic descriptions.

Research:
We plan to establish 18 *Echinacea* accessions in the field for a joint research project with the University of Louisiana Monroe looking at improved methodologies for extracting bioactive compounds related to stimulation of bone marrow production. Two of those accession plots will also be used for seed increase. One additional *E. pallida* accession will be planted for seed increase, making 19 total *Echinacea* field plots.

Seed dormancy, viability, storage, and germination trials will continue. Taxa of particular interest during 2014 include *Actaea racemosa*, *Fraxinus quadrangulata*, *Hypericum androsaemum*, *H. ascyron* subsp. *pyramidatum*, *H. gentianoides*, *H. hirsutum*, *H. hypericoides*, *H. maculatum*, *H. patulum*, *H. perforatum*, *H. prolificum*, *H. punctatum*, and *H. scabrum*.

Research with NC7-woody.landscape accessions will continue to asses pollen viability and self-compatibility of *Gymnocladus,* viability testing and germination protocol enhancement of *Aronia,* comparison of conventional freezer and cryopreservation on *Gymnocladus,* completion of winged and dewinged *Fraxinus* germination study,

Staff Development:
Dan Barney is scheduled to attend the 2014 American Society for Horticultural Sciences conference in Orlando Florida during July 27 - August 1. He will chair the Fruit Breeding Working Group and submit a workshop proposal on Applying Sensory Aspects in Plant Breeding, co-sponsored by the Fruit Breeding and Vegetable Breeding Working Groups.

Dan Barney is also scheduled to attend the Herbaceous Ornamentals Crop Germplasm Committee meeting in Grand Rapids, Michigan at the end of October 2014.

Plans for staff development for 2014 will focus on training experiences for Jeff Carstens, which are likely to include attendance at the Iowa Shade Tree Short Course, ArcGIS skills, field work with other botanists/taxonomists, and safety training.

E. Maize Curation (M. Millard)

Personnel:
2013 was a stable year for full time staff on the maize project. Bruce Hall continues as federal Agricultural Research Science Technician. Brady North continues as the ISU Ag Specialist I. Mark Millard continues as maize curator. However, the GEM team lost a federal Field Tech to industry and the maize team was called on to help out the GEM project, especially during harvest after the government shutdown to help cover for this loss. Brady North should be commended for his extra effort during the government shutdown in getting the maize nursery harvested on time. All but two federal employees at the NCRPIS were not allowed to work during the first week of the shutdown including the curator and the maize federal technician. Thanks to Mr. North's and other state employees' efforts the maize nursery was harvested on time. The federal budget sequester contributed to another reduction in 2013 summer student staffing. This is one of the main factors in reduced maize increase nursery sizes experienced in recent years.

Research Progress:
The maize curator worked with MaizeGDB staff to develop a prototype application for MaizeGDB called TYPSimSelector. The alpha version is located at http://alpha.maizedb.org. This application allows genotypic comparison of 2,500 inbred accessions using 680,000 SNP markers to establish identity by sequence (IBS) relationships. Relationships between lines are presented based upon similarity and divergence scores (where identical lines are assigned a similarity score of 1 and a divergence is measured as '1 minus similarity'). Identity by state (IBS) was calculated for all possible pairwise comparisons using PLINK v1.07. The application is a web version of a 4,000 by 4,000 similarity matrix provided by Dr. Cinta Romay in Buckler's lab at USDA-PSNRU that I reworked last year to a 16 million row table for simplified presentation. The interface was presented by MaizeGDB staff at the 2013 Maize Genetics meetings.

The curator will continue to work with MaizeGDB staff to refine the tool and use it for collection management. A primary use will be during regeneration planning, resulting in reduced regeneration and maintenance costs. The curator also hopes to sample DNA and obtain GBS data from inbreds that could potentially be added to the collection. Characterizing the inbreds prior to incorporating them into the collection may be helpful in determining whether they should be introduced into the collections as new permanent accessions before a lot of effort goes into regeneration.

The maize project coauthored a paper on the 2,500 maize inbred collection in 2013: Romay, M., M. Millard, J. Glaubitz, J. Peiffer, K. Swarts, T. Casstevens, R. Elshire, C. Acharya, S. Mitchell, S. Flint-Garcia, M. McMullen, J. Holland, E.S. Buckler and C.A. Gardner. 2013. Comprehensive genotyping of the USA national maize inbred seed bank. Genome Biology 14:R55.

The maize curator tested over 50 GRIN-Global curator tool releases and has been doing parallel testing of maize curatorial operations in GRIN and a near data replication in GRIN-Global. Additionally the maize curatorial technicians and student employees have been enlisted to duplicate their GRIN operations in GRIN-Global. The maize curator continues to provide advice on solutions to the GRIN-

Global team on issues presented by parallel testing by all NPGS facilities. NPGS implementation of GRIN-Global is expected in 2014. Several genebanks across the world including Canada, CIMMYT, CIAT, CIP, Chile, Bolivia, Mexico, and Australia to name a few are in the process of learning, evaluating, and even implementing GRIN-Global in their operations. The maize curator continues to monitor communications to the team regarding GRIN-Global, providing advice as required.

The Annual General Meeting of the CGIAR genebank managers was held in Ames in September 2013. The maize curator answered questions on the newer GRIN-Global features and provided input on curatorial issues that the CGIAR and the NCRPIS maize curation project have in common. The maize nursery and processing area was part of a tour given by the NCRPIS staff to the meeting participants, emphasizing current technology and techniques that could be adopted by other banks. Despite challenges of weather extremes of wet, dry, hot and cool, and budgetary challenges of sequester and shutdown, the Ames 2013 maize nursery operations gave a good show.

The maize curatorial team tries technology new to the NCRPIS to improve greenhouse regeneration success and efficiency. The maize technicians researched and are experimenting with LED lights to reduce energy consumption and increase biologically effective wavelengths of light. Figure 1 shows the first fixture.

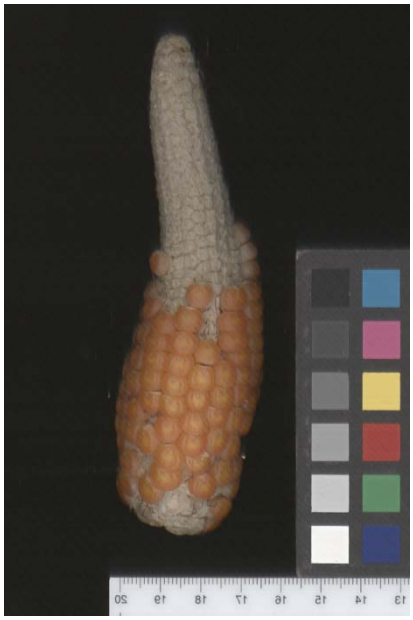
The Ames collection has a number of accessions where old seed of poor viability were donated. After an initial cycle at the station regenerating routine accessions, the maize technicians in 2013 endeavored to regenerate these more challenging accessions. They enhanced an activated charcoal protocol provided online by the ISU Schnable Lab, http://schnablelab.plantgenomics.iastate.edu/resources/protocols/, to improve on the results of initial growth chamber attempts. Results are promising with a greater number of seedlings surviving to maturity, but further enhancements will be tried in 2014.

Inbred lines have become an important part of the collection and the station has a number of inbreds that were initially maintained in the 1940s, 50s, and 60s by bulking pollen. The maize curator had removed a number of these from available status over the years because it was apparent that these lines had become contaminated during these early sib pollinations. The project has begun using the activated carbon technique to go back to original or early generation seed of the 40s and 50s to recover the original inbred. Figure 3 shows an apparent successful recovery.

Figure 1: Maize under first LED light at the NCRPIS.

Figure 2: Maize carbon germination rescue.

Figure 3: Single "correct" ear of PI 186184 (Inbred 381, Uruguay) below compared to Figure 4: Probable hybrids on the right from the 1st increase of 1950 Ames seed.



Acquisition:
In 2013, 39 new accessions were received. These included 22 GEM accessions from Raleigh and Ames locations. Eleven accessions were received representing different cycles of three tropical populations selected by Dr. A. Hallauer for temperate adaptation. The populations are Iowa Suwan-1 (C1,C3,C5), Iowa Tuxpeno (C1,C3,C5), and Iowa Tuson (C1,C3,C7,C9). Four CSS Plant Registration accessions were received via NCGRP that have become available. CE-777 from the Czech Republic is used in flow cytometry calibration. Only one new PVP was received in 2014 because the period of protection changed from 18 years to 20 years in 1994. Maize PVP expirations will resume in mid-2014. Inbreds Oh1VI, HP302, HP304W; and O'Heyne Popcorn complete the 2013 acquisition list

Regeneration:
There were 216 (1.0% of the collection) *Zea* accession regeneration attempts harvested in 2013. This compares with 410 (2.0% of the collection) Zea accession regeneration attempts harvested in 2012, 475 (2.3% of the collection) in 2011 and 560 (2.8% of the collection) in 2010. For perspective, maize accessions store for about 30 years in the intermediate cold storage conditions at Ames. The breakdown of the regeneration nurseries are as follows:

1. Another small nursery was grown in Ames in 2013 consisting of 141 accessions. The nursery was composed of 61 expired PVPs, 40 non-PVP inbreds, and 40 populations. This compares to 123 in 2012 and 260 in 2011 (1,772 rows vs. 1,778 rows vs. 2,009 25-foot rows). Several inbreds in high demand were grown at the 20 or 40 rows per accession level rather than the standard 10.

   Cool weather and spring rains delayed the planting by a couple of weeks with fields planted May 15th and May 17th. After planting, some rows were drowned out. Drip irrigation line could not be buried and so was not installed when the planting was small. The rains were minimal from late June till the 3rd week in July. Drip lines were laid on top of the ground and from mid-July to mid-September the fields were irrigated. As has happened in recent seasons, the limited available student labor pool made it difficult to handle the peak pollination season. Unfortunately, a hail storm at the ISU Agronomy farm essentially destroyed Drs. J. Edwards' and P. Scott's nurseries, and they generously made their student labor available to us to handle the early peak. PhD student A. Vanous and the GEM team would also often assist at the end of the work day, made possible due to staggered nursery plantings and different peak times. As the peak season arrived, unseasonably cool weather during late July and early August also enabled the pollination staff to keep up.

   Harvest started later due to the later planting and cool late summer weather, but looked good. Then the government shutdown occurred. All federal staff was sent home including the maize curator, federal technician, and federal student employees except for pathologist C. Block and entomologist S. Hanlin, who are considered essential for security of systems and life of biological organisms. Fortunately, the maize curation staff has a state funded technician, Mr. Brady North. With the assistance of ISU employed students and other permanent ISU-NCRPIS staff, harvest progressed some during the peak harvest time. Luckily they had access to an ISU-owned Farmall 140 tractor and a flat rack to haul the

harvest in from the field. They could not use any federal vehicles, equipment, or computers during the shutdown. Dr. Gardner and Area Director Dr. Matteri worked to have Mr. Bruce Hall, our maize curation federal technician, declared a critical employee during the second week of the shutdown and he assisted with harvest. Thanks to their efforts the maize nursery was harvested in a timely way. After the shutdown, the maize crew assisted the GEM crew to finish harvesting the GEM nursery which had only started, and with their combine yield trial harvest.

No Stewart's wilt was observed in any increases in 2013 as was the case in 2012, 2011 and 2010, thus no ELISA testing is necessary on 2013 Ames increase lots to meet phytosanitary requirements. There were some ear health issues due to a sequence of hot-cool-hot weather from pollination to harvest, but test weight of most mid-to-late season material is good. When all factors are considered, the summer regeneration is rated as above average.

2. Due to the rescission a much smaller tropical nursery of 20 accessions was sent to Puerto Rico rather than St. Croix in May 2013 for tropical increase.

3. Monsanto grew, pollinated, and harvested 50 tropical populations from Oahu, HI grown between February-July 2013, targeting 100 females per population of mainly lowland tropical adaptation. Many thanks to all at Monsanto who assisted in these large tropical nurseries. Ears are to be shipped to Ames after adventitious presence testing in 2014 for ear description and processing.

4. Twelve GEM lines were grown by the North Carolina GEM team in the summer of 2013 for the collection. Thanks to Mike Krakowsky and his N. Carolina team.

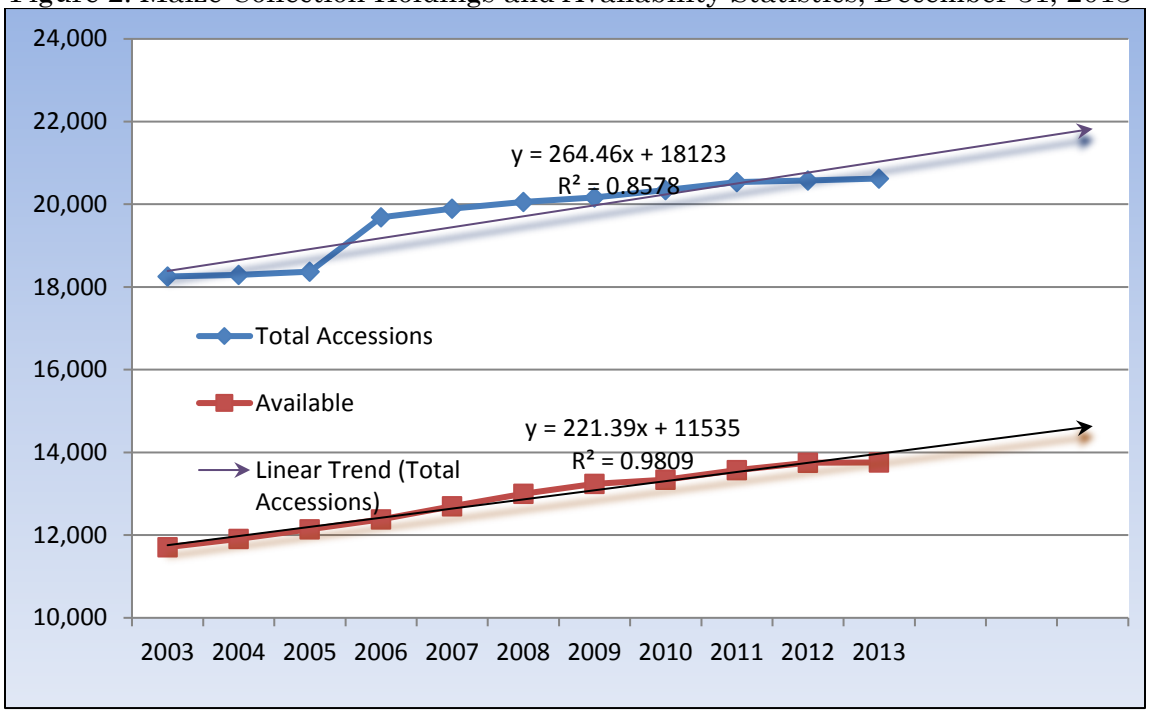
5. Ten GEMs were grown by the Ames GEM team in the summer of 2013 for the collection. Many thanks to Mike Blanco, Fred Engstrom and their GEM team.

6. Greenhouse increase harvests included 29 maize and one teosinte accessions. Fifty-six accessions were planted in the greenhouse for harvests in 2014.

Maintenance:
There were 20,624 accessions of *Zea* held at the NCRPIS as of December 31, 2013. This represents a .2% increase over the 20,579 accessions held at the NCRPIS at the end of 2012. GEMs and expiring PVPs made up the majority of the additions. The maize curator maintains an additional 100 accessions from the *Coix* and *Tripsacum* genera.

There were 13,757 available accessions at the end of 2013 (66.7% of the total) compared to 13,753 (66.8%) at the end of 2012 and 13,572 (66.1%) at the end of 2011. Significantly, although the absolute number of accessions available continues to increase, the percent available declined for the first time in a number of years. Progress in this are continues to be slow due to resource uncertainties. Progress would not be possible without in kind regeneration assistance of Monsanto, the GEM programs in North Carolina and Iowa, and others.

Figure 2. Maize Collection Holdings and Availability Statistics, December 31, 2013



This table indicates that *Zea* accession availability continues to maintain though the collection grows and accessions become unavailable. Efforts in recent years have been focused on increasing inbreds and expired PVPs to meet demand. Flat budgets and staffing make substantial increases in the number of available accessions difficult.

Yearly Accession Availability				
Year	**Total Accessions**	**Available Accessions**	**% Available**	**New Accessions**
2004	18,293	11,910	65.1%	1063*
2005	18,370	12,145	66.1%	75
2006	19,687	12,378	62.9%	285
2007	19,894	12,699	63.8%	124
2008	20,057	12,997	64.8%	150
2009	20,166	12,239	65.7%	105
2010	20,347	13,338	65.6%	178
2011	20,540	13,572	66.1%	180
2012	20,579	13,753	66.8%	39
2013	20,624	13,757	66.7%	39
***Accessions from Major Goodman collection were received in 2004, but were incorporated into the collection totals in 2005, 2006, and 2007 as time permitted.**				

Viability testing continued to decline in 2013 because of the vacant tech position handling testing. A seed storage tech is handling testing part time. There were 306 accessions tested in 2013 representing 1.5% of the collection. In 2012, 743 (3.6%) were tested and in 2011 508 accessions representing 2.5% of the collection. Five percent, 6%, and 7% of the collection was tested in 2010, 2009, and 2008 respectively. A goal of testing collections every 10 years is desirable to ensure seed is as healthy as possible for research. In 2013 no additional accessions were backed up at the NCGRP as regenerations focused on accessions already backed up but in high demand. Forty-four, 126, 105, and 71 accessions were backed up in 2012, 2011, 2010, and 2009 respectively. The percent of the collection backed up held at 73%.

Distribution:
Orders for all accessions maintained by the maize curator including those of the genera Tripsacum and Coix decreased 7% in 2013 compared to 2012. This compares to increases of 9% in 2012 and 14% in 2011. This decrease can be attributed to two factors. There was only one newly expired PVP in 2013. Secondly, there was a policy change in 2013 regarding non-research request.

Annual Distribution Data*								
Year	**Total Packets**	**Foreign Packets**	**Total Accns.**	**Foreign Accns.**	**Orders**	**Foreign Orders**	**Requestors**	**Foreign Requestors**
2009	13,538	1,767	5,113	1049	783	78	531	66
2010	22,111	1,587	4,296	945	655	73	456	63
2011	16,638	4,087	4,479	2477	748	78	546	67
2012	20,086	3,412	4,476	1,436	814	100	621	88
2013	**13,786**	**3,800**	**3,573**	**1,578**	**755**	**93**	**593**	**83**
Averages 2009-2013	17,232	2,931	4,387	1,497	751	84	549	73
*** Includes normal distribution orders, non-research orders, and orders planted for observations. Observations orders are not included in the appendix tables, but are significant in maize.**								

In recent years, the NCRPIS policy on **non-research** requests to first time requestors was to send a small number of requested accessions with adequate inventory along with a letter of explanation indicating that we would not distribute any further requests to the first time requestor for **non-research** purposes. **In May 2013**, with all NCRPIS curators in agreement, **the policy was changed** to indicate that no non-research requests would be filled. If the requestor feels his request was incorrectly classified as a non-research request, they are encouraged to communicate in more detail the purpose of their request. This table shows how the change in distribution statistics have changed since classification of this type of order began in 2010. This policy change could result in a 10-20% reduction in maize order shipments in 2014 and perhaps a 2-3% reduction in packet distributions.

	Distributed				Cancelled			
Year	**NR Order Packets**	**NR Order Accns.**	**NR Orders**	**NR Requestors**	**NR Order Packets**	**NR Order Accns.**	**NR Orders**	**NR Requestors**
2010	184	155	54	54	32	32	7	7
2011	318	225	100	97	33	28	13	12
2012	555	237	168	168	121	80	30	29
2013	252	149	110	110	590	289	194	192

Expired PVP-lines continue to be a major maize distribution category followed by NAM inbred parents, the Goodman-Buckler inbred diversity set, and all other inbred lines. Orders for expired PVPs were sent to 170 requestors (30% of all *Zea* requestors). Expired PVPs made up some portion of 36% of all Zea orders shipped. Packet distributions of these expired PVP inbreds was almost flat from previous years because of a low number of expired PVPs in 2013.

Expired PVP Annual Distribution Data				
Year	**Total Packets Distributed**	**Total Accessions Distributed**	**Orders Processed**	**Individual Cooperators**
2009	3,981	194	240	128
2010	5,227	231	234	146
2011	5,137	277	264	158
2012	6,788	303	270	169
2013	**6,830**	**340**	**269**	**170**

Characterization:
There were 7,682 data points loaded into GRIN on 363 accessions in 2013. This compares to 13,212 data points on 5,196 accessions in 2012 and 14,607 data points loaded on 2,807 accessions in 2011. The number of accessions characterized was down because of fewer accessions being processed and no new traits added as the project awaits GRIN-Global.

We imaged 463 accessions in 2013 compare to 556, 699, and 520 in 2012, 2011 and 2009 respectively. This figure is dependent on maize processing which has been flat or reduced in recent years. Image loading to GRIN awaits a new process in GRIN-Global.

Evaluation:
Two disease screening nurseries were sent out in 2013. Dr. Bill Dolezal, Pioneer Hi-Bred/DuPont, screened 250 accessions for northern leaf blight resistance and diplodia ear rot screening. Unfortunately this nursery was lost due to the weather conditions in Johnston, Iowa, as in 2012. Many thanks are extended to DuPont/Pioneer Hi-Bred for this long-term contribution. Dr. Charles Block, USDA-ARS pathologist at the NCRPIS, screened 133 accessions for Stewart's wilt resistance.

Plans for 2014:
In 2014 attending to regenerations and regeneration processing will need to take precedence. Student labor **is** expected to increase. A tropical regeneration nursery is planned. Additional in kind cooperator regeneration are expected. Regeneration remains my first priority because without viable seed, distribution and resulting research cannot be done.

Data will continue to be analyzed and assistance given for publications of the results of the 2,500+ inbred phenotyping/genotyping project.

Monsanto continues to regenerate tropical accessions on Oahu, Hawaii. One hundred tropical accessions will be shipped in February, 2014. Additional nurseries will occur during the winter 2014-2015. Processing is caught up so increase effort will go into this cooperative effort.

Pioneer will be regenerating 50 accessions on Puerto Rico.

The SNP data provided in 2012 from the inbred genotyping/phenotyping project will be heavily used in determining the status of non-PI'ed inbred lines. NSL and Ames numbered accessions will be reviewed and PI numbers assigned. Over 1,200 Ames-numbered accessions and 400 available NSL-numbered accessions could be assigned permanent PI numbers in 2014.

NSL and Ames numbered accessions will be reviewed and PI numbers assigned. Over 1,200 Ames-numbered accessions and 400 available NSL-numbered accessions could be assigned permanent PI numbers in 2014.

GRIN-Global development - assisting NPGS migration from GRIN to GRIN-Global will continue to be a major effort for the maize curator. As more users test, additional needs are identified. Enhancement of versions for deployment in the U.S. is anticipated to continue in 2014.

We will continue to acquire germplasm from public collections and sources.

I will continue to augment the collection of images currently on GRIN of 5,000 accessions with images of additional accessions in 2014.

F. Oilseed Crops (L. Marek, L. Crim, I. Larsen)

Project management:
Curator Dr. Laura Marek is assisted by Irvin Larsen, full time USDA Research Technician and by Lloyd Crim, Farm Equipment Operator, who continues to work for the oilseeds project part-time. The project is supported by a team of hourly student workers.

Acquisitions:
The oilseed project received 95 new oil seed accessions in 2013.

Helianthus:
Eighteen cultivated *Helianthus annuus* accessions were received in 2013: one accession with previously expired property rights protection (CSR; Crop Science Registry) was received from NCGRP, Ft Collins; 14 cultivated lines were received directly from the developers at the USDA-ARS Sunflower and Plant Biology Research Unit, Fargo, ND with permission to accession and distribute; three lines were donated by Dr. Wenwei Xu, TX A&M. Three of the cultivated lines were increased in 2013 and at least 10 of the remainder will be increased in 2014. Seventy-two new wild *Helianthus* accessions were received in 2013. Thirty five accessions (17 annual, 18 perennial), wild collected in the southeast, southwest and central US were donated by Chase Mason, graduate student at the University of

Georgia. Twenty-two accessions (12 annual and 10 perennial) were collected during a National Germplasm Resources Laboratory Plant Exchange Office sponsored exploration in CA and southwestern OR by Dr. Marek (leader), and Dr. Gerald Seiler (USDA-ARS, Fargo, ND) including the first accessions of *Helianthus bolanderi* collected from Oregon to be included in a genebank and the first accessions of the newly reported (2013) wild perennial sunflower species *Helianthus winteri*. Two additional *H. winteri* accessions were collected by Dr. Marek and Mr. Larsen during a late September trip to CA. Eleven new wild *H. annuus* accessions collected in Texas were received from Dr. Wenwei Xu, Texas A&M. Thirty six of the new wild *Helianthus* accessions will be being regenerated in 2014.

Miscellaneous Asters:
Six accessions of miscellaneous asters were received in 2013. Three accessions of *Centrapalus pauciflorus* var. *pauciflorus* were requested and received from NCGRP after the developer abandoned his Plant Variety Protection (PVP) application and approved the distribution. Mr. Mason, Univerisity of Georgia graduate student, also donated three accessions of *Phoebanthus tenuifolius,* providing the NPGS its first representation of this genus. *Phoebanthus* has been determined to be the genus most closely related taxonomically to *Helianthus* and represents a valuable outgroup addition to the wild *Helianthus* collection. The three *Centrapalus* accessions were regenerated successfully in 2013; the three *Phoebanthus* accessions will be regenerated during 2014.

Collection Maintenance:
General statistics about availability and management of the collections are presented in Tables 1 and 2 in the appendix. We continue to regenerate fewer accessions than in previous years due to reduced and stagnant operating budgets. Selected details for oil seed accessions increased during 2013 are noted below.

Helianthus, Ames regenerations:
Cultivated *H. annuus* accessions are 95% available. We manage our increases to maintain a high level of availability and to ensure that core collection accessions and other specific accession groups of interest are available. In 2013, 46 cultivated *H. annuus* accessions were regenerated in the field. Twenty-four accessions were grown in screened cages with added pollinators; 22 were grown in four row plots with head bagging and sib pollination All plots were harvested. In addition, we partnered with Dr. Jessica Barb, ISU Agronomy Department, to regenerate the entire UGA-SAM1 association mapping population (288 cultivated lines). With our assistance, Dr. Barb planted the population in replicated 10 ft single row plots to evaluate several traits related to self-fertility. We added a third replicate for lines with low inventory. Dr. Barb used up to four plants per plot for her studies. We used all remaining plants for regeneration by bagging heads and sib pollinating. Processing of the harvest is under way.

Cultivated *H. annuus* accessions requiring long seasons or short days to flower are increased in the NCRPIS greenhouse as space allows. One accessions was successfully increased during the winter of 2012-2013.winter.

Wild annual *Helianthus* accessions are 95% available and wild perennial accessions are 76% available. We attempted seven wild annual *Helianthus* regenerations. The

seed from two accessions did not germinate and the accessions will be inactivated. All five remaining annual accessions were successfully regenerated. Seed was harvested from nine perennial accessions, all previously established in the field.

Helianthus, Parlier alternate grow-out site regenerations:
We continue to partner with NPGS Parlier, CA personnel to regenerate wild taxa requiring longer growing seasons than can be reliably obtained in Ames. The Parlier environment also provides a valuable alternative for growing mountain and desert species that do not grow well in mid-western humidity and heavy soils. The Parlier location uses sunflower cages and pollinator insects (honeybees) purchased by NCRPIS and can grow up to 40 sunflower accessions per year. We germinate seeds in Ames and ship live seedlings to Parlier. The Parlier staff transplants seedlings and manages plant growth. Plots are caged before flowering, pollinator insects are added after pollen production begins, and harvested material is shipped to Ames for threshing and processing. In 2013, we sent seedlings for 32 accessions (48 accessions were attempted; 16 accessions did not germinate and will be inactivated), and three plots established in 2012 were maintained and re-caged. All plots were harvested although one of the re-caged 2012 plots did not return viable seed (few plants survived the 2012-2013 winter). The 2013 harvested material arrived in Ames in December for processing.

The Parlier staff records basic field data (transplant, flowering and harvest dates) but does not have the staff to record standard descriptor data such as ray and disc flower color, plant height, and branching characteristics nor to take images. Phenotypic information is a valuable component associated with each accession and it is important to capture the observation data. In September 2013, Mr. Larsen, oilseeds project technician, and I traveled to Parlier to record descriptor information and to take images.

We have an excellent partnership with the NPGS Parlier staff, ensuring successful regenerations of many wild sunflower taxa. We are most grateful for the dedicated efforts of Mr. Jerry Serimian, Parlier field technician, and Dr. Gabriela Romano, Parlier curator and their supporting staff. Dr. Romano left the USDA during September 2013 and the search for a new curator is underway.

Brassicaceae regenerations:
Brassicaceae accessions are 90% available. In spring 2013, two *Brassica* and two *Camelina* accessions were established in the field. Seed was harvested from all four accessions. Spring 2013 was exceedingly wet in central Iowa and it was mid-June before oilseed fields were prepared limiting the Brassicaceae accessions which could be planted. Six of nine fall 2012 planted winter type *B. napus* and *B. rapa* were harvested in early summer 2013; three accessions did not survive the winter. Twelve winter type B. napus accessions were direct seeded in fall 2013 to overwinter and be harvested in early summer 2014. In addition, two perennial *Crambe* accessions, maintained in the field from 2012, were harvested in 2013. These two accessions will be maintained for one additional season to ensure sufficient seed. One species, *Crambe maritima*, native to southern England and northern France coastal areas, generally does not flower before plants reach four years of age.

The NCRPIS Station Greenhouse 2 (GH-2) is managed to provide conditions that approximate a Mediterranean climate allowing us to regenerate Brassicaceae accessions native to that region and other Brassicaceae taxa that flower very early in the growing season. We have been focused on making all accessions of *Thlaspi arvense* available. *T. arvense*, native to the Mediterranean area and weedy in agricultural fields worldwide, is of interest because its seed oil has very favorable characteristics for biofuel uses. It flowers very early in the season in Iowa and is present in all NCRPIS farm fields as a weed. To get reasonable regenerations and to ensure the genetic integrity of each accession, we have been increasing *T. arvense* in GH-2. All 13 of the *Thlaspi arvense* planted in fall 2012 were harvested in late spring 2013. As discussed in the 2012 annual report, we made a separation of about a dozen plants which bolted and flowered much earlier than the remaining plants of Ames 31018, a *Thlaspi arvense* collection from 2010 west of Pine, CO, southwest of Denver. No other *T. arvense* accessions in our winter FGH-2 regenerations have flowered as quickly. Plants grown from seed harvested from the early and later flowering plants maintained their flowering differential in FGH-2 during 2012-2013 and a new accession number will be assigned to the early flowering selection. Eleven *Thlaspi arvense* accessions, ten from the 2010 Colorado collections and one from Canada (2012 collections) were started in fall 2013 for winter 2013-2014 greenhouse regeneration. One accession of *Brassica dimorpha* was also started in fall 2013 for greenhouse regeneration. *B. dimorpha* is also a Mediterranean native (from the Aures Mts in eastern Algeria) and does not flower or grow well in the field in Iowa.

We are maintaining five additional Brassicaceae accessions in GH-2 including backup plants for the two *Crambe* accessions overwintering in the field. We have harvested seed from four of the greenhouse maintained accessions and expect that only one additional flowering season should be necessary to complete the regenerations.

<u>*Linum*</u>:
Cultivated flax accessions are 99.6% available. One cultivated flax regeneration was attempted in 2013 and the plot was harvested. Processing is underway. Wild flax accessions are 83% available. No wild flax regenerations were attempted in 2013; however, two accessions regenerated in 2012 were stored and made available for distribution.

<u>*Cuphea*</u>:
No *Cuphea* regenerations were attempted in 2013. 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 agronomic development efforts by members of the National *Cuphea* Consortium. Over all, the *Cuphea* collection is 79% available.

<u>Miscellaneous asters</u>:
The miscellaneous asters are 27% available. Three of the six new miscellaneous aster accessions received in 2013 (the *Centrapalus pauciflorus* var. *pauciflorus* accessions*)* were attempted in 2013 and all three plots were harvested. Processing is underway.

Euphorbia:
The *Euphorbia* collection is 41% available. No *Euphorbia* regenerations were attempted in 2012.

Distributions:
General statistics about oil seed collection distributions are presented in Appendix Table 3. During the past year the NCRPIS policy in regard to distribution of seeds for home gardening purposes was clarified for consistent interpretation by curatorial personnel, and to ensure harmonization with NPGS policies, to provide seed for research and educational objectives. The majority of home gardener requests are cancelled without a seed distribution.

Helianthus:
In 2013, 137 orders containing sunflower accessions were distributed. The largest *Helianthus* distribution was 2670 accessions (1750 cultivated and 960 wild *H. annuus* accessions) sent to a company in TX managing a disease resistance evaluation for a European seed company. Six complete and four partial distributions (1784 total accessions) of the UGA-SAM1 association mapping population were sent to seven researchers at five different universities working to map genetic loci associated with a range of traits including self-compatibility, heliotropism and seed color. Orders were sent to support disease evaluations and breeding including drought and salt tolerance and, for an ornamental breeding program, plant height. Orders were sent to support genomic research such as marker development and evaluation of inter-specific crosses among the different annual and perennial sunflower species. Tissue culture continues to be a research topic of interest as does investigation of root development.

Brassicaceae:
In 2013, the largest distribution of Brassicaceae accessions consisted of three orders of *Brassica* species (843 accessions) sent to a researcher at the University of Missouri for diversity analysis. Two large orders (609 and 220 accessions) were sent to researchers at North Dakota State University and Ag Canada for disease evaluations. Additional orders were sent to various locations for disease screening although the largest number of orders were sent to support breeding research with a variety of goals including adaptation to different environments and identification of useful agronomic and chemical traits at locations around the world such as evaluation of secondary metabolites and oil quality. The diversity present in the Brassicaceae collection (262 taxa from 21 genera) supports a wide range of research purposes. One hundred ten orders containing Brassicaceae germplasm were distributed t in 2013.

Linum:
Thirteen orders requesting flax accessions were distributed in 2013, the largest of which (135) was sent to a researcher in France looking for resistance to *Verticillium*. Other requesters were looking at oil and forage qualities, diversity within the *Linum* genus and floral development.

Cuphea:
Twelve orders requesting *Cuphea* accessions were distributed in 2013. About half of the requests were for researchers investigating some aspect of oil metabolism and

half were for an ornamental related use. In addition one request was from a researcher looking at insect use of sticky versus non-sticky *Cuphea* stems.

Euphorbia:
Seven orders requesting *Euphorbia* accessions were distributed in 2013. Seed was requested for reference material, ornamental development, study of sesquiterpene synthesis, screening for secondary metabolites with antimicrobial activity, and to look at kinetics of the photosynthetic enzyme Rubisco.

Miscellaneous asters:
Twelve orders requesting miscellaneous aster accessions were distributed in 2013. One project was examining invasive plants, another was examining sesquiterpene synthesis and others were looking at ornamental uses. One researcher was looking into the potential of *Centrapalus* as an oilseed crop in Canada.

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

Helianthus:
Disease resistance evaluations: *Sclerotinia* is the most important disease in sunflower production fields in northern North America. The pathology group at the USDA-ARS Sunflower and Plant Biology Research Unit, Fargo, began field evaluations in 2008 to screen all untested cultivated sunflower accessions for response to this important disease after I identified all accessions lacking disease evaluation data. An initial test group of 250 was selected and these accessions have remained a focus of field efforts directed by the Fargo pathologist. We continue to partner with the pathology group in Fargo and work to ensure that the accessions identified as "best" are available for distribution to the sunflower research community. In 2011, field evaluations expanded to include screening for Phomopsis resistance and top accessions identified in 2011 and confirmed in 2012 were part of a successful priority regeneration effort in 2013.

Field evaluations are labor intensive and are clearly subject to variable weather conditions. We are also participating in joint effort managed by the Ames NCRPIS pathologist to screen a representative subset of all wild sunflower accessions for *Sclerotinia* resistance in the greenhouse. In previous years' efforts, the Ames pathologist developed a greenhouse screen that successfully predicted field response allowing only the most promising accessions to be followed up with field testing. Generally, wild annual accessions are susceptible and wild perennial accessions are resistant; however, tested *H. argophyllus* (an annual species native to southwestern coastal Texas and of interest in several biomass projects) accessions averaged more than 80% resistant. About 200 wild perennial accessions were evaluated during the 2013 greenhouse screening period (November through May).

Insect/biomass screen:
In cooperation with Dr. Jarrad Prasifka, USDA-ARS entomologist at the Sunflower and Plant Biology Research Unit in Fargo, ND, we maintained replicated plots of a selected PI accession and several commercial and pre-commercial lines for Dr. Prasifka's evaluation. We recorded basic developmental benchmarks, Dr. Prasifka

visited in September and harvested sunflower heads, and we harvested remaining above and below ground biomass for selected plants which was shipped to Fargo for additional analysis.

Professional Activities:
Meetings and Presentations:
January: I attended the 2013 National Sunflower Association Research Forum, Fargo, ND. This meeting represents an important opportunity to interact with the sunflower research and production community. The Sunflower Crop Germplasm Committee held their meeting in association with the Research Forum and I presented a NCRPIS sunflower collection status report.

.

September: I participated in the CGIAR genebank managers' annual meeting, held in Ames, and provided an overview of the Oilseeds Project during the field tour.

October: I attended the annual meeting of the Association for the Advancement of Industrial Crops in Washington, DE. The new Crops CGC meeting was cancelled because the meeting fell during the time period of the federal government shutdown.

Publications:
Ziebell, A., Barb, J., Sandhu, S., Moyers, B., Sykes, R., Doeppke, C., Gracom, K., Carlile, M., Marek, L., Davis, M., Knapp, S., Burke, J. 2013. Sunflower as a biofuels crop: an analysis of lignocellulosic chemical properties. Biomass and Bioenergy:
Mandel, J.R., Nambeesan, S., Bowers, J., Marek, L., Ebert, D., Rieseberg, L., Knapp, S., Burke, J., editors. Association Mapping and the Genomic Consequences of Selection in Sunflower. PLoS Genet. 9(3):e1003378. doi:10.1371/journal.pgen.1003378.

Kane, N., Burke, J., Marek, L., Seiler, G., Vear, F., Knapp, S., Vincourt, P., Rieseberg, L. 2013. Sunflower genetic, genomic, and ecological resources. Molecular Ecology Resources. 13(1):10-20.

Berhow, M.A., Polat, U., Glinski, J.A., Glensk, M., Vaughn, S.F., Isbell, T., Ayala-Diaz, I., Marek, L., Gardner, C. 2013. Optimized analysis and quantification of glucosinolates from *Camelina sativa* seeds by reverse-phase liquid chromatography. Industrial Crops and Products. 43:119-125.

Active Grants:
FY 2013 Western US *Helianthus* collection trip proposal approved and funded $5,000. Role: PI

FY2010-2013 Plant Germplasm Evaluation proposal funded, "Evaluation of *Thlaspi* and *Camelina* Accessions", $15,000 (molecular and agronomic analyses). Role: PI

USDA-ARS Sclerotinia Initiative Research Project, seven separate grants, "Evaluation of Wild *Helianthus* Species for Resistance to Sclerotinia Stalk Rot", total $163,811; 2006-2013. Role: Co-PI.

Service Activities:
Journal peer review:
I served as a peer reviewer for submissions to Horticultural Science and Crop and Pasture Science.

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

Agronomy Department Activities:
After a two year hiatus, the Agronomy P&S group began semi-regular meetings again. I help organize these meetings

Special Mention:
During October 2013, the federal government was shut down for 16 days. As an ISU employee, I was able to continue to work on the Oilseeds Project, along with Lloyd Crim, with equipment borrowed from the Iowa State Agronomy Department. We did not have access to the internet, to our databases, or equipment purchased with federal funds, at the Station during the shutdown. The oilseeds project was fortunate to have two student employees directly funded by Dr. John Burke at the University of Georgia (collaboration with the UGA-SAM1 Association Mapping population regeneration). In addition, Dr. Jessica Barb, ISU Agronomy Department, and her student crew managed their field work and helped ensure our harvesting stayed current.

G. 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."

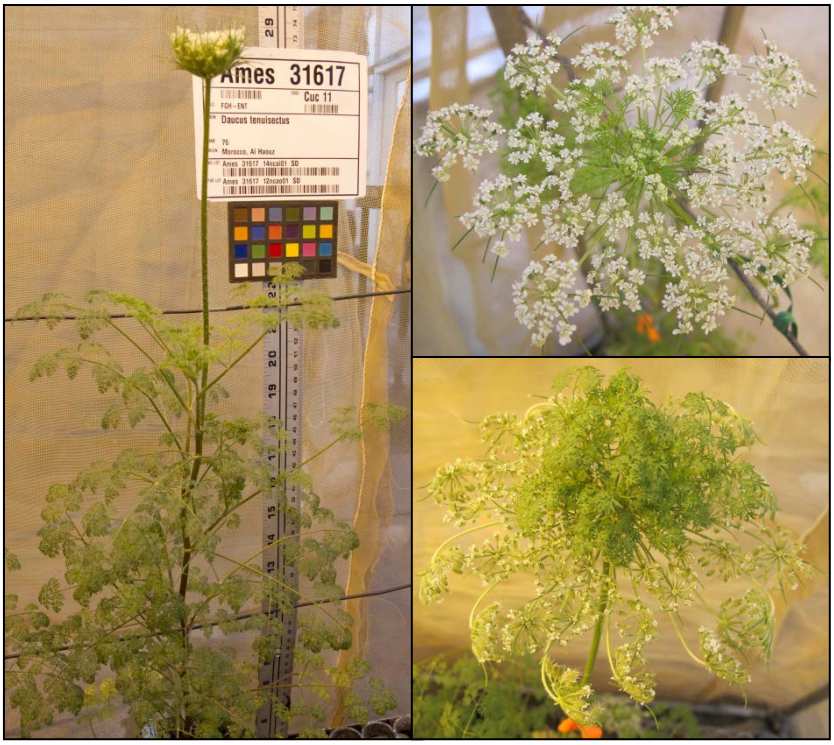
Acquisition:
Twelve wild *Daucus* accessions were collected by David Spooner (USDA-ARS, Madison, WI) during the NPGS sponsored Morocco collection trip. This included three *D. carota* subsp. *gummifer*, three *D. carota* subsp. *maximus*, two *D. carota* subsp. *sativus*, one *D. crinitus*, two *D. muricatus*, and one *D. mauritii* – a species not previously available from the NCRPIS collection. Another *Daucus carota*, YK714900, was received from NCGRP as an abandoned PVP. One *Cucumis melo* accession, 'Aliabadi', was received as an expired PVP, and a new PI number (PI 667182) was assigned to a controlled pollinated *C. melo* regeneration seed lot grown from original seed of PI 420177. The longstanding, open-pollinated distribution seed lot of PI 420177 has been reported to have potential resistance to *Didymella bryoniae* (gummy stem blight) and will continue to be maintained as the original accession number. The regeneration lot assigned PI 667182 has not been evaluated for this resistance.

Maintenance:
Data for vegetable crop regenerations attempted and number of accessions harvested in 2013 are summarized in the appendices in "Table 2: NCRPIS Accessions (Accs) Germinated, Regenerated, Made Available, Backed Up."

Cucumis increases included both greenhouse and field regenerations of 81 *C. melo*, 23 *C. sativus*, and 13 wild *Cucumis* species. Due to a significant number of transplants lost to an unusual event of Fusarium crown rot in 2012, transplanting protocols were modified for 2013 in an attempt to avoid or limit potential losses from the disease. Modifications included planting seeds in larger peat pots allowing for more greenhouse soil around roots and stems after transplanting to limit their exposure to field soil possibly containing the pathogen, a three-day hardening-off period to strengthen the stems before transplanting, pre- and post- transplanting application of liquid fertilizers and biological fungicides to promote rapid plant development, and delay in applying paper mulch around the stems to allow for air circulation preventing possible pathogen development. We are unable to say whether these modifications were effective because Fusarium crown rot was not an issue in 2013. Harvests were made on 22 *C. sativus*, 80 *C. melo*, and 10 wild *Cucumis* field and greenhouse regenerations. Accessions where low seed quantities were harvested or those that failed to germinate may be regenerated again in 2014.

Cucurbita pepo field regenerations focused on accessions with low seed quantities or distribution lots 20+ years old. Four of five accessions in field cages were successfully regenerated while one accession produced only a few fruit.

Daucus regeneration efforts focused primarily on wild, annual species collected in Tunisia and Morocco including *D. durieua*, *D. tenuisectus*, *D. sahariensis*, and *D. syrticus*. Harvests were made on 17 of 23 accessions, and seed processing is currently in progress. *Daucus tenuisectus*, a new species in the NPGS collection collected for taxonomic studies, is now available for distribution. In addition to the Ames, IA *Daucus* regenerations, we received seed increases on six accessions from Rosa Yzquierdo, Seminis Vegetable Seeds, Idaho and five accessions from Rob Maxwell, Bejo Seeds, Idaho. A *Daucus carota* accession, originally separated as a contaminant from a 2009 *Cuminum cyminum* accession collected from Tunisia, was regenerated in Parlier, CA and assigned a new Ames number. Six cultivated biennial accessions each were sent to Seminis Vegetable Seeds (Idaho) and Bejo Seed (Oregon) for regeneration in the 2013-2014 growing season, and 20 wild *Daucus* accessions were sent to Nunhems (Netherlands) for regeneration in the 2014 and 2015 growing seasons.

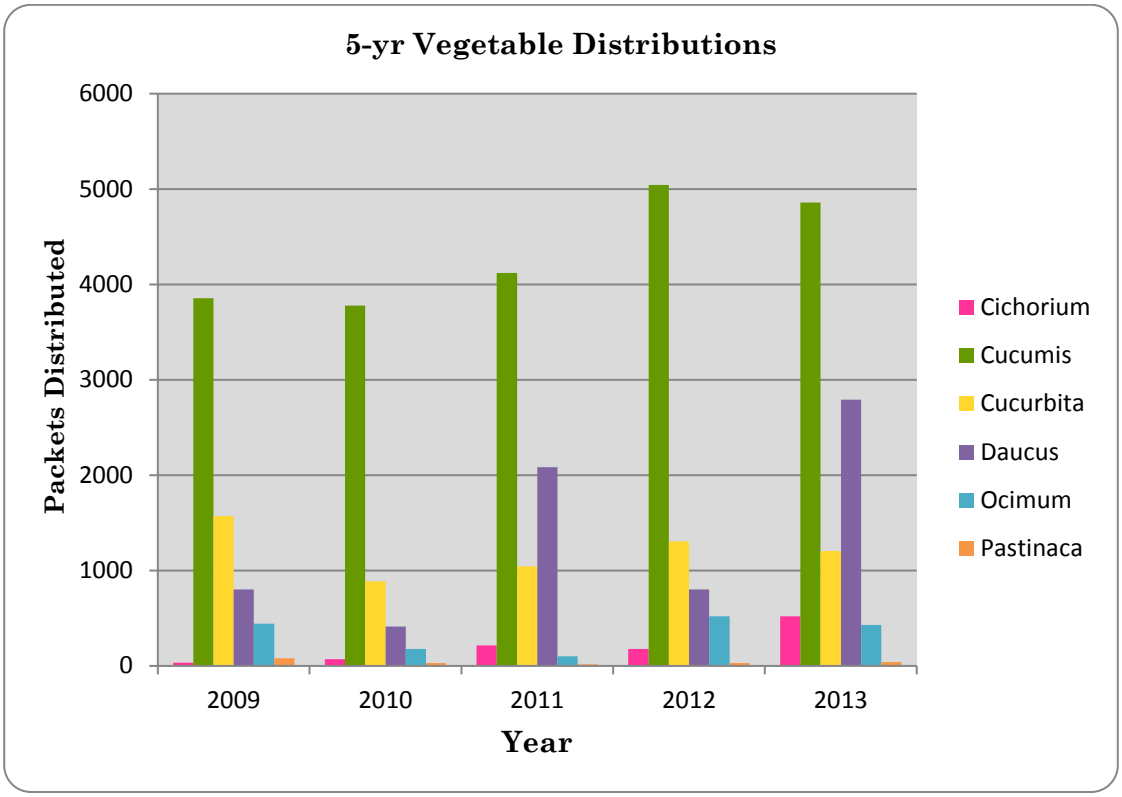


Daucus tenuisectus Coss. Ex Batt

As NCRPIS accessions are regenerated, backup seed samples are sent to NCGRP in Ft. Collins. Overall, 83% of the accessions in the vegetable collections are backed up. Six of eight vegetable site-crops have 80% or more of their accessions backed up at NCGRP (Table 2).

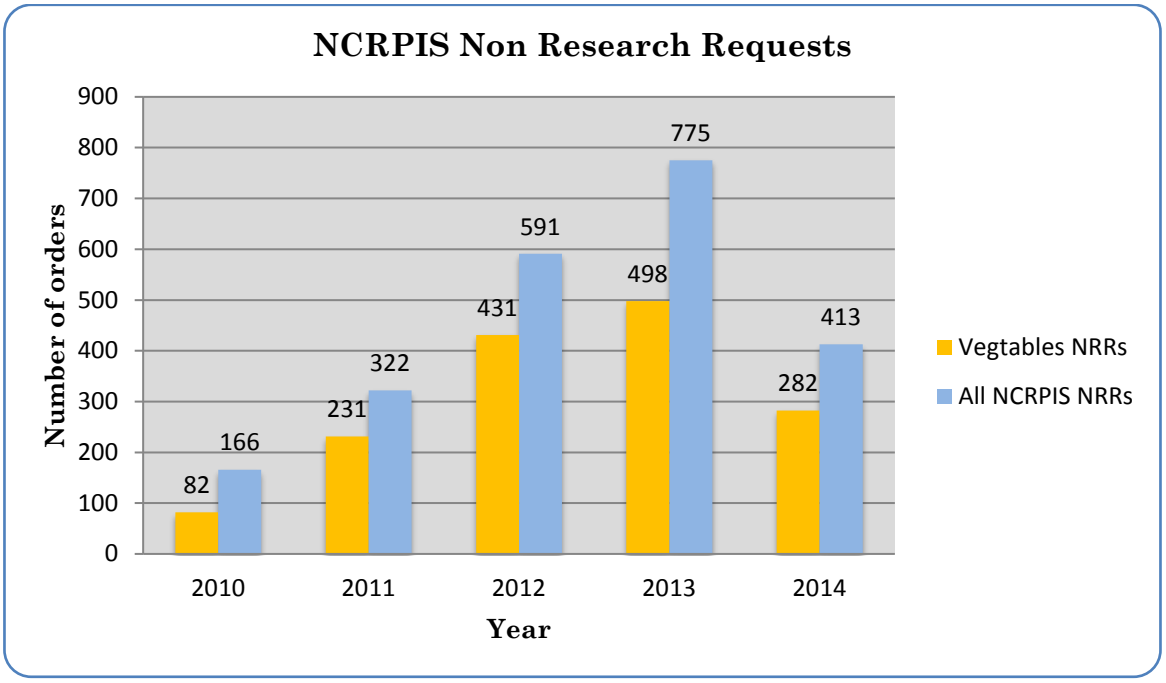
In 2013, 148 vegetable accessions were tested for viability (Table 2), focusing primarily on regeneration lots.

Distribution:
Packet and accession distributions for the vegetable collections are summarized in the appendices in "Table 3A-1: External NCRPIS Distributions – This includes both DI (research and education) and NR (home gardener) order types." In 2013, 9,846 seed packets (items) involving 4867 accessions were distributed to fulfill 323 orders (252 domestic, 71 foreign) equaling 286 recipients. This represents 24% of the 40,409 total packets distributed by the NCRPIS in 2013. A five-year distribution history of the vegetable crops is shown in the following chart.



The percent vegetable packet distributions by genus/maintenance crop shows *Pastinaca* at less than 1%, *Cichorium* 5%, *Ocimum* 4%, *Daucus* 28%, *Cucurbita* 12%, and *Cucumis* at 50% (melons 19%, cucumbers 29%, wild species 2%). Vegetable research requests received in 2013 included topics such as disease evaluations, breeding for specific traits and disease resistances, evaluation of various cucurbits for use as root stocks, genetic and molecular studies, and diversity assessment for biotic and abiotic stress tolerance.

Non Research Requests (NRR), i.e., home gardener requests, continue to make up a significant portion of the Vegetable Project requests as shown in the "NCRPIS Non Research Requests" chart below. In 2013, 689 orders were received for accessions maintained by the Vegetable Project with 498 of the orders classified as NRR (compared to 431 NRRs received in 2012). Due to the high volume of NRRs received by the NCRPIS as a whole in the first few months of 2013 and the impact such orders were having on station resources, a new policy was implemented in May 2013 to **not** distribute germplasm resources for home gardening use or for other purposes where readily available commercial varieties would meet the requestor's needs. The new policy replaces the previous one-time-distribution policy for NRRs. It is too early to know what impact the new policy will have on the number of NRRs received at this station. The number of NRRs received at the NCRPIS from January through April 2014 indicates a continued high volume of such requests even though more of these orders are being cancelled.



NOTE: NRR order data for 2014 for January through April, only.

Characterization and Taxonomy:

Digital images, and 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*. Plant habit, flowering dates, and life-cycle notes were recorded for *Daucus*. Images taken of vegetable accessions in 2012 will be loaded to GRIN. Images are taken to document plant, leaf, flower, fruit, or root characteristics.

The 2013 *Daucus* observation field was the final planting in collaboration with David Spooner (USDA-ARS, Madison, WI) for his work on a monograph of the genus *Daucus*. Eighty-seven *Daucus* accessions (43 biennial, 4 perennial, 40 annual) and nine allied Apiaceae species were transplanted into field plots to verify taxonomy, collect characterization data and herbarium specimens, and to capture digital

images of plants, flowers, and foliage. Biennial accessions were started in the greenhouse in November 2012 and vernalized. Annual plants were started in the greenhouse in March 2013. All plants were transplanted into two replicated plots on April 30, 2013. Because the 2012 Daucus observation planting was abandoned due to heavy infestation of aster yellows phytoplasma, all accessions in one rep of the 2013 field were caged and screened to protect the plants from leafhopper vectors. Characterization data were acquired from nearly all accessions in the field. Herbarium specimens were collected only from accessions for which specimens had not been obtained during previous years' observation plantings. These specimens are being held by Dr. Spooner in Madison, WI. Dr. Spooner and his graduate student, Carlos Arbizu, visited Ames July 1-5, July 9-11, and August 8-9 to assist with collecting data.

Collecting descriptors and images on roots of accessions planted in the *Daucus* observation fields presented numerous challenges. We often found roots were distorted or stunted due to soil conditions. In order to capture root data and images, two wooden 8' x 3' x 24" boxes were constructed in the greenhouse and filled with sand. Seeds of 20 accessions were sown in two rows each, seedlings were thinned to 20 per accession, and fertilized weekly with a commercial liquid fertilizer (NPK 20-10-20). Roots were allowed to grow until bolting initiated or up to 15 days before harvesting for characterization and imaging. Resulting roots were easily harvested from the sand beds without being distorted or stunted. The "sandbox" method works especially well for the very long, thin tap-root and fibrous-root types. We should be able to grow at least 60 accessions for root characterization each year. We will work through our backlog of Daucus accessions for which root data and images are lacking, focusing on accessions planted as part of Dr. Spooner's taxonomic research.

Taxonomic identities are reviewed and confirmed as each accession is regenerated or grown in observation plots. The 2013 re-identifications included seven *Cucumis spp.* re-identified to two *C. anguria* var. *longaculeatus*, two *C. metuliferus*, one C. *myriocarpus* subsp. *myriocarpus*, and two *C. zambianus*. Two *Daucus durieua* were reclassified as *Torilis nodosa* and two *D. crinitus* to *D. muricatus*. One *Pseudorlaya pumila* was reclassified to *D. crinitus*; and ten *Cucurbita pepo* var. *texana* to *C. pepo* var. *ozarkana*.

Evaluation/Utilization:
Dr. Charles Block (NCRPIS pathologist) continues to screen all *Cucurbita* and *Cucumis* seedlings grown for regeneration for the presence of squash mosaic virus, using ELISA protocols before seedlings are transplanted to the field. Seedling screening has been conducted since 1993. He also visually inspects all cucurbit field plantings for disease during the growing season. Seed-borne diseases are of specific interest, with bacterial fruit blotch (*Acidovorax citrulli*) in *Cucumis melo* being of particular concern. 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.

Publications/Posters:
Spooner, D., Simon, P., Widrlechner, M., Reitsma, K.R., Palmquist, D. 2014. Reassessment of Practical Species Identifications of the USDA *Daucus carota* Germplasm Collection: Morphological Data. Crop Science. 54(2):706-718.

To be submitted to the American Journal of Botany in 2014: Arbizu, C. Reitsma, K., Simon, P., Spooner, D. Morphometric Study of *Daucus*: A Counterpart to a Phylogenomic Study.

Reitsma, K.R. and Clark, L.C. 2013. *Daucus* Germplasm Collection at the North Central Regional Plant Introduction Station. In: Proceedings of the 36th International Carrot Conference, August 14-16, 2013, Madison, WI.

Reitsma, K.R. 2013. North Central Regional Plant Introduction Station, USDA-ARS, National Plant Germplasm *Daucus* Collection. Presentation for Crop Wild Relatives - Daucus meeting, August 17, 2013, University of Wisconsin, Madison, WI.

Plans for 2014:
Regenerations:
In October 2013, 32 biennial *Daucus* accessions were planted in the greenhouse for regeneration in field cages during the 2014 summer. Three accessions failed to germinate. Eleven accessions bolted prior to vernalization in February 2014 and are being regenerated as annuals in greenhouse isolation cages. The remaining 18 biennial accessions will be transplanted into field cages after vernalization for pollination by flies, alfalfa leaf cutter bees and honey bees. Another 28 annual *Daucus* accessions have been planted in the greenhouse for transplanting into field cages in May 2014. Approximately 100 accessions of *Cucumis* and 5 to 10 accessions of *Cucurbita* will be regenerated in field cages in the summer. Regenerations of wild *Cucumis* species and hard-to-handle *Cucumis* will continue in the greenhouse as time, space, and other resources permit.

Germinations:
Viability tests will be performed on the 2013 cucurbit regeneration seed lots in April 2014 and on the 2013 *Daucus* regeneration seed lots in the summer of 2014. Maintenance germination testing of *Cucumis* and *Cucurbita* distribution lots will be done in 2014.

Characterization:
As mentioned previously, the 2013 *Daucus* observation planting was the third and final such planting in Ames, IA in collaboration with Dr. David Spooner (USDA-ARS, Madison, WI) to evaluate and characterize the diversity in the genus *Daucus*. All observation data except the seed descriptor data have been loaded to GRIN resulting in 3231 records. These data, as well as the images and herbarium specimens, will be useful in Dr. Spooner's work to develop a monograph for the genus *Daucus*. Dr. Spooner and Dr. Philipp Simon (USDA-ARS, Madison, WI) will plant an observation planting in Madison, WI to collect phenotypic and genotypic data to further evaluate taxonomic ambiguities between *D. broteri*, *D. guttatus* and *D. bicolor* in an effort to determine their position in Daucus taxonomy.

Image loading to GRIN "Classic" was suspended in 2013 in preparation for the launch of the new GRIN-Global database. Images from the Daucus observation planting and vegetable accessions regenerated in 2013 will be loaded into GRIN Global when it becomes active.

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*, and 99 *Daucus*). Labeling embedded in digital images of these accessions will be updated with the new PI numbers before they are loaded to GRIN.

Evaluation:
Collaboration continues on improving the year-round cage and insect-pollinator program for regenerating vegetable crops.

The Plant Pathology Project will continue to collaborate in monitoring the effectiveness of the cage program in reducing the incidence 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 citrulli*.

The proposal "Phenotypic and molecular marker evaluation of carrot and wild *Daucus carota* germplasm recently added to the NPGS" has been submitted by Drs. Philipp Simon and David Spooner (USDA-ARS, Madison, WI) through the Root and Bulb Vegetable Crop Germplasm Committee (RBV-CGC) for funding in 2014. Phenotypic evaluation for key carrot descriptors (storage root shape and color, annual - biennial flowering behavior, other RBV-CGC approved descriptors), and Alternaria leaf blight susceptibility will be collected on the 167 wild and domesticated carrot germplasm accessions collected for the NPGS from 2007 to 2013. Genotyping-by-sequencing (GSB) will be used to characterize the genetic diversity of the germplasm. These data will be integrated with other genomic data to study carrot genetics, domestication, speciation, and evolution. All data collected will be provided to the curator of the Daucus collection for inclusion in GRIN.

H. Research Leader Activities (C. Gardner)

Administration and Leadership Activities:
C. Gardner administers 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 contributes to the coordination and execution of activities which support those objectives. Gardner serves as the Coordinator of the Hatch-funded Multistate NC7 Project. Budgetary anomalies due to shifting Congressional and Agency priorities continue to command more time and resources. Because of delays in release of funds to the management unit, each year we deal with uncertainty and making timely decisions for work plans many taxa that require germination and vernalization treatments in the winter are challenging. The GEM Project CRIS continues to be leveraged to support maize curatorial activities as well, and this cannot continue indefinitely.

About 5% of her time in 2013 was devoted to assisting GRIN-Global System development team members. International implementation of the GRIN-Global system is in progress, and focus is now directed to 'gap analysis' efforts with the DBMU and key GRIN users at the NPGS sites to ensure a smooth migrated to / implementation of the GRIN-Global System in the U.S. in 2013.

Pete Cyr, our Software Applications and Network Systems Information Specialist, serves as the development lead for the Curator Tool and Business Tier. Other Ames personnel include 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, and Candice Gardner. NCRPIS development efforts will be primarily devoted to this critically important project for another year. Together with personnel from the ARS GRIN Database Management Unit (DBMU) personnel, National Program Leader (and Project PI) Peter Bretting, other NPGS site personnel with GRIN expertise, and our Global Crop Diversity Trust and international partners, we look forward to maturation and NPGS deployment of the system.

Research Activities:
Graduate student Ivan Ayala-Diaz, a Fulbright Fellow from Colombia, completed his Ph.D. research on *Thlaspi* and *Camelina* in 2013 under the guidance of Dr. Mark Westgate, ISU, and Dr. Gardner, and in collaboration with NCRPIS Oilseeds Curator, Dr. Laura Marek. This includes a Camelina mapping population developed in collaboration with Sustainable Oils, Montana (now Targeted Growth, Inc.).

Adam Vanous pursues a Ph.D. program that deals with phenomena associated with generating haploid and doubled haploid (DH) lines from exotic maize.

Andrew Smelser, GEM Project technician, completed his M.S. project evaluating the efficacy of the various races for haploid induction and subsequent doubling.

As an outcome of Vanous' MS project dealing with methods to double chromosome numbers of haploid lines, thousands of doubled haploid lines were generated from B73 and from Oh43. In 2012 and 2013 we grew these lines for observation, curious about whether DH lines derived from an inbred line would vary. A significant number of lines showed phenotypic variation for morphology, plant and ear height, flowering date, and kernel traits. A new series of questions has been generated about inherent variability in conventionally derived inbred lines, whether the haploid or induction processes are responsible for genetic or epigenetic changes, etc.

<u>2014 Plans:</u>
The GEM Technical Steering Group provided the resources to random mate (sib mate) backcrosses of tropical accessions to ex-PVP maize inbreds. The backcrosses populations, backcrosses sibmated once, and backcrosses sibmated twice will be grown for haploid induction in Ames in 2014. We seek to determine whether random mating backcrosses prior to haploid induction favors maximum recovery of the exotic donor genome as compared to inducing the backcross generation.

<u>Presentations and Publications:</u>
In 2013, outreach efforts by C. Gardner included an oral presentation at the 2013 Illinois Corn Breeders' School on capturing useful alleles from diverse maize.

Romay, M.C., Millard, M.J., Glaubitz, J.C., Peiffer, J.A., Swarts, K.L., Casstevens, T.M., Elshire, R.J., Acharya, C.B., Mitchell, S.E., Flint Garcia, S.A., McMullen, M.D., Holland, J.B., Buckler IV, E.S., Gardner, C.A. 2013. Comprehensive genotyping of the US national maize inbred seed bank. Genome Biology. 14(6):1-18.

Berhow, M.A., Polat, U., Glinski, J.A., Glensk, M., Vaughn, S.F., Isbell, T., Ayala-Diaz, I., Marek, L., Gardner, C.A. 2013. Optimized analysis and quantification of glucosinolates from Camelina sativa seeds by reverse-phase liquid chromatography. Industrial Crops and Products. 43:119-125.

Year 2013 Table 1.		NCRPIS Accessions (Accs), Acquired, Available					
01/01/2013 to 12/31/2013							
CURATOR	**GENUS_CROP**	**# Accs**	**# Accs Acquired**	**% Acquired**	# Avail	% Avail	**% Avail Last Year**
Barney	NC7-medicinals	499	0	0%	365	73%	73%
	NC7-mints	174	0	0%	127	73%	73%
	NC7-ornamentals	835	1	0%	530	63%	64%
	Total:	**1508**	**1**	**0%**	1022	68%	**68%**
Brenner	NC7-amaranth	3345	1	0%	3235	97%	96%
	NC7-celosia	56	0	0%	35	63%	63%
	NC7-echinochloa	305	0	0%	269	88%	88%
	NC7-grasses	130	0	0%	84	65%	63%
	NC7-legumes	247	0	0%	115	47%	46%
	NC7-melilotus	1004	3	0%	837	83%	76%
	NC7-panicum	935	0	0%	907	97%	97%
	NC7-perilla	25	0	0%	23	92%	88%
	NC7-portulaca	9	1	11%	6	67%	75%
	NC7-quinoa	361	4	1%	285	79%	73%
	NC7-setaria	1014	0	0%	938	93%	93%
	NC7-spinach	410	0	0%	400	98%	97%
	NC7-umbels	1172	19	2%	711	61%	62%
	Total:	**9013**	**28**	**0%**	7845	87%	**86%**
Carstens	NC7-woody.landscape	1765	62	4%	865	49%	45%
	Total:	**1765**	**62**	**4%**	865	49%	**45%**
Marek	NC7-asters	387	3	1%	105	27%	23%
	NC7-brassica	2012	0	0%	1863	93%	92%
	NC7-brassica.pvp	6	0	0%	0	0%	0%
	NC7-crucifers	1219	0	0%	1040	85%	84%
	NC7-crucifers.pvp	1	0	0%	0	0%	0%
	NC7-cuphea	639	0	0%	512	80%	80%
	NC7-euphorbia	209	0	0%	88	42%	42%
	NC7-flax	2834	0	0%	2823	100%	100%
	NC7-flax.wilds	134	0	0%	109	81%	70%
	NC7-sun.cults	2149	7	0%	1772	82%	93%
	NC7-sun.wilds.ann	1436	27	2%	1360	95%	94%
	NC7-sun.wilds.per	857	10	1%	665	78%	74%
	NC7-sun.wilds.sp	2	0	0%	0	0%	0%
	Total:	**11885**	**47**	**0%**	10337	87%	**88%**
Millard	NC7-corn.kin	100	0	0%	6	6%	6%
	NC7-maize.gems	212	22	10%	181	85%	92%
	NC7-maize.inb	2530	4	0%	1962	78%	78%
	NC7-maize.pop	17101	12	0%	11195	65%	66%
	NC7-maize.pvp	342	1	0%	336	98%	88%
	NC7-maize.wilds	439	0	0%	83	19%	20%
	NC7-zea.totals	20624	39	0%	13757	67%	67%
	Total:	**20724**	**39**	**0%**	13763	66%	**67%**
Reitsma	NC7-chicory	279	0	0%	212	76%	77%
	NC7-cucumis.cucs	1379	0	0%	1308	95%	95%
	NC7-cucumis.melo	3204	2	0%	2287	71%	72%
	NC7-cucumis.wilds	321	0	0%	177	55%	54%
	NC7-cucurbita	975	0	0%	762	78%	79%
	NC7-daucus	1381	13	1%	1056	76%	77%
	NC7-ocimum	98	0	0%	91	93%	93%
	NC7-parsnips	73	0	0%	51	70%	72%
	Total:	**7710**	**15**	**0%**	5944	77%	**77%**
NCRPIS Total:		**52605**	**192**	**0%**	39776	76%	**74%**

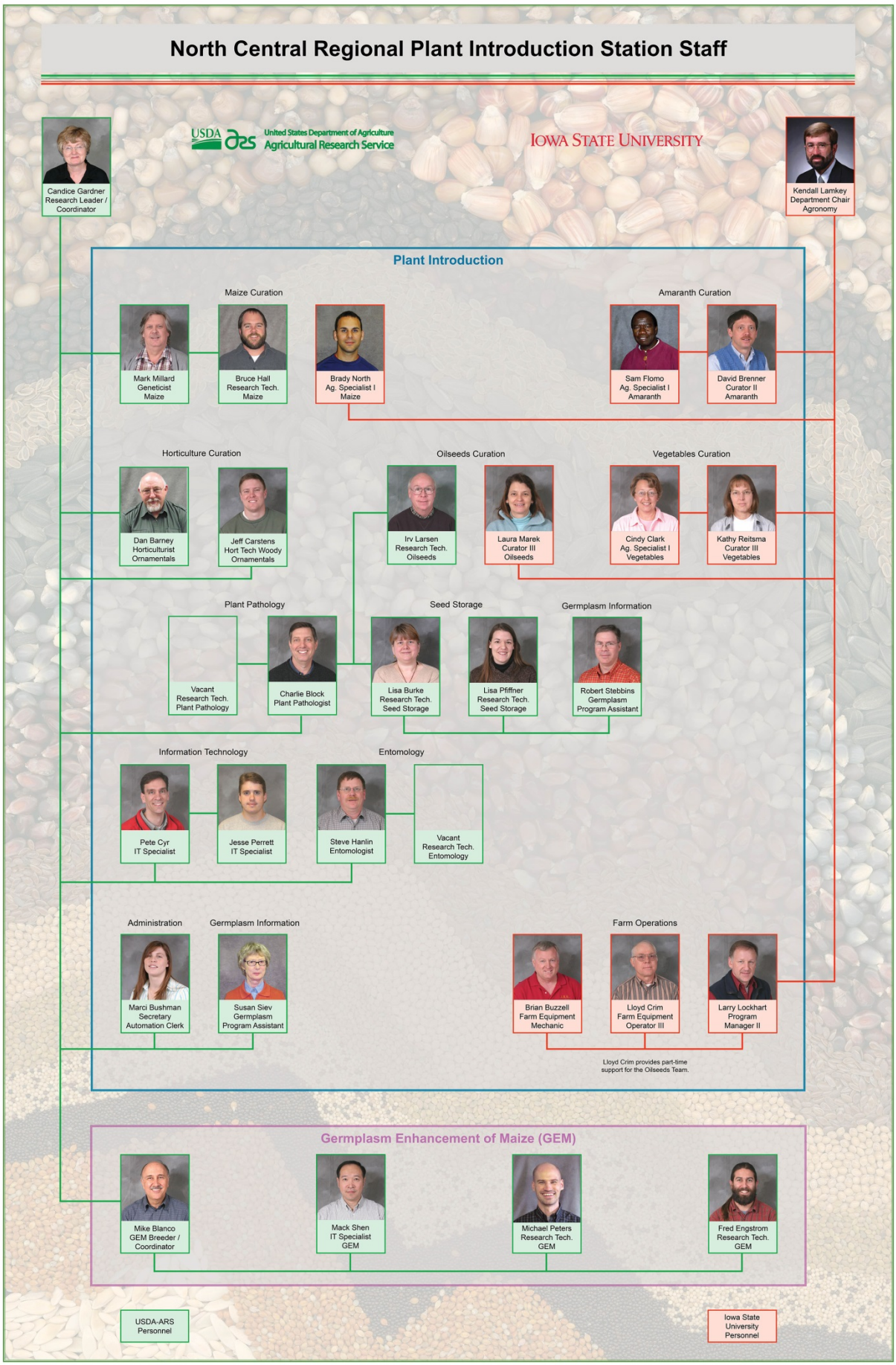
Year 2013 Table 2.		NCRPIS Accessions (Accs) Germinated, Regenerated, Made Available, Backed Up											
01/01/2013 to 12/31/2013													
CURATOR	GENUS_CROP	# Accs	# Accs Germed	% Accs Germed	# Attempted Regen	# Harvested Regen	# Perm Perennial	# Perennial Harvested (Vegetative)	# Accs Made Avail	# Accs Growing	# Accs Backed Up for YR	Total # Accs Backed Up	% Accs Backed Up
Barney	NC7-medicinals	499	0	0%	76	7	0	0	0	0	2	384	77%
	NC7-mints	174	0	0%	0	0	0	0	1	0	1	143	82%
	NC7-ornamentals	835	0	0%	38	13	8	0	30	0	2	535	64%
	Total:	**1508**	**0**	**0%**	**114**	**20**	**8**	**0**	**31**	**0**	**5**	**1062**	**70%**
Brenner	NC7-amaranth	3345	86	3%	51	46	0	0	85	0	82	3250	97%
	NC7-celosia	56	0	0%	0	0	0	0	0	0	0	35	63%
	NC7-echinochloa	305	0	0%	0	1	0	0	0	0	0	266	87%
	NC7-grasses	130	0	0%	4	0	0	0	2	0	0	88	68%
	NC7-legumes	247	0	0%	0	0	0	0	1	0	0	176	71%
	NC7-melilotus	1004	76	8%	30	32	0	0	73	0	69	899	90%
	NC7-panicum	935	0	0%	1	1	0	0	1	0	160	911	97%
	NC7-perilla	25	4	16%	2	3	0	0	4	0	0	23	92%
	NC7-portulaca	9	0	0%	3	4	0	0	0	0	0	6	67%
	NC7-quinoa	361	34	9%	25	21	0	0	5	0	5	301	83%
	NC7-setaria	1014	0	0%	15	15	0	0	0	0	15	968	95%
	NC7-spinach	410	32	8%	34	4	0	0	31	0	12	396	97%
	NC7-umbels	1172	19	2%	40	43	0	0	6	0	4	724	62%
	Total:	**9013**	**251**	**3%**	**205**	**170**	**0**	**0**	**208**	**0**	**347**	**8043**	**89%**
Carstens	NC7-woody.landscape	1765	17	1%	36	107	25	2	104	0	44	706	40%
	Total:	**1765**	**17**	**1%**	**36**	**107**	**25**	**2**	**104**	**0**	**44**	**706**	**40%**
Marek	NC7-asters	387	0	0%	6	3	0	0	19	0	0	122	32%
	NC7-brassica	2012	7	0%	14	2	1	0	6	1	0	1982	99%
	NC7-brassica.pvp	6	0	0%	0	0	0	0	0	0	0	6	100%
	NC7-crucifers	1219	22	2%	13	14	11	0	23	7	9	1056	87%
	NC7-crucifers.pvp	1	0	0%	0	0	0	0	0	0	0	1	100%
	NC7-cuphea	639	0	0%	0	0	0	14	0	0	0	583	91%
	NC7-euphorbia	209	0	0%	0	0	0	4	1	1	0	85	41%
	NC7-flax	2834	0	0%	1	0	0	0	0	0	0	2832	100%
	NC7-flax.wilds	134	2	1%	0	0	0	0	16	0	2	111	83%
	NC7-sun.cults	2149	283	13%	339	334	2	0	77	0	43	1794	83%
	NC7-sun.wilds.ann	1436	36	3%	19	8	2	0	43	1	34	1379	96%
	NC7-sun.wilds.per	857	47	5%	48	27	5	0	43	18	35	654	76%
	NC7-sun.wilds.sp	2	0	0%	0	0	0	0	0	0	0	0	0%
	Total:	**11885**	**397**	**3%**	**440**	**388**	**21**	**18**	**228**	**28**	**123**	**10605**	**89%**
Millard	NC7-corn.kin	100	3	3%	4	4	2	2	0	0	0	10	10%
	NC7-maize.gems	212	14	7%	8	36	0	0	15	0	0	71	33%
	NC7-maize.inb	2530	55	2%	99	71	0	0	50	0	0	1550	61%
	NC7-maize.pop	17101	206	1%	44	46	0	0	4	0	0	13127	77%
	NC7-maize.pvp	342	28	8%	61	61	0	0	54	0	0	342	100%
	NC7-maize.wilds	439	3	1%	1	2	1	2	2	2	0	44	10%
	NC7-zea.totals	20624	306	1%	213	216	1	2	125	2	0	15134	73%
	Total:	**20724**	**309**	**1%**	**217**	**220**	**3**	**4**	**125**	**2**	**0**	**15144**	**73%**
Reitsma	NC7-chicory	279	0	0%	0	0	0	0	0	0	23	244	87%
	NC7-cucumis.cucs	1379	11	1%	22	20	0	0	14	0	129	1309	95%
	NC7-cucumis.melo	3204	38	1%	90	79	0	0	37	0	28	2582	81%
	NC7-cucumis.wilds	321	4	1%	2	10	0	0	4	0	27	177	55%
	NC7-cucurbita	975	11	1%	5	5	0	0	12	0	7	818	84%
	NC7-daucus	1381	82	6%	53	29	0	0	17	0	48	1153	83%
	NC7-ocimum	98	0	0%	0	0	0	0	0	0	0	91	93%
	NC7-parsnips	73	2	3%	0	0	0	0	0	0	0	50	68%
	Total:	**7710**	**148**	**2%**	**172**	**143**	**0**	**0**	**84**	**0**	**262**	**6424**	**83%**
NCRPIS Total:		**52605**	**1122**	**2%**	**1184**	**1048**	**57**	**24**	**780**	**30**	**781**	**41984**	**80%**

Year 2013 Table 3A			External NCRPIS Distributions - Includes both DI (research and education) and NR (home gardner) order types											
01/01/2013 to 12/31/2013			External Domestic Distributions				Foreign Distributions				External Domestic and Foreign Distributions			
CURATOR	GENUS_CROP	# Accs in Collection	# Accs	# Orders	# Recipients	# Items	# Accs	# Orders	# Recipients	# Items	# Accs	# Orders	# Recipients	# Items
Barney	NC7-medicinals	499	58	29	28	91	57	2	2	59	94	31	30	150
	NC7-mints	174	85	26	26	135	14	4	4	15	87	30	30	150
	NC7-ornamentals	835	114	39	35	141	49	6	6	49	154	45	41	190
	Total:	**1508**	**257**	**75**	**67**	**367**	**120**	**11**	**11**	**123**	**335**	**86**	**78**	**490**
Brenner	NC7-amaranth	3345	574	59	56	722	1350	12	12	1658	1586	71	68	2380
	NC7-celosia	56	7	6	6	9	6	4	4	7	9	10	10	16
	NC7-echinochloa	305	67	9	7	85	11	2	2	11	75	11	9	96
	NC7-grasses	130	10	7	6	11	1	1	1	1	11	8	7	12
	NC7-legumes	247	11	4	4	14	79	2	2	79	86	6	6	93
	NC7-melilotus	1004	19	12	12	27	112	6	5	119	126	18	17	146
	NC7-panicum	935	46	16	13	58	12	3	3	12	56	19	16	70
	NC7-perilla	25	5	4	4	7	1	1	1	1	6	5	5	8
	NC7-portulaca	9	6	8	8	18	1	1	1	1	6	9	9	19
	NC7-quinoa	361	200	65	61	735	176	29	28	850	221	94	89	1585
	NC7-setaria	1014	88	17	16	120	118	5	5	124	180	22	21	244
	NC7-spinach	410	401	16	13	571	21	0	0	21	401	16	13	592
	NC7-umbels	1172	234	50	49	304	162	5	5	205	336	55	54	509
	Total:	**9013**	**1668**	**209**	**188**	**2681**	**2050**	**62**	**59**	**3089**	**3099**	**271**	**247**	**5770**
Carstens	NC7-woody landscape	1765	130	59	47	167	78	17	16	98	186	76	63	265
	Total:	**1765**	**130**	**59**	**47**	**167**	**78**	**17**	**16**	**98**	**186**	**76**	**63**	**265**
Marek	NC7-asters	387	34	13	12	41	4	2	2	4	38	15	14	45
	NC7-brassica.pvp	6	0	0	0	0	0	0	0	0	0	0	0	0
	NC7-brassica	2012	1506	53	51	2214	233	24	22	372	1537	77	73	2586
	NC7-crucifers	1219	354	49	44	681	335	18	17	536	577	67	61	1217
	NC7-crucifers.pvp	1	0	0	0	0	0	0	0	0	0	0	0	0
	NC7-cuphea	639	108	16	14	134	26	2	2	26	119	18	16	160
	NC7-euphorbia	209	8	4	4	8	20	2	2	20	22	6	6	28
	NC7-flax	2834	29	13	12	35	15	3	3	15	40	16	15	50
	NC7-flax.wilds	134	60	6	6	73	19	2	2	20	62	8	8	93
	NC7-sun.cults	2149	2056	87	68	3365	723	30	28	1307	2064	117	96	4672
	NC7-sun.wilds.ann	1453	1111	50	41	1357	198	13	11	232	1163	63	52	1589
	NC7-sun.wilds.per	857	178	35	32	246	101	7	6	107	243	42	38	353
	NC7-sun.wilds.sp	2	0	0	0	0	0	0	0	0	0	0	0	0
	Total:	**11902**	**5444**	**255**	**213**	**8154**	**1674**	**85**	**75**	**2639**	**5865**	**340**	**288**	**10793**
Millard	NC7-corn.kin	100	6	7	7	12	5	3	3	6	6	10	10	18
	NC7-maize.gems	212	138	14	13	186	177	11	10	253	186	25	23	439
	NC7-maize.inb	2530	1085	251	213	2496	497	49	47	808	1221	300	260	3304
	NC7-maize.pop	17101	1291	308	280	1983	479	29	29	523	1593	337	309	2506
	NC7-maize.pvp	342	340	225	141	4638	338	41	36	2102	340	266	177	6740
	NC7-maize.wilds	439	42	40	39	130	82	11	9	108	90	51	48	238
	NC7-zea.totals	20634	2896	657	509	9433	1573	92	82	3794	3430	749	591	13227
	Total:	**20734**	**2902**	**661**	**512**	**9445**	**1578**	**93**	**83**	**3800**	**3436**	**754**	**595**	**13245**
Reitsma	NC7-chicory	279	216	13	13	502	17	2	2	17	217	15	15	519
	NC7-cucumis.cucs	1379	1311	95	87	1590	801	31	25	1226	1314	126	112	2816
	NC7-cucumis.melo	3204	310	75	69	385	1215	25	24	1452	1389	100	93	1837
	NC7-cucumis.wilds	321	62	16	13	76	102	8	7	130	119	24	20	206
	NC7-cucurbita	975	448	92	89	680	415	11	11	524	613	103	100	1204
	NC7-daucus	1381	1072	78	72	1426	1070	8	7	1365	1093	86	79	2791
	NC7-ocimum	98	91	38	36	380	38	5	5	51	91	43	41	431
	NC7-parsnips	73	30	8	8	40	2	1	1	2	31	9	9	42
	Total:	**7710**	**3540**	**252**	**226**	**5079**	**3660**	**71**	**60**	**4767**	**4867**	**323**	**286**	**9846**
NCRPIS Total:		**52632**	**13941**	**1202**	**926**	**25893**	**9160**	**321**	**278**	**14516**	**17788**	**1523**	**1204**	**40409**

Year 2013 Table 3B			Cancelled External NCRPIS Items - NR (home gardner) order types											
01/01/2013 to 12/31/2013			External Domestic Distributions				Foreign Distributions				External Domestic and Foreign Distributions			
CURATOR	GENUS_CROP	# Accs in Collection	# Accs	# Orders	# Recipients	# Items	# Accs	# Orders	# Recipients	# Items	# Accs	# Orders	# Recipients	# Items
Barney	NC7-medicinals	499	46	47	46	85	8	3	3	8	50	50	49	93
	NC7-mints	174	44	63	62	119	5	1	1	5	47	64	63	124
	NC7-ornamentals	834	93	87	86	200	16	2	2	16	97	89	88	216
	Total:	**1507**	**183**	**144**	**140**	**404**	**29**	**4**	**4**	**29**	**194**	**148**	**144**	**433**
Brenner	NC7-amaranth	3345	55	44	44	73	15	2	2	17	67	46	46	90
	NC7-celosia	56	13	11	11	22	0	0	0	0	13	11	11	22
	NC7-echinochloa	306	1	2	2	2	0	0	0	0	1	2	2	2
	NC7-grasses	130	1	1	1	1	0	0	0	0	1	1	1	1
	NC7-legumes	247	0	0	0	0	0	0	0	0	0	0	0	0
	NC7-melilotus	1002	10	23	22	27	0	0	0	0	10	23	22	27
	NC7-panicum	934	1	1	1	1	0	0	0	0	1	1	1	1
	NC7-perilla	25	5	11	11	14	0	0	0	0	5	11	11	14
	NC7-portulaca	8	6	5	5	11	1	1	1	1	6	6	6	12
	NC7-quinoa	357	54	51	51	89	4	2	2	4	54	53	53	93
	NC7-setaria	1014	2	2	2	2	0	0	0	0	2	2	2	2
	NC7-spinach	410	51	96	91	164	5	0	0	5	52	96	91	169
	NC7-umbels	1151	110	121	121	266	34	3	3	38	130	124	124	304
	Total:	**8985**	**309**	**267**	**256**	**672**	**59**	**6**	**6**	**65**	**342**	**273**	**262**	**737**
Carstens	NC7-woody.landscape	1709	116	64	63	173	3	2	2	3	118	66	65	176
	Total:	**1709**	**116**	**64**	**63**	**173**	**3**	**2**	**2**	**3**	**118**	**66**	**65**	**176**
Marek	NC7-asters	384	10	9	9	11	2	1	1	2	11	10	10	13
	NC7-brassica	2012	35	32	31	58	4	1	1	4	39	33	32	62
	NC7-brassica.pvp	6	0	0	0	0	0	0	0	0	0	0	0	0
	NC7-crucifers	1219	70	45	44	95	3	3	3	3	70	48	47	98
	NC7-crucifers.pvp	1	0	0	0	0	0	0	0	0	0	0	0	0
	NC7-cuphea	639	12	12	12	16	0	0	0	0	12	12	12	16
	NC7-euphorbia	209	2	2	2	2	0	0	0	0	2	2	2	2
	NC7-flax	2834	21	13	13	24	0	0	0	0	21	13	13	24
	NC7-flax.wilds	134	9	3	3	9	0	0	0	0	9	3	3	9
	NC7-sun.cults	1855	72	59	58	104	1	1	1	1	73	60	59	105
	NC7-sun.wilds.ann	1405	18	32	32	40	1	1	1	1	19	33	33	41
	NC7-sun.wilds.per	848	40	43	41	69	3	2	2	3	42	45	43	72
	NC7-sun.wilds.sp	2	0	0	0	0	0	0	0	0	0	0	0	0
	Total:	**11548**	**289**	**180**	**169**	**428**	**14**	**5**	**5**	**14**	**298**	**185**	**174**	**442**
Millard	NC7-corn.kin	100	2	2	2	2	0	0	0	0	2	2	2	2
	NC7-maize.gems	184	2	2	2	2	0	0	0	0	2	2	2	2
	NC7-maize.inb	2526	14	12	12	15	0	0	0	0	14	12	12	15
	NC7-maize.pop	17089	258	181	179	572	7	4	4	7	264	185	183	579
	NC7-maize.pvp	341	8	11	11	17	0	0	0	0	8	11	11	17
	NC7-maize.wilds	439	2	2	2	2	2	1	1	2	4	3	3	4
	NC7-zea.totals	20579	284	193	190	608	9	5	5	9	292	198	195	617
	Total:	**20679**	**286**	**194**	**191**	**610**	**9**	**5**	**5**	**9**	**294**	**199**	**196**	**619**
Reitsma	NC7-chicory	279	20	7	7	24	6	2	2	6	26	9	9	30
	NC7-cucumis.cucs	1379	98	144	142	283	25	8	8	34	112	152	150	317
	NC7-cucumis.melo	3202	154	143	143	319	15	4	4	15	161	147	147	334
	NC7-cucumis.wilds	321	20	15	15	22	1	1	1	1	21	16	16	23
	NC7-cucurbita	975	122	192	187	500	12	5	5	12	124	197	192	512
	NC7-daucus	1369	78	132	127	262	44	7	7	66	108	139	134	328
	NC7-ocimum	98	39	96	96	185	5	2	2	5	39	98	98	190
	NC7-parsnips	71	7	6	6	8	6	3	3	8	12	9	9	16
	Total:	**7695**	**538**	**413**	**399**	**1603**	**114**	**14**	**14**	**147**	**603**	**427**	**413**	**1750**
NCRPIS Total:		**52123**	**1721**	**667**	**631**	**3890**	**228**	**19**	**19**	**267**	**1849**	**685**	**650**	**4157**

Year 2013 Table 4		NCRPIS Accessions (Accs) Observations (Obs) in GRIN, Images in GRIN								
01/01/2013 to 12/31/2013										
CURATOR	GENUS_CROP	# Accs in Collection	# of Accs Obs Trials	# Obs in GRIN for Year	# Accs Obs in GRIN for Year	# Accs Obs In GRIN Last Year	# Accs Obs in GRIN (all years)	# of Accs Imaged	# Acc Images in GRIN for Year	# Acc Images in GRIN (all years)
Barney	NC7-medicinals	499	20	10	10	0	317	5	10	299
	NC7-mints	174	0	11	10	1	37	0	10	57
	NC7-ornamentals	835	0	2	1	2	220	1	1	279
	Total:	**1508**	**20**	**23**	**21**	**3**	**574**	**6**	**21**	**635**
Brenner	NC7-amaranth	3345	129	15	12	339	3342	1	9	876
	NC7-celosia	56	0	3	2	56	56	0	2	19
	NC7-echinochloa	305	0	22	14	9	305	0	14	63
	NC7-grasses	130	0	0	0	4	21	0	0	25
	NC7-legumes	247	0	7	3	244	244	2	3	31
	NC7-melilotus	1004	5	55	46	67	992	4	45	190
	NC7-panicum	935	4	11	3	19	930	1	5	127
	NC7-perilla	25	0	5	4	25	25	1	4	11
	NC7-portulaca	9	1	0	0	4	5	2	2	4
	NC7-quinoa	361	4	59	42	350	356	7	39	152
	NC7-setaria	1014	3	25	14	19	1003	0	14	156
	NC7-spinach	410	1	6	3	126	410	0	3	17
	NC7-umbels	1172	9	114	31	1137	1148	9	23	207
	Total:	**9013**	**156**	**322**	**174**	**2399**	**8837**	**27**	**163**	**1878**
Carstens	NC7-woody.landscape	1775	25	0	0	139	805	110	117	814
	Total:	**1775**	**25**	**0**	**0**	**139**	**805**	**110**	**117**	**814**
Marek	NC7-asters	390	0	0	0	0	4	2	0	25
	NC7-brassica	2012	0	0	0	0	1901	1	0	333
	NC7-brassica.pvp	6	0	0	0	0	0	0	0	0
	NC7-crucifers	1219	1	0	0	0	821	0	0	340
	NC7-crucifers.pvp	1	0	0	0	0	1	0	0	0
	NC7-cuphea	639	0	0	0	3	368	0	0	14
	NC7-euphorbia	209	0	0	0	0	0	0	0	0
	NC7-flax	2834	0	0	0	1	2826	0	0	1
	NC7-flax.wilds	134	0	0	0	0	82	0	0	17
	NC7-sun.cults	2161	54	2825	344	70	1788	93	87	256
	NC7-sun.wilds.ann	1453	17	296	18	13	1292	41	7	72
	NC7-sun.wilds.per	875	187	609	49	38	599	31	16	131
	NC7-sun.wilds.sp	2	0	0	0	0	0	0	0	0
	Total:	**11935**	**259**	**3730**	**411**	**125**	**9682**	**168**	**110**	**1189**
Millard	NC7-corn.kin	100	0	0	0	0	0	4	0	0
	NC7-maize.gems	213	0	285	16	109	171	17	0	103
	NC7-maize.inb	2530	356	1341	60	1578	2364	85	0	589
	NC7-maize.pop	17110	0	5177	232	3172	14505	304	0	4206
	NC7-maize.pvp	342	89	879	55	337	342	53	0	219
	NC7-maize.wilds	439	0	0	0	0	264	4	0	107
	NC7-zea.totals	20634	445	7682	363	5196	17646	463	0	5224
	Total:	**20734**	**445**	**7682**	**363**	**5196**	**17646**	**467**	**0**	**5224**
Reitsma	NC7-chicory	279	0	3	3	2	279	0	3	259
	NC7-cucumis.cucs	1379	0	96	72	6	1377	23	71	920
	NC7-cucumis.melo	3204	0	375	180	19	3196	81	180	649
	NC7-cucumis.wilds	321	0	0	0	7	289	9	20	75
	NC7-cucurbita	975	6	103	45	16	970	9	45	151
	NC7-daucus	1381	115	1799	402	263	1364	45	446	687
	NC7-ocimum	98	0	17	13	0	98	0	13	13
	NC7-parsnips	73	0	1	1	0	71	0	1	1
	Total:	**7710**	**121**	**2394**	**716**	**313**	**7644**	**167**	**779**	**2755**
NCRPIS Total:		**52675**	**1026**	**14151**	**1685**	**8175**	**45188**	**945**	**1190**	**12495**

Figure 1


North Central Regional Plant Introduction Station Staff
USDA ARS United States Department of Agriculture Agricultural Research Service
IOWA STATE UNIVERSITY
Candice Gardner Research Leader / Coordinator
Kendall Lamkey Department Chair Agronomy
Plant Introduction
Maize Curation
Mark Millard Geneticist Maize
Bruce Hall Research Tech. Maize
Brady North Ag. Specialist I Maize
Amaranth Curation
Sam Flomo Ag. Specialist I Amaranth
David Brenner Curator II Amaranth
Horticulture Curation
Dan Barney Horticulturist Ornamentals
Jeff Carstens Hort Tech Woody Ornamentals
Oilseeds Curation
Irv Larsen Research Tech. Oilseeds
Laura Marek Curator III Oilseeds
Vegetables Curation
Cindy Clark Ag. Specialist I Vegetables
Kathy Reitsma Curator III Vegetables
Plant Pathology
Vacant Research Tech. Plant Pathology
Charlie Block Plant Pathologist
Seed Storage
Lisa Burke Research Tech. Seed Storage
Lisa Pfiffner Research Tech. Seed Storage
Germplasm Information
Robert Stebbins Germplasm Program Assistant
Information Technology
Pete Cyr IT Specialist
Jesse Perrett IT Specialist
Entomology
Steve Hanlin Entomologist
Vacant Research Tech. Entomology
Administration
Marci Bushman Secretary Automation Clerk
Germplasm Information
Susan Siev Germplasm Program Assistant
Farm Operations
Brian Buzzell Farm Equipment Mechanic
Lloyd Crim Farm Equipment Operator III
Larry Lockhart Program Manager II
Lloyd Crim provides part-time support for the Oilseeds Team.
Germplasm Enhancement of Maize (GEM)
Mike Blanco GEM Breeder / Coordinator
Mack Shen IT Specialist GEM
Michael Peters Research Tech. GEM
Fred Engstrom Research Tech. GEM
USDA-ARS Personnel
Iowa State University Personnel