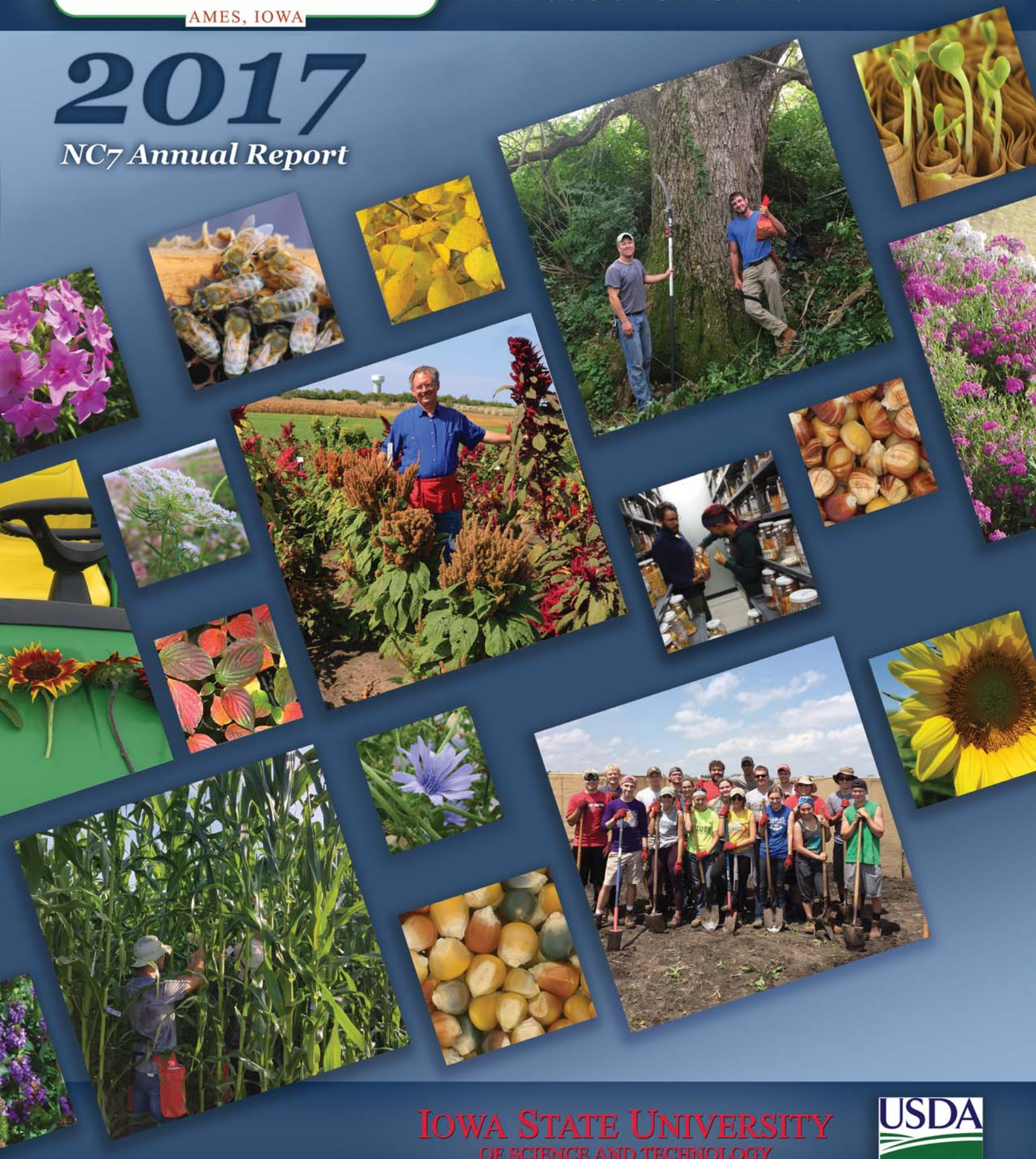
NCRPIS

AMES, IOWA

# North Central Regional Plant Introduction Station

# 2017

## *NC7 Annual Report*



IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

USDA

# NCRPIS ANNUAL REPORT - 2017

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**NORTH CENTRAL REGIONAL PLANT INTRODUCTION STATION**
**NC-7 ANNUAL REPORT, JANUARY 1 - DECEMBER 31, 2018**

## 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; transitioned to J. Colletti

### 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 | L. Hoagland / 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 | M. Caffe-Treml |
| 6. Minnesota | A. Lorenz | 12. Wisconsin | W. Tracy |

Non-voting participants:

| | | | |
|---|---|---|---|
| 13. California-Davis | R. Karban | 27. Missouri | S. Flint Garcia |
| 14. Connecticut | M. Brand | 28. Missouri | S. Jose |
| 15. Delaware | R. Wisser | 29. Nebraska | C. Urea |
| 16. Illinois | J. Juvick | 30. New Jersey | S. Handel |
| 17. Illinois | G. Kling | 31. New Jersey | T. Molnar |
| 18. Illinois | S. Korban | 32. New York | J. Doyle |
| 19. Illinois | D. Lee | 33. New York | M. Gore |
| 20. Indiana | J. Janick | 34. New York | P. Griffiths |
| 21. Iowa | K. Lamkey | 35. New York | A. Hastings |
| 22. Kansas | A. Fritz | 36. New York | M. Smith |
| 23. Kentucky | T. Phillips | 37. Wisconsin | S. Kaeppler |
| 24. Michigan | R. Grumet | 38. Wisconsin | N. de Leon |
| 25. Michigan | J. Hancock | 39. Texas | D. Baltensperger |
| 26. Mississippi | S. Popescu | | |

### 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 | *J.L. Willett |
| 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 – May, 2017 – June, 2018:**

Departures:

- Heather Kearney, USDA-ARS Germplasm Program Asst, October 20, 2017

Promotions:

- Narinder Pal, USDA-ARS Biol. Science Tech (Plant Pathology)

New Hires:

- Kurt Kabriel, ISU student May, 2017, then ORISE intern, Information Technology, January, 2018
- Joyce Lok, ORISE intern, Germplasm Enhancement of Maize Project, Oct, 2017

Transitions: None

Vacant USDA-ARS Positions:

- Agri. Science Research Technician, Oilseeds (vice-Larsen)
- Cat 4 Plant Pathologist (vice-Block)
- Cat 4 Maize Curator (geneticist)
- IT Specialist (new)
- Term Cat 3 Agronomist (Germplasm Enhancement of Maize - GEM)
- Term Biol. Science Tech (Seed Storage)

Vacant ISU Positions: None

Appendix Figure 1 illustrates the organization of the NCRPIS staff and their roles.

Management of Federal and ISU Student Temporary Employees:
USDA-ARS resources provided for 19 student part-time temporary positions in FY 2016, primarily via the Research Support Agreement with Iowa State University, and a Ph.D. student (plant breeding and genetics, GEM funds). NC7 resources provided for an addition 0.5 student FTE. The ORISE and other temporary positions support curatorial activities including regeneration, seed processing, viability testing, farm and facilities operations, IT support, and the GEM Project. Students were interviewed and selected by ISU Program Manager Fred Engstrom. Marci Bushman and Heather Kearney managed the administrative aspects of all student hires, with support and guidance from Ames ARS & APHIS HR Specialists Lindsay Evans and Sireena Foley, and ARS Admin. Officers Carol Moran, and Candace Weuve.

**Budget:**

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.

We are grateful that Hatch funding resources were maintained throughout the difficult sequestration period, and hope they continue to be stable or increase in the future. Currently, about 96% of Hatch NC7 funds are devoted to the wages and salaries of the nine permanent ISU employees. In the near future we will be unable to provide incremental salary increases due to Hatch funding constraints. If ISU wage increases of 1.5% are granted in FY18, this figure climbs to 97%; if an additional 1% increase is granted in FY19 barring personnel changes. This limits professional meeting travel, technical training, and temporary student hiring with ISU resources.

FY2018 USDA-ARS funding was essentially the same as final FY2014 funding, minus a one percent assessment for 'Big Data.' The PI CRIS was funded at $2.38M (net to location) and the GEM CRIS at $1.2M. Student hiring for summer 2018 was challenging, despite raising our starting wage for ISU students by almost $2/hour to $12/hour, and we were not quite able to fulfill the need for 25 summer FTE, but much better than in 2017. We attribute this to both the requirement for all agriculture students to complete internships, and the growing disparity in what we can offer for wages versus other hiring opportunities. F. Engstrom advertised positions more widely across ISU colleges, and the students that did apply were excellent.

Any 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. Given the high turnover since 2014, a great deal of time and attention has been paid to recruitment and hiring activities, and will continue given the current six vacancies.

Position descriptions for the second maize geneticist (curator) were submitted in November, 2016. Together with the vacant Plant Pathologist, Oilseeds technician, and GEM support scientist positions, these core positions remain unfilled. Hopefully recruitment will proceed for all positions in summer 2018.

**Construction and Facilities:**
Seed storage space is becoming limiting, and needs to be addressed within the next four to five years. A request has been made for support for a 2500 sq ft -20˚C cold storage building to support essentially doubling the longevity of viability of many of our taxa. In general, space is extremely tight for all personnel and functions.

Greenhouse pest control continues to be augmented with biological controls such as green lacewings (*Chrysoperla rufilabris*), ladybugs (*Hippodamia convergens*), a whitefly parasite (*Encarsia formosa*), and an insect new to the arsenal, the rove beetle (Staphylinidae, *Dalotia*) to help control thrips and other insects.

Please see the Information Management section of this report for details on upgrades that continue to enhance the NCRPIS' information technology infrastructure. The continued implementation of virtual servers and their configuration is noteworthy.

**Equipment:**
An intercom communication system was installed within and between structures at the station to support personnel safety during emergencies as well as routine communications. Additional webcams for security and exterior lighting were strategically installed for security. They cannot prevent theft such as the losses of bees or germplasm that occurred in 2017, but can be useful in identifying those involved. Other genebank site personnel are also reporting theft of plant genetic resources and equipment.

Additional LED lights were installed in some greenhouse areas. As funding becomes available, we will continue to upgrade greenhouse lighting technology to improve plant productivity and reduce costs. LED lighting is rapidly evolving, and fixtures that provide for improved photosynthetic efficiency will become available at less cost. A QSorter, an optical seed sorter that captures 3D images and NIR data was purchased with ARS Midwest Area and HQ support from QualySense, a Swiss company. We hope to explore various seed characterization and develop algorithms based on the spectra and images. Additional modern seed sorting technology will be sought.

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

(Part IV. summarizes the accomplishments and progress for calendar year 2017, presented in greater detail in the individual staff reports in the document.)

**Technical Exchange:** An exchange relationship continues between the NCRPIS maize genebank and the CIMMYT maize genebank. In May-June of 2016, Cristian Zavala, lead technician for the CIMMYT genebank who reports to curator Denise Costitch, spent a month at the NCRPIS with the maize curatorial team. Cristian focused on characterization processes and learning how curatorial personnel use GRIN-Global to manage information workflows. In November of 2016, Brady North, Agricultural Research Specialist, spent a month with the CIMMYT technical personnel, traveled to several of their locations at various altitudes, learned their processes, and offered GRIN-Global training. Brady was able to see the Tolucca site, where they have been able to successfully regenerate highland tropical maize the past three seasons. As a result, a contract was established with CIMMYT to regenerate NPGS tropical highland maize at their Tolucca site in summer 2018.

**Acquisition and Documentation Highlights:**
In 2017, collection development continued with the acquisition of 250 new accessions (Appendix Table 1, 5). This compares with 786 new accessions in 2016, 229 in 2015, 766 in 2014; 192 in 2013, 470 in 2012, 485 in 2011, 516 in 2010, and 521 in 2009. New accessions include a variety of taxa collected by NCRPIS curators, including 99 ornamental and medicinal accessions from Tennessee, Kentucky, North Dakota State University, Ohio, the Brenton Arboretum, and the Mid-Atlantic Regional Seed Bank. Additionally, 105 maize inbreds and populations, eight *Chenopodium sp.*, and others were acquired.

The U.S. is now a partner to the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). How this will be implemented by the NPGS is under development. International collection continues to be challenging as countries adopt variations of the SMTA or other requirements that the NPGS cannot accept. 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.

Original seed samples continue to be scanned in order to provide useful visual references for comparison of regeneration lots with original samples.

**Regeneration and Maintenance Highlights:**
In 2017, 1601 accessions were grown for regeneration and 1210 were harvested. This contrasts with 1033 accessions grown for regeneration and 1067 harvested in 2016; 1,627/1,169 in 2015; 1,230 / 1,085 in 2014; 1,184 / 1,048 in 2013; 759 / 954 in 2012; and 1,069 / 1,017 in 2008 (Appendix Tables 2, 5). The low 2016 number reflects budget uncertainty at the critical time when germinations and vernalizations must occur in preparation for the production season. A large tropical maize winter nursery was planted in fall 2017 near Puerto Vallarta, Mexico, a high priority and the first use of this site and nursery provider. About 1123 accessions were made available to the public. Accessions backed up at the National Laboratory for Genetic Resource Preservation (NLGRP) in Ft. Collins in 2017 numbered 595, compared to 428 in 2016; 431 in 2015; 1,231 in 2014; 781 in 2013; 799 in 2012; 792 in 2011; 2,388 in 2010; and 1,848 in 2009. The overall percent of NCRPIS collection holdings backed up at the NLGRP is 80%. This ranges from 12% for the maize crop wild relatives to 100% for several taxa (Appendix Table 2, 5). More than 2,040 accessions were also sent to Ft. Collins to inclusion in the annual deposit to the Svalbard Global Seed Vault. Overall collection availability is 76%, despite 8% growth in collection size since 2006.

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 (S. McClintic-Friddle), Bejo Seeds (R. Maxwell), and New Mexico State University (C. Cramer).

Assistance for maize regeneration and observation was provided for tropical maize populations by Monsanto (D. Butruille) in Hawaii, and by DuPont Pioneer in Puerto Rico. USDA-ARS staff of Mayaguez, PR (R. Goenaga) and the St. Croix quarantine nursery staff supported regeneration of tropical maize accessions, but Hurricane Maria destroyed the planting, along with much of Puerto Rico's infrastructure. 3rd Millennium Genetics in Puerto Rico returned an increase of lowland tropical maize populations from Central and South American from the Goodman racial collection. Raleigh ARS GEM Project Coordinator Matt Krakowsky provided increases of nine GEM lines and the Ames GEM team regenerated 12 GEM lines.

Spinach regenerations continue to be supported by cooperative efforts between the USDA-ARS and Sakata Seed America, Inc. in Salinas, CA.

**Distribution:**
Approximately 38% of the germplasm distributions were to international and 62% to domestic requestors. Distributions set a new record (Appendix Table 3).

| Year | # Items | # Unique Accessions | # Orders | # Requestors |
|---|---|---|---|---|
| 2017 | 55,474 | 22,801 | 1,410 | 1,019 |
| 2016 | 39,520 | 18,093 | 1,254 | 963 |
| 2015 | 34,188 | 14,279 | 1,186 | 945 |
| 2014 | 41,655 | 17,558 | 1,285 | 993 |
| 2013 | 40,409 | 17,788 | 1,523 | 1,204 |
| 2012 | 45,115 | 18,811 | 1,632 | 1,344 |
| 2011 | 38,402 | 18,634 | 1,501 | 1,180 |
| 2010 | 26,651 | 13,226 | 1,183 | 820 |
| 2009 | 26,904 | 13,515 | 1,487 | 1,081 |

Non-research requests (home gardeners), which heavily target vegetable germplasm, have largely stabilized. Approximately one-half of all orders to NC7 are cancelled non-research requests; other NPGS sites are also heavily targeted. 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. GRIN-Global's user friendly order module also helps individuals to order more, and more diverse germplasm from a number of NPGS sites at once.

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 2017 | % of Total Collections | % of 2017 Distributions | % of 2016 Distributions | % of 2014 Distributions |
|---|---|---|---|---|---|
| Brenner | 9,240 | 17 | 23 | 18 | 14 |
| Carstens† | 3,675 | 7 | 2 | 1 | <1 |
| Marek | 12,637 | 23 | 35 | 25 | 16 |
| Millard | 21,053 | 39 | 22 | 34 | 35 |
| Reitsma | 7,839 | 14 | 18 | 22 | 28 |
| **Totals** | **54,444** | **100** | **100** | **100** | **100** |

†Carstens and Barney collections assumed by Carstens in late 2015

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. There was unusually high demand in 2017 for oilseeds Brassica, amaranth, the

sunflower SAM lines, Setaria, and spinach. Maize inbred requests continue to be driven by publication of information from genomic (genotyping by sequencing) and phenotypic analyses projects.

**Evaluation and Characterization:**
Maize technical staff continued to develop maize specific computer applications to capture field observations, ear and kernel lab observations, inventory actions, harvest and seed weights that are captured in MS Access and then loaded into the GRIN-Global database via the drag and drop feature. With the release of the 'Attachment Wizard' that works in conjunction with GRIN-Global, image loading has resumed. A large volume of accession-associated images and other types of documents can now be attached to accessions or groups of accessions.

In 2017, the NCRPIS utilized 4,676 accessions internally for observation, evaluation and characterization for a wide array of descriptor information, and for viability testing (Appendix Tables 2, 4). Appendix Table 4 lists observations associated with traits entered in the GRIN/GRIN-Global database (http://www.ars.grin.gov/npgs/). Other uses include pathogen testing to meet international distribution requirements and back up.

**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, implemented in 2015. This has been the sole primary focus of NCRPIS developer Pete Cyr since 2008, and a major focus of two other NCRPIS staff members, Mark Millard (system analyst) and Lisa Burke (beta testing, training) with substantial time invested by additional personnel. The Database Management Unit (DBMU) in Beltsville, is responsible for hosting and maintaining the system, developing the public interface, GRIN Taxonomy, and changes to the system's Middle (business) Tier and administration. Periodic video training conferences continue to be offered by DBMU personnel (documentation specialist Marty Reisinger) for NPGS site personnel participation, as they have been for the past four years, and other training as requested.

Ten national or international genebanks have now implemented GRIN-Global for genebank use, and most of these have live public interfaces. Another 16 are in the process of evaluating and/or implementing the system.

For the past 30 months, the NPGS has utilized a GRIN-Global Advisory Committee (AdCom) as a forum for genebank personnel and developers to identify development needs, prioritize them, test, and approve software for release. The AdCom is chaired by NCRPIS staff member Lisa Burke, and has been highly productive. An international AdCom has been formulated with participation by key personnel from the Crop Trust, the US NPGS, CIMMYT, and CIP and confers monthly. Its first charge is to formalize a process by which international development products can be checked into branches of the Git vault (maintained by the Trust at CIMMYT)

A focus for our next ARS Program cycle is to develop inter-operability between GG and other key information providers' portals, such as Gramene, LIS (Legume Information System), or GOBii, for example.

Please see the IT section for technical details of NCRPIS support activities. We owe IT Specialist Jesse Perrett, Kurt Kabriel, and Fred Engstrom sincere thanks for their efforts to implement the NCRPIS intercom communications system.

**Germplasm's Viability and Health:**
Viability testing was conducted on 6% of the collection accession in 2017; a concerted effort is being made to assure all seed lots 10 years or older have current germination information. 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. A field was added the GRIN-Global System to differentiate simple viability from 'pure live seed' and a dataview will support the calculations involved. Dormant seeds that do not readily germinate should be considered in the context of accession viability.

Pathology ASRT Dr. Narinder Pal and C. Block validated their seed health assay which distinguishes *Pantoea stewartii* from other *Pantoea* species. This assay provides a solution to the problem of false positives from the ELISA test for tropical *Pantoea* isolates. Their work has been submitted for publication, and is important as international movement of seed corn typically require freedom from the Stewart's wilt organism. It is anticipated that seed health testing for Goss' wilt will become a common requirement in the near future. Dr. Pal's lab carried out all seed health testing and fungicide treatment to support international seed shipments.

Field inspections were made for all crops, and all cucurbit seedlings were screened routinely for presence of Squash Mosaic Virus via ELISA; Outcomes are detailed in the pathology section of this report. Northern corn leaf blight was not a problem in the field in 2017, unlike 2016.

In 2017, we continued testing for adventitious presence (AP) of genetically engineered organisms (GEO) in maize germplasm accessions new to the NCRPIS, and sampled newly produced seedlots.

**Insect management:**
The Entomology staff provided six insect pollinator species to control pollinate 972 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 accessions 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. International collaborators are screening GEM germplasm for late wilt, maize rough dwarf virus, corn stunt, and others. A University of Nebraska collaborator screened about 100 GEM lines in 2017 for Bacterial Leaf Streak, a relatively new disease, and will again in 2018.

The Ames and Raleigh, NC GEM Projects and public collaborators have released 316 lines from 2001-2016, representing more than 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 has generated 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. USDA-ARS and ISU jointly released 204 doubled haploid lines in 2014; the next set of lines from the allelic diversity project will be released in January, 2019. These lines have one-quarter exotic, three-quarters temperate background.

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. Monsanto donated a solar powered, engineered photoperiod control house to ISU that should aid Ames maize researchers' efforts to make breeding crosses with tropical lines in 2018. 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.

GEM field days, held every September are well attended by scientists, breeders and graduate students. The field days offer a unique opportunity for more molecular-focused researchers to understand the diversity of the materials available for research, and the activities that support germplasm development.

**Outreach and Scholarship:**
More than 500 visitors toured the NCRPIS during 2017. 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 continue to try to improve conservation methods to better use the resources available to us, and to develop labor and resource saving technologies. ARS leadership has been requested to help secure resources for a -20˚C cold storage building in order to extend longevity of seed viability. 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 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. The horticulturists' report details how collection priorities have been determined, and how gap analyses affect these priorities.

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.

Curator Laura Marek will continue to collaborate with *Helianthus* researchers to understand the genetic basis of multiple important traits. Horticulturist Carstens' collaborations also include understanding ploidy levels of elm, ash, and other species, and their geographic distributions.

Software development efforts continue to center on the development and deployment of the successor to the GRIN system, GRIN-Global (GG), 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. A formal process is used to submit and address enhancement requests, prioritize development, assign work to developers, and to securely share new software applications between GG adopters to extend the system's functions and features.

## 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.

Among the benefits for the representatives are the opportunity for exposure to research in areas outside their own area of expertise, leading to greater understanding and insights, and the opportunity for service to their institutions, to the NPGS, and to germplasm security.

Some of the NC-7 RTAC's specific suggestions and contributions from their 2017 Annual Meeting in Ames, IA include the following: (from the meeting minutes):

- The 2017 RTAC meeting was hosted by William Tracy at the University of Wisconsin-Madison, and highlighted the extensive research initiatives related to realizing the value of plant genetic resources for crop improvement. The opportunities afforded by the meetings and field tours are key to establishing the types of collaborative relationships that lead to long-term partnerships for major research and development efforts. Highlights included tours with University researchers:
  - Julie Dawson of the Urban & Regional Food Systems on variety trials for fresh market growers, organic systems production testing, and public events.
  - Lucia Guitterez about small grains research, quantitative genetics of complex traits, and the 'fields of flavor' project.
  - Charlene Grahn, PhD student discussed the carrot research program focused on production, disease resistance, and market-sensitive traits, use of crop wild relatives in the program.
  - Bill Tracy and Pat Flannery gave a synopsis of the sweet corn research and breeding program, endosperm types, genes controlling various aspects of sweetness and quality, and introgression of diverse tropical sweet corn germplasm into high quality elite temperate backgrounds
  - Wisconsin Crop Innovation Center (WCIC) tour hosted by Mike Petersen and Shawn Kaeppler, history of the center's development and innovation accomplishments, the laboratory and greenhouse programs, and transformation project capacity.
- ISU Agricultural Experiment Station Dean Wendy Wintersteen, NC7 Academic Advisor, stressed the value of the NC-7 RTAC participants' information exchanges. She stressed the importance of demonstrating impact and public return on investment in germplasm research and utilization and the critical partnerships between NIFA, ARS, NASS and the universities for accomplishing mission.
- Concurrence of the review and approval of the 2017/2018 NC-7 Hatch Project budget by the NCR AES Directors.
- Five crops have potential for acquisition of accessions that may have transgenes (as their intellectual property protection expires), maize, soybean, sugar beet, canola and cotton. The RTAC believes that providers of these accessions need to provide documentation concerning the transgenes.
- The committee thanks Dr. Tracy and the faculty and staff of the University of Wisconsin-Madison for hosting the 2017 meeting; we look forward to the 2018 meeting.

## VI. SUPPORT TEAM REPORTS:

### A. Farm (F. Engstrom, C. Hopkins, 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. We coordinated and completed facility construction and upgrades.

**Labor:**
During 2017, 89 applications for hourly employment were received and reviewed. There were 61 interviews, resulting in 46 new and 35 returning hourly employees hired. Currently there are 24.2 (FTE) Biological Science Aides working at the NCRPIS.

**NCRPIS Farm Crew Personnel:**
- Fred Engstrom, (Program Manager II) joined the staff July 1, 2016.
- Brian Buzzell (ISU Farm Mechanic) joined the staff in May 2002.
- Cole Hopkins (ISU Agricultural Specialist II) joined the staff in September, 2016, and assists the vegetable project half-time, and facility operations half-time.

**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 administered use biological controls for greenhouse pest control.
2. Reorganized equipment storage shed with pallet racking to maximize space utilization.
3. Installed intercom system for improved communications during weather or other emergencies, with J. Perrett and K. Kabriel.
4. Installed additional felt mat / drip irrigation systems in greenhouses #1 and #3, replaced evaporative cooling pads as needed.
5. Arranged for repair of compressors, HVAC equipment in multiple areas.
6. Installed additional pneumatic outlets in multiple areas for improved equipment use.
7. Additional webcams installed for security at key points and additional security light install with J. Perrett and K. Kabriel.
8. Installed dual flush toilets in headquarters building for water conservation.
9. Installed recirculating hot water system in part of headquarters building.
10. Installation of new LED lights for some greenhouse areas and updated older lighting styles to energy efficient lights in other works areas.

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

Equipment Purchased:

1. 23 new LED greenhouse lights with SmartPar controls were purchased for Greenhouse 1.
2. Walk behind brush mower utilized by entomology, facility and oilseeds projects.
3. 100 gallon tank and 12 volt pump for supplemental watering of accessions.
4. Pneumatic oil dispenser and metering system for equipment maintenance.
5. Replaced two JD Gators with trade.
6. QSorter, an optical color sorter that incorporates 3D vision and NIR spectroscopy for seed sorting and characterization applications.

**Tours:**
During 2017 there were more than 500 visitors.

**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, J. Perrett)

Jesse Perrett served as the first-line of support for NCRPIS during 2017. Jesse is supervised by Pete Cyr who is dedicated to the GRIN-Global project. Jesse supervised Kurt Kabriel, ORISE intern, from June to present in assisting with IT related tasks. The following list outlines the progress made by the IT team during 2017 at NCRPIS.

**Equipment:**
As of December 2017, the NCRPIS had 68 desktop and 35 laptop/tablet workstations installed for use by permanent staff members and part-time temporary student help. Most station computers are equipped with solid state drives, have at least 8 gigabytes of memory, and quad core processors. The centralized functions required by the station were supported by 20 physical servers and around 23 active virtual servers including those used for file storage, intranet, backups, and door security systems. New field tablet devices with barcode scanners were issued to crews for data collection and pollinator tool usage.

A Cisco ASA 5525X firewall is installed and configured in order to provide enhanced security as well as increased network performance in line with the gigabit network infrastructure. Each server rack is protected by a battery backup. In addition, a station generator system will provide power in the event of power grid failures. The generators in conjunction with the individual rack mounted battery backups should limit the possibility of power failure related server issues.

The station continues to implement virtual servers wherever possible in order to better utilize existing server capabilities and improve efficiency. Virtual server hosts use solid state drive tiered storage systems utilizing the technology built into Microsoft Windows Server 2016 to enhance storage performance of existing servers at minimal cost.

In 2017, the new Lenel door access system was operated in standalone site mode for five months while we waited for the completion of T1 line installation for Epacs connectivity. During this time, cardholder modifications were accomplished manually without connectivity to the Epacs network. We also implemented a new system to reuse Corporate 1000 cards for student access.

A new LincPass Light Activation Station was set up and configured with the LincPass Activator role. This allows for card activation, credential updates, and LincPass PIN resets to be done locally saving employees from having to schedule appointments and drive out to NCAH (National Center for Animal Health) for these tasks.

Staff printed over 8000 field ready wooden stakes. Issues with print quality and print consistency were fixed to ensure minimal misprints.

**Software:**
All workstations at NCRPIS are using Windows 8.1 or Windows 10. Microsoft Office 2013, Microsoft Office 365, Adobe Acrobat Professional DC, Adobe Creative Suite, Oracle applications for GRIN, and the GRIN Global Curator Tool were installed on systems as necessary. Laptops and tablets were encrypted by bit-locker.

An RSA server is used in conjunction with local RSA SecureID tokens to provide multi-factor authentication for administrative access to computer and server systems per USDA and ARS requirements.

The new GRIN Global pollinator tool software was tested and deployed to ensure user-friendly operation and accurate capture of field pollinator data.

During 2017, 63 computers and 21 servers were renamed and all computers were updated in preparation for an ARS directive to install BIGFix on all university located computers. Deployed BIGFix to all computers. This allows the OCIO (Office of Chief Information Officer) to monitor our patch and update installation status and include our location in any emails regarding outdated or unsafe software.

During 2017, Symantec Endpoint Protection (SEP) was used for antivirus and firewall management. In addition to SEP, Malwarebytes Anti-Malware and Malwarebytes Anti-Exploit were installed with a centrally managed enterprise version for greater virus and firewall protection. The combination of these security technologies provides much better protection against security vulnerabilities and some protection in the event of zero-day exploits. Frequent updates to anti-virus and anti-spyware definitions in conjunction with regular full system scans help ensure that these workstations remain vulnerability free.

In 2017, System Center Configuration Manager (SCCM) was used to verify and deploy Windows updates. SCCM is utilized for more control over software deployment and system management for all computers. The station is using Iowa State University SCCM servers which provides the added benefit of ease of management as well as allowing deployment packages for common software installations to be automatically available for use.

**Documentation:**
Weather station history data was provided via SharePoint to allow users to download current and past weather data including calculated GDU and CHU (heat unit) data. The station uses SharePoint Server 2013 Intranet site for advanced document management and retention. The NCRPIS public webpage was configured using the website management tool Umbraco. Posted IT support videos and training documents, and information about farm operation, safety, and health to the NCRPIS intranet website.

**Plans for 2018:**
- Upgrade station camera system with 10 new cameras.
- Upgrade SharePoint to version 2016.
- Install and configure station wireless intercom system.
- Upgrade remaining Windows workstations to Windows 10.
- Continue to upgrade servers to Microsoft Server 2016.
- Implement monthly windows updates via SCCM.
- Decommission old equipment including outdated servers and workstations.
- Continue to replace NCRPIS workstations on an as needed basis (targeting a 3-5 year lifespan for daily use workstations).

**GRIN-Global:**
The GRIN-Global project is a joint partnership between the USDA-ARS NPGS, the Global Crop Diversity Trust and Bioversity International. The project goal was to develop a new genebank information management system to replace the legacy 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 Resource Information System (dubbed GRIN-Global) supports five different languages, can be configured to support four database systems, and can be installed on a single desktop computer or a network. The development of the GRIN-Global curator desktop suite of applications (which includes the Curator Tool, Search Tool, various Wizards, and all reports/labels) continued throughout 2017 in direct support of NCRPIS daily curatorial operations. The new enhanced versions of the Curator Tool were developed, tested, and security scanned at NCRPIS before being released to the USDA/NPGS and international GRIN-Global partners. Some of the enhancements to the Curator Tool include a new Viability Wizard for processing germination tests, a new Attachment Wizard for attaching documents (like images, PDFs, spreadsheets, and text documents) to accession/inventory records, and numerous enhancements to the Order Wizard for more efficient processing of germplasm orders. NCRPIS development team enhanced the new Pollinator Tool for creating, tracking, and closing pollinator requests to ease the workflow of processing pollinator management.

## C. Information Management-Germplasm Collections (L. Burke, S. Estrada)

**Acquisition:**
The North Central Regional Plant Introduction Station (NCRPIS) acquired 303 (552 inventory lots) of new accessions in 2017. Of these new accessions, 168 were received from within the National Plant Germplasm System (NPGS) through exploration and

transfer (66 from the Seeds of Success program and 44 from the NLGRP). The woody landscape collection grew by 38 accessions that were collected by Jeff Carstens, NCRPIS Horticulturist. An additional 14 accessions were collected by Dave Brenner on a collection trip to Tampa, Florida. Maize accessions acquired included 88 GEM released lines from Raleigh, NC and Ames, IA. Five additional Helianthus pre-breeding lines were donated by Loren Rieseberg, University of British Columbia.

As new accessions are recorded in the Germplasm Resources Information Network (GRIN-Global) 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, intellectual property rights considerations, and any additional pertinent information provided by the donor. An excel workbook was developed to streamline the assembly of passport data and aid in loading data to the GG database.

**Maintenance:**
Curatorial assistance was provided by processing requests for taxonomic re-identifications and nominations of accessions to the inactive file. In total, 72 accessions received taxonomic re-identifications and 2 accessions were inactivated.

Additionally, 292 accessions were assigned PI numbers. Two-hundred sixty-six of these accessions were from the GEM breeding program.

This year the NCRPIS initiated a project to digitize all paper documentation related to accession provenance and performance. In total, 14,616 documents were uploaded to the GRIN database using the new Attachment Wizard. This includes all 3,503 taxonomic re-identification forms as well as 11,115 accession cards from the card catalogue. The card catalogue contains valuable passport information and inventory grow-outs for accessions that were received before the implementation of a GRIN database in the mid-1980s.

## D. Order processing (L. Burke, S. Estrada)

This year order processing focused heavily on utilizing GRIN order actions to track progress through order processing rather than relying heavily on email communications regarding progress. Order actions allowed both NCRPIS teams (curatorial personnel, seed storage, pathology), personnel from other NPGS sites, APHIS, and the GRIN-Global feedback group to more easily track an order as it travels through the pipeline. This was exceptionally useful for tracking additional paperwork that is required for exporting germplasm internationally, and for those orders that include accessions from multiple NPGS sites.

We also focused on the use of excel workbook templates to enter and modify order records in GRIN-Global. Paperwork related to orders is being attached directly to GRIN orders via the Order Wizard's attachment tab. These documents are accessible by internal NPGS users. External users may also add attachments (usually an import permit or shipping instructions) through their public website order history.

In addition, we can now print packet labels directly onto the packets (approx. $0.01 per packet) rather than onto a sticker label ($0.02-$0.04 per label) that was later affixed to the packet. This improvement not only reduced the materials cost by 50% but also reduced time spent affixing stickers to packets.

During 2017, 2733 orders were entered into GRIN-Global. Of these, 2314 entered the order processing system via the GRIN-Global Public Website. 2,761 orders containing 88,089 items were completed in 2017. Of these, 90% were considered to be external (non-genebank use) orders. 1,724 (62%) of all NCRPIS orders were fulfilled. 1,461 (59%) were shipped outside of the NPGS.

**Detail summary of NCRPIS germplasm distributions**

| Order Type | Total No. Orders (%) | | Total No. Order Items (%) | | Avg No. items per order | | No. orders shipped (%) | | No. items shipped (%) | | Avg No. items shipped per order |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Backup* | 34 | (1) | 2843 | (3) | 84 | | 33 | (97) | 2842 | (100) | 86 |
| Distribution* | 1529 | (55) | 64438 | (73) | 42 | | 1380 | (90) | 55188 | (86) | 40 |
| Germination | 124 | (4) | 4245 | (5) | 34 | | 123 | (99) | 4218 | (99) | 34 |
| Herbarium/reidentification | 23 | (1) | 276 | (0) | 12 | | 23 | (100) | 276 | (100) | 12 |
| Non-research, non-educational* | 892 | (32) | 10707 | (12) | 12 | | 9 | (1) | 79 | (1) | 9 |
| Observation/evaluation* | 38 | (1) | 1880 | (2) | 49 | | 36 | (95) | 1239 | (66) | 34 |
| Phytosanitary Testing | 46 | (2) | 2070 | (2) | 45 | | 45 | (98) | 2068 | (100) | 46 |
| Repatriation* | 3 | (0) | 33 | (0) | 11 | | 3 | (100) | 33 | (100) | 11 |
| Replenishment/regrow | 63 | (2) | 1563 | (2) | 25 | | 63 | (100) | 1538 | (98) | 24 |
| Transfer | 9 | (0) | 34 | (0) | 4 | | 9 | (100) | 34 | (100) | 4 |
| **External only*** | 2496 | (90) | 79901 | (91) | 32.0 | | 1461 | (59) | 59381 | (74) | 41 |
| **Grand Total** | 2761 | (100) | 88089 | (100) | 31.9 | | 1724 | (62) | 67515 | (77) | 39 |

*External orders consist of the marked categories

55% of orders received were classified as 'Distribution' requests and accounted for 73% of all requested germplasm. 32% of orders were deemed to be Non-research, non-educational requests (NRR), and accounted for approximately 10,000 items (12% of items requested). Internal orders made up 10% of all orders completed in 2017 and accounted for 9% of all requested germplasm.

Our time was spent processing and shipping 62% of all NCRPIS orders. One percent of NRR requests were honored. On average, a germplasm request consisted of 32 items. The average number of items shipped per order was higher at 39-41 due to an increase in requests for entire collections. 10% of all distributed orders were for 39 or more items. Furthermore, 7 of these orders were for more than 1,000 items.

**Shipped orders:**
1,461 external requests for 59,381 germplasm items were shipped. 74% of these orders were shipped within the United States and 22% were exported internationally. Seven backup orders containing 2,043 items from the Oilseeds, Vegetables, and Amaranth

curatorial groups were shipped to Fort Collins for inclusion in the Svalbard back up from the NPGS. All but one of the international orders were distribution requests; an observation/evaluation order was sent to Switzerland to support testing of the Qualysense color sorter.

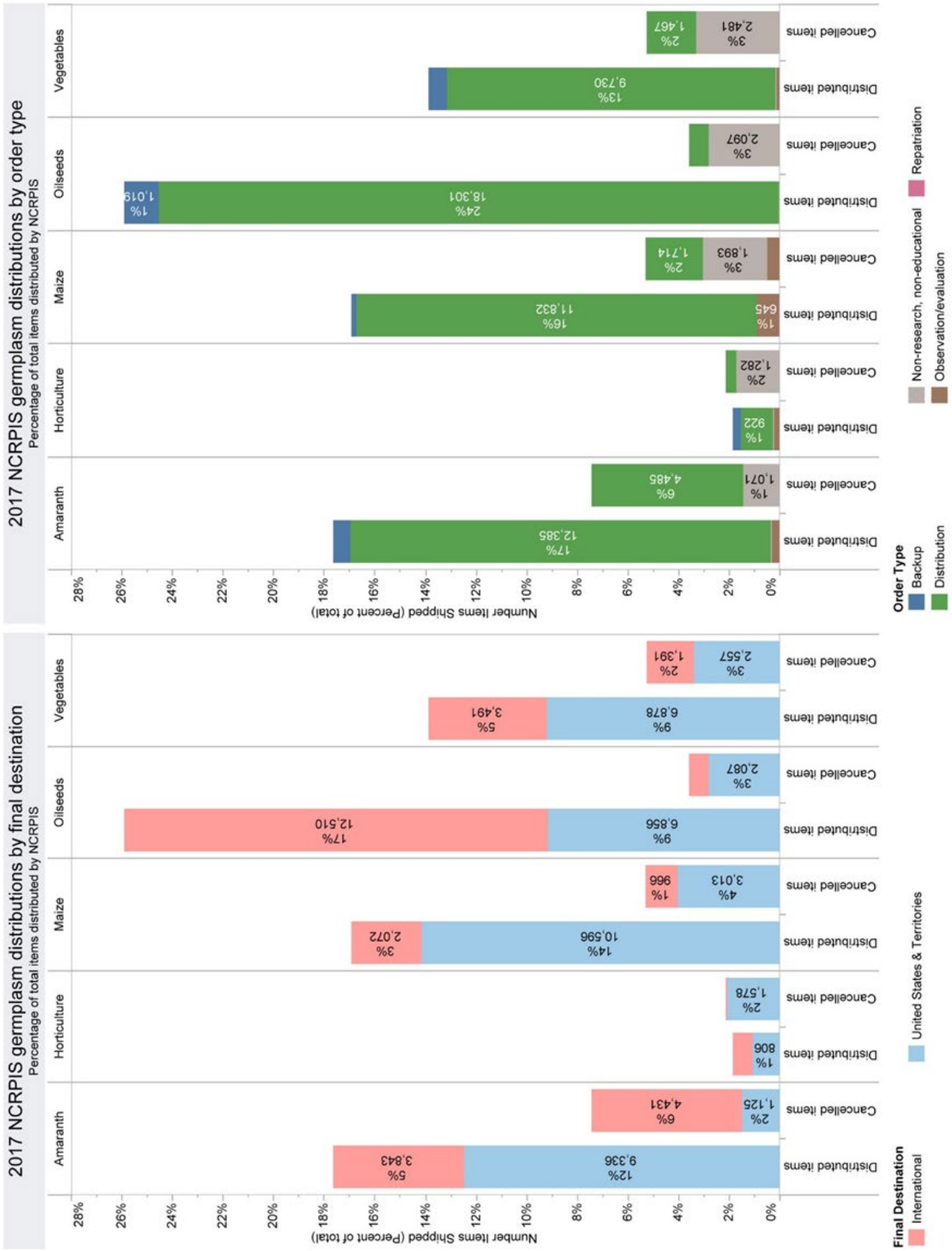
Although international orders accounted for only 22% of shipped orders, a considerable amount of documentation effort is required to process these germplasm requests. Each country and crop has unique restrictions regarding the importation of plant material. Only 22% of international distributions shipped required an import permit. Import permit restrictions ranged from the simpler direct shipment from NCRPIS to more complicated restrictions which required additional pathology testing and other documentation. Approximately one-third of all international orders were shipped directly from the NC7 distribution facility and two-thirds were transferred to APHIS in Beltsville for issue of a phytosanitary certificate before final export. One-third of all orders shipped required a phytosanitary certificate with an additional declaration statement that was issued by our pathology group. Pathology also conducted additional laboratory testing (5% of all international orders) and/or worked in coordination with the curatorial groups to complete required seed treatments (4%).

The bar graphs below show 2017 NCRPIS germplasm distributions by curatorial group. The left graph depicts the final destination of germplasm requests. Germplasm requests for Maize (14%) and Amaranth (12%) dominated domestic distributions. Oilseeds accounted for 17% of all international shipments, and sunflower distributions of 500 or more items were made to France, Spain, and China.

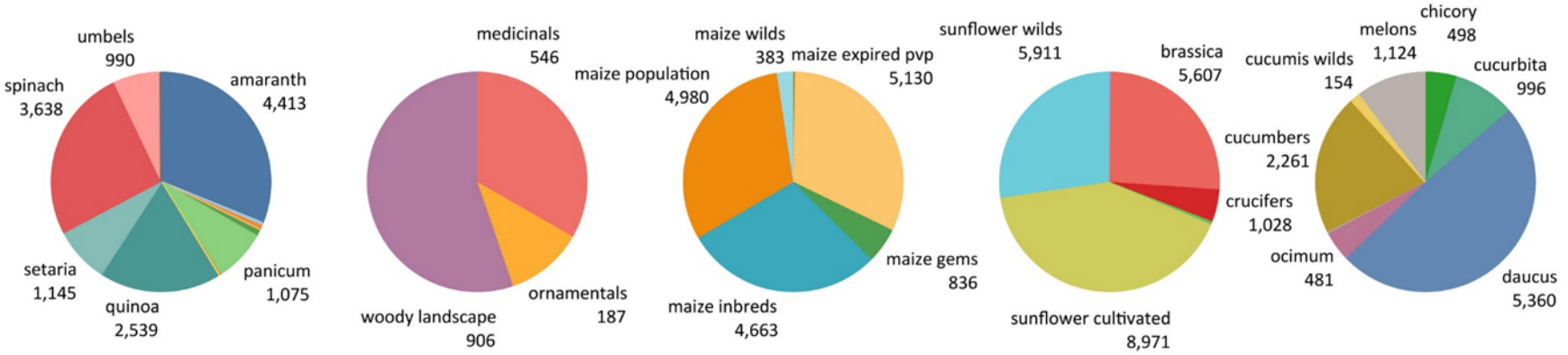
Non-research requests and international orders composed most of the cancelled germplasm items. Cancelled international orders were usually due to a lack of import permit or being unable to satisfy import requirements. One example was a request from China for the entire amaranth collection received for amaranth and other taxa, but we were unable to fulfill the request due to lack of an import permit.

Pie charts display the number of items distributed by curatorial group. Vegetables, ornamentals, and oilseeds were in high demand for a few inventory maintenance groups while maize and the amaranth curator's requests (including amaranth, spinach and quinoa) were more balanced across a variety of management groups.

The bubble chart illustrates the proportions of germplasm distributed to the United States and territories and the number of items being distributed by each curatorial group. International demand this year was high for oilseeds – particularly wild and cultivated sunflowers.


2017 NCRPIS germplasm distributions by final destination
Percentage of total items distributed by NCRPIS
Number Items Shipped (Percent of total)
Amaranth
Horticulture
Maize
Oilseeds
Vegetables
Distributed Items
Cancelled Items
12%
9,336
5%
3,843
2%
1,125
6%
4,431
1%
806
2%
1,578
14%
10,596
3%
2,072
4%
3,013
1%
966
9%
6,856
17%
12,510
3%
2,087
9%
6,878
5%
3,491
3%
2,557
2%
1,391
Final Destination
International
United States & Territories
2017 NCRPIS germplasm distributions by order type
Percentage of total items distributed by NCRPIS
17%
12,385
6%
4,485
1%
1,071
1%
922
2%
1,282
16%
11,832
1%
645
2%
1,714
3%
1,893
24%
18,301
1%
1,019
3%
2,097
13%
9,730
2%
1,467
3%
2,481
Order Type
Backup
Distribution
Non-research, non-educational
Observation/evaluation
Repatriation

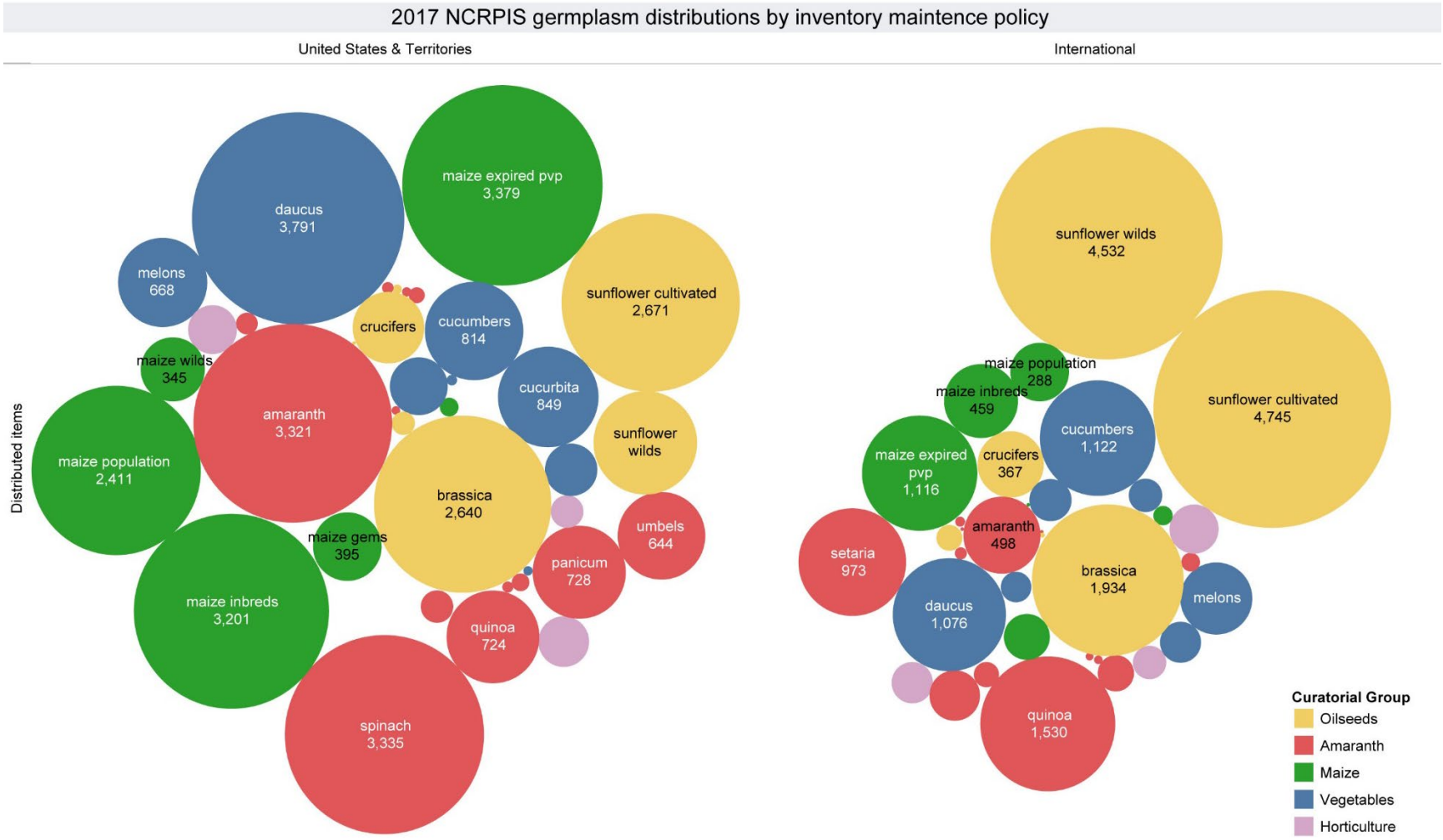
## Crop Distributions by NCRPIS Curatorial Group




**Inventory Group**

| | | | | | | |
|---|---|---|---|---|---|---|
| amaranth | perilla | medicinals | crucifers | ocimum | maize inbreds | woody landscape |
| echinochloa | portulaca | ornamentals | cuphea | parsnips | maize population | |
| legumes | quinoa | corn.kin | euphorbia | cucumbers | maize wilds | |
| grasses | setaria | asters | chicory | cucumis wilds | melons | |
| melilotus | spinach | brassica | cucurbita | maize expired pvp | sunflower cultivated | |
| panicum | umbels | celosia | daucus | maize gems | sunflower wilds | |

Inventory maintanence groups of 150 or more items are labeled.


2017 NCRPIS germplasm distributions by inventory maintence policy
United States & Territories
International
Distributed items
daucus
3,791
maize expired pvp
3,379
melons
668
sunflower cultivated
2,671
crucifers
cucumbers
814
maize wilds
345
cucurbita
849
amaranth
3,321
sunflower
wilds
maize population
2,411
brassica
2,640
umbels
644
maize gems
395
panicum
728
maize inbreds
3,201
quinoa
724
spinach
3,335
sunflower wilds
4,532
maize population
288
maize inbreds
459
sunflower cultivated
4,745
cucumbers
1,122
maize expired
pvp
1,116
crucifers
367
amaranth
498
setaria
973
brassica
1,934
melons
daucus
1,076
quinoa
1,530
Curatorial Group
Oilseeds
Amaranth
Maize
Vegetables
Horticulture

## E. Seed Storage (L. Burke, S. Estrada)

The seed storage area was staffed by one full-time, permanent federal employee (Lisa Burke), a three-quarter time temporary employee and three part-time student employees during 2017. We stored 1825 inventory lots, including 744 original seed lots. Of the increase lots, 774 were produced in Ames and 262 were produced outside of Ames. Across all stored inventory seed lots, we sampled and reviewed seed quantity of 2495 lots, and any discrepancies with GRIN information were corrected in the GRIN database. Six hundred and sixty nine samples were prepared and transferred to the -20C freezer for long-term storage.

We filled 1385 seed orders in 2017, including those for distribution, observation, germination, transfer and backup. NCRPIS distributed 55474 packets to meet distribution and observation requests. There were 797 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. Thirteen inventory lots were transferred to other NPGS genebanks. In 2017, 2043 samples were prepared and sent to the NLGRP in Ft. Collins for inclusion in the annual shipment to the Svalbard Global Trust Vault.

With the aid of our student workers, we prepacked 39,746 packets from 3,370 inventory lots. Prepacking increases efficiency of seed storage operations by speeding up seed order filling and also help keeps the on-hand inventories more accurate. Prepacking also reduces the need to review total seed counts for individual accessions because distribution lots are continually monitored and only reviewed when order activity is high for a given accession.

In 2017, scanning of original samples was postponed until the vacant seed storage technician position can be filled.

Lisa Burke continued to participate in the development of GRIN Global. She served on the GRIN –Global Advisory Committee as chairperson.

Lisa Burke continued as the station's CPR/AED/First Aid instructor. She provided two –year First Aid certification for 20 NCRPIS student workers and two-year CPR/AED/First Aid certification for 16 staff members and 2 student workers. 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.

## F. Germination (L. Pfiffner)

The germination lab was staffed by one full-time federal employee (Lisa Pfiffner) and up to 3 part-time student employees.

In 2017, the germination lab completed germination or Tetrazolium (TZ) testing on 119 orders containing 3,607accessions.

| Type of Order | # Orders | # Accessions |
|---|---|---|
| Regeneration/Other | 82 | 1455 |
| Maintenance | 29 | 2122 |
| TZ | 8 | 30 |

Progress was made in maintenance testing of the following crops, 200 *Amaranth* inventory lots tested, 99 *Cucumis sativus* lots, 439 *Brassica* lots, 245 *Spinacia* lots and 701 *Zea mays* lots. An additional 272 inventory lots were TZ tested after standard germination testing was completed, which aids in differentiating dormant from dead seed. By testing additional ungerminated seeds following the initial germination test, the information verifies whether seed is viable or non-viable, giving a complete look at the state of the inventory lot.

Germination protocols are based from AOSA protocols and from the Handbook of Seed Technology for Genebanks. If a taxon is not found in either of these references, then protocols are researched and devised for that genus/species.

Curators of *Daucus pusillus*, *Euphorbia lagascae* and wild *Chenopodium spp.* requested that improved germination protocols be found for these species. Experiments were conducted and research is ongoing.

Attended ISTA-AOSA-SCST Native Seed Workshop in Denver, CO.

Below is a table showing all crop groups, all available accessions, broken down by age groupings, illustrating how many need a maintenance or a first germination test.

## Seed Lot Ages and Viability Testing Needs

| | | Total avail lots | # Avail lots 1-10 yrs old | # Avail lots 11-20 yrs old | # Avail lot >21 years old | Test schedule yrs | Lots need new germ | Lots that have no germ | Total to germ |
|---|---|---|---|---|---|---|---|---|---|
| **Brenner** | NC7-amaranth | 3237 | 443 | 1045 | 1749 | 10 | 1353 | 5 | 1358 |
| | NC7-celosia | 38 | 12 | 16 | 10 | 10 | 6 | 0 | 6 |
| | NC7-echinochloa | 277 | 30 | 20 | 227 | 10 | 12 | 0 | 12 |
| | NC7-grasses | 86 | 11 | 13 | 62 | 10 | 73 | 1 | 74 |
| | NC7-legumes | 159 | 51 | 11 | 97 | 20 | 1 | 40 | 41 |
| | NC7-melilotus | 891 | 148 | 108 | 635 | 20 | 6 | 2 | 8 |
| | NC7-panicum | 910 | 18 | 39 | 853 | 20 | 242 | 1 | 243 |
| | NC7-perilla | 22 | 20 | 0 | 2 | 3 | 8 | 0 | 8 |
| | NC7-portulaca | 10 | 10 | 0 | 0 | 5 | 1 | 1 | 2 |
| | NC7-quinoa | 290 | 175 | 42 | 73 | 10 | 17 | 8 | 25 |
| | NC7-setaria | 1006 | 102 | 64 | 840 | 20 | 164 | 62 | 226 |
| | NC7-spinach | 379 | 161 | 155 | 63 | 10 | 1 | 0 | 1 |
| | NC7-umbels | 759 | 157 | 448 | 154 | 5 | 135 | 4 | 139 |
| | | 8064 | 1338 | 1961 | 4765 | | 2019 | 124 | 2143 |
| | %of total | | 17% | 24% | 59% | | | | 27% |
| **Carstens** | NC7-medicinals* | 710 | 234 | 376 | 100 | 10 | 480 | 25 | 505 |
| | NC7-ornamentals* | 512 | 256 | 121 | 135 | 10 | 100 | 39 | 139 |
| | NC7-woody.landscape* | 877 | 550 | 241 | 86 | 10 | 76 | 287 | 363 |
| | | 2099 | 1040 | 738 | 321 | | 656 | 351 | 1007 |
| | %of total | | 50% | 35% | 15% | | | | 48% |
| **Marek** | NC7-asters* | 143 | 69 | 28 | 46 | 10 | 26 | 34 | 60 |
| | NC7-brassica | 1670 | 96 | 285 | 1289 | 10 | 521 | 0 | 521 |
| | NC7-crucifers | 1137 | 195 | 367 | 575 | 10 | 564 | 57 | 621 |
| | NC7-cuphea | 498 | 10 | 101 | 387 | 10 | 410 | 71 | 481 |
| | NC7-euphorbia | 96 | 31 | 8 | 57 | 10 | 3 | 22 | 25 |
| | NC7-flax** | 2823 | 21 | 305 | 2497 | 10 | 1154 | 0 | 1154 |
| | NC7-flax.wilds | 116 | 34 | 74 | 8 | 10 | 68 | 18 | 86 |
| | NC7-sun.cults | 1798 | 378 | 406 | 1014 | 10 | 885 | 39 | 924 |
| | NC7-sun.wilds.ann | 1598 | 347 | 585 | 666 | 10 | 846 | 180 | 1026 |
| | NC7-sun.wilds.per | 733 | 312 | 348 | 73 | 10 | 287 | 84 | 371 |
| | | 10612 | 1493 | 2507 | 6612 | | 4764 | 505 | 5269 |
| | %of total | | 14% | 24% | 62% | | | | 50% |
| **Millard** | NC7-corn.kin | 7 | 1 | 3 | 3 | 10 | 1 | 0 | 1 |
| | NC7-maize.wilds | 76 | 33 | 4 | 39 | 10 | 36 | 0 | 36 |
| | NC7-maize.inb | 2164 | 794 | 842 | 528 | 10 | 230 | 4 | 234 |
| | NC7-maize.inb.stndrd | 45 | 8 | 8 | 29 | 10 | 2 | 0 | 2 |
| | NC7-maize.check | 5 | 1 | 3 | 1 | 10 | 4 | 0 | 4 |
| | NC7-maize.pvp.expired | 454 | 371 | 83 | 0 | 10 | 19 | 0 | 19 |
| | NC7-maize.gems | 268 | 199 | 69 | 0 | 10 | 9 | 0 | 9 |
| | NC7-maize.pop | 7246 | 969 | 2074 | 4203 | 10 | 4544 | 5 | 4549 |
| | NC7-maize.pop.GalinA | 17 | 11 | 6 | 0 | 10 | 9 | 0 | 9 |
| | NC7-maize.pop.GoodR | 261 | 20 | 64 | 177 | 10 | 99 | 0 | 99 |
| | NC7-maize.pop.GoodR2 | 35 | 10 | 11 | 14 | 10 | 11 | 0 | 11 |
| | NC7-maize.pop.Gtrop | 3639 | 53 | 8 | 3578 | 10 | 1773 | 0 | 1773 |
| | NC7-maize.pop.GtropA | 496 | 129 | 83 | 284 | 10 | 246 | 0 | 246 |
| | | 14713 | 2599 | 3258 | 8856 | | 6983 | 9 | 6992 |
| | %of total | | 18% | 22% | 60% | | | | 48% |
| **Reitsma** | NC7-chicory | 212 | 21 | 57 | 134 | 7 | 1 | 0 | 1 |
| | NC7-cucumis.cucs | 1333 | 221 | 303 | 809 | 10 | 44 | 2 | 46 |
| | NC7-cucumis.melo | 1970 | 197 | 558 | 1215 | 10 | 154 | 21 | 175 |
| | NC7-cucumis.wilds | 203 | 69 | 63 | 71 | 10 | 21 | 3 | 24 |
| | NC7-cucurbita | 731 | 85 | 150 | 496 | 10 | 192 | 3 | 195 |
| | NC7-daucus | 1181 | 335 | 452 | 394 | 7 | 65 | 11 | 76 |
| | NC7-ocimum | 98 | 89 | 9 | 0 | 5 | 1 | 0 | 1 |
| | NC7-parsnips | 57 | 8 | 29 | 20 | 5 | 0 | 0 | 0 |
| | | 5785 | 1025 | 1621 | 3119 | | 478 | 40 | 518 |
| | %of total | | 18% | 28% | 54% | | | | 9% |

| | | 1-10 yrs old | 11-20 yrs old | >21 yrs old | | New germ | No germ | Total to germ |
|---|---|---|---|---|---|---|---|---|
| Total available lots | 41273 | 7495 | 10085 | 23673 | | 14900 | 1029 | 15929 |
| Percentage of total available lots | | 18% | 25% | 57% | | 36% | 3% | 39% |

*Inventory Maintenance Policy groups that have no standardized germination testing protocols

**2,496 lots received in 1998

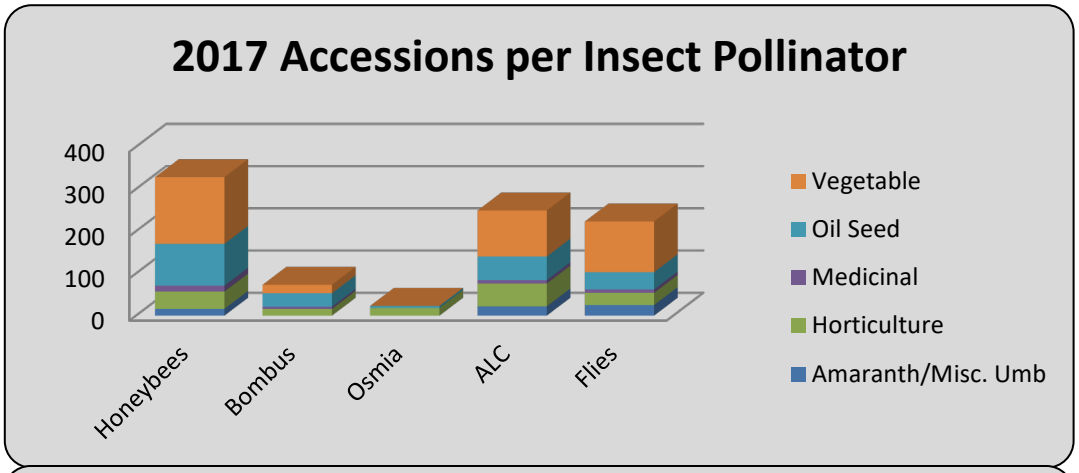
## VII. CURATORIAL AND SCIENTIFIC TEAM REPORTS:

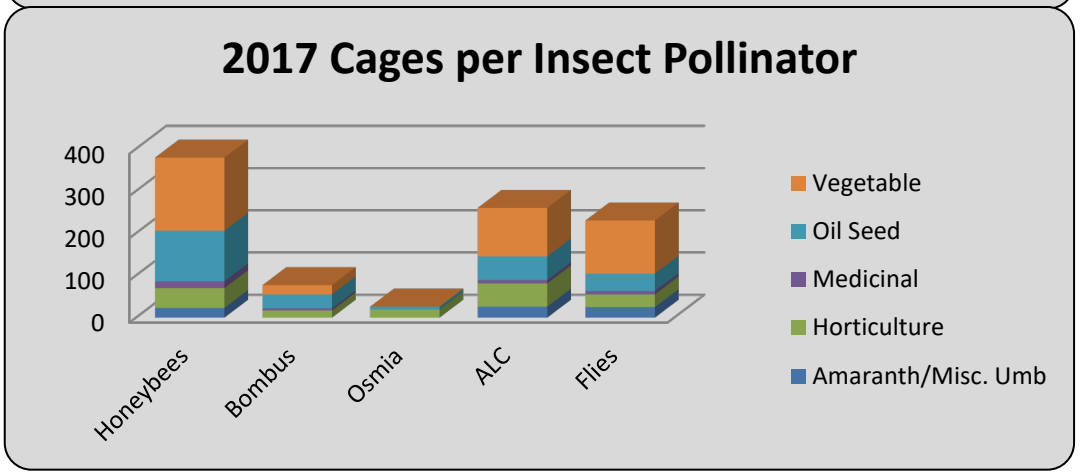
### A. Controlled Insect Pollination Service Program (S. Hanlin)

**Summary of Pollinators supplied to 2017 regeneration cages**

| Number of Unique ACCESSIONS per pollinator | | | | | | |
|---|---|---|---|---|---|---|
| | Honeybee | Bombus | Osmia | ALC | Flies | TOTAL |
| Amaranth/MisUmb | 17 | 0 | 0 | 22 | 25 | 63 |
| Horticulture | 41 | 16 | 18 | 54 | 29 | 158 |
| Medicinal | 14 | 5 | 0 | 8 | 8 | 35 |
| Oilseed | 99 | 32 | 4 | 56 | 41 | 233 |
| Vegetable | 158 | 20 | 0 | 109 | 120 | 407 |
| OVERALL | 329 | 73 | 22 | 249 | 223 | 896 |

| Number of TOTAL CAGE/HIVES per pollinator | | | | | | |
|---|---|---|---|---|---|---|
| | Honeybee | Bombus | Osmia | ALC | Flies | TOTAL |
| Amaranth/MisUmb | 23 | 0 | 0 | 26 | 25 | 74 |
| Horticulture | 47 | 17 | 19 | 55 | 30 | 168 |
| Medicinal | 16 | 5 | 0 | 8 | 8 | 37 |
| Oilseed | 120 | 33 | 6 | 56 | 41 | 257 |
| Vegetable | 173 | 22 | 0 | 115 | 126 | 436 |
| OVERALL | 379 | 77 | 25 | 260 | 230 | 972 |



**Progress:**

Caged pollination:

Bee pollinators (minus the alfalfa leafcutting bee) were supplied a single time to 482 cages for controlled pollination of 424 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 328 accessions in the field and 1 accessions in a single greenhouse.

**2017 Honeybee Pollinator Deliveries to Regeneration Cages**

| Crop Group | Total # of Accessions | # of Genera | # Accessions/Genera |
|---|---|---|---|
| Misc. Umbels | 17 | 7 | 5 Melilotus, 5 *Petroselinum*, 2 *Chaerophyllum,* 2 *Eryngium*, 1 Coronilla, 1 *Pimpinella,* 1 *Trocdaris* |
| Horticulture | 41 | 10 | 18 Cornus, 10 *Spiraea*, 4 *Caragana*, 2 *Alcea*, 2 *Staphylea*, 1 *Althaea*, 1 *Diervilla*, 1 *Euonymus*, 1 *Phlox*, 1 *Viburnum* |
| Medicinal | 14 | 3 | 7 *Echinacea*, 4 *Prunella*, 3 *Monarda* |
| Oilseeds | 99 | 1 | 99 *Helianthus* |
| Vegetable | 158 | 6 | 71 *Daucus*, 47 *Cucumis*, 23 *Cucurbita*, 9 *Pastinaca* , 4 *Cichorium*, 4 *Ocimum* |
| **Total** | **329** | **27** | |

Overwintering success: 80% of the 25 three and four story parent colonies left outside, 77% of the 36 two story parent colonies and 48% of the 89 double-story nucleus colonies stored in the indoor wintering facility survived. These percentages are compared to the 100%, 67% and 66% from 2016. If was observed that with the double nucleus hives most losses occurred by early February with a 65% mortality.

All three and four story hives remained outside during the winter 2016/2017 at two locations and were wrapped with thirty pound roofing paper. We removed all colonies from the room starting on March 7 and unwrapped all outside colonies on March 9. The nucleus hives were removed from the over-wintering room on March 20. In the winter of 2017/2018, we placed in the overwintering room 22 two story parent colonies and 65 double story nucleus hives. We wrapped 32 three story parent colonies at two outdoor locations.

We purchased 30 "BeeWeaver" three-pound packages and 50 "BeeWeaver" queens to supplement over-winter losses and to supply spring nucs used for cage pollinations. The queens arrived by USPS in April and the packages were again picked up by the "bee crew" in Mid-May at the supplier's location in Texas. The packages were placed into full size hives and given four feedings of high fructose corn syrup (HFCS) and two pollen patty treatments. Most of the caged queens were placed into nucleus boxes with two frames of brood and a single frame of honey and adhering bees. We used four

purchased queens to re-queen packages in which the queens had perished in shipping. To increase our colony numbers, twenty nucs were placed at an outlying yard in late May, allowed to increase, and put into full size equipment in early June. However by August, only twelve were still alive. Because of the shortage of nucs throughout the summer of 2017, this was our only attempt to use this method for colony increase during the summer.

In early May we selected queens from eight resilient, over-wintered parent colonies and set them up as "cell builder colonies" for queen production during the summer 2017. Grafting began in early May, knowing that with the first graft we generally have only approximately 50% success, we could use the purchased queens to supply most of the nucs to be made in early May. Our average was 23 queen cells per week for the months of grafting, with nucleus hives produced until the second week of August. Summer 2017 was a challenge in both queen and nuc production; several periods saw reduced production of both. A large percentage of the package hives and several nucs with caged queens became overly aggressive in late summer and had to be relocated to prevent bystanders from getting stung. All nucs not in use in cages for pollination were fed high fructose corn syrup (HFCS), an additional super was placed below and treated for mites to prepare them for over-wintering.

All hives were fed HFCS into mid-November, but most of the colonies and nucs went into winter lighter than 2016 and needed to be fed in February to assist with survival. The mortality rate prior to placing hives into the over-wintering room in December was 8% for the parent colonies and 15% for the nucleus hives.

Mite counts were made using the powdered sugar roll method in late July - early August on 50% of the total colonies and double story nucs. Mite counts were between 1 - 20 mites per 100 bees, higher than the documented economic injury levels (EIL) of 5 per 100 bees. In August and September all colonies and nucleus hives were treated with either Amitraz (Apivar®) or Thymol/essential oils (ApiLife Var®). A sugar roll sample was taken in late October after the treatment period and no mites were observed in the sampled hives. (See ARS Photo by Scott Bauer)

In March through April 2017, all parent colonies and nucleus hives were given six feedings of HFCS with two feedings medicated with Fumagilin – B® for the prevention of dysentery (nosema). All parent colonies were fed two feedings of un-medicated syrup in mid-July to promote brood production and improve nucleus hive production. In October - November, all hives were fed five feedings starting with three medicated and two non-medicated. During the summer neither European Foul Brood (EFB) nor American Foul Brood (AFB) were observed, however in July two treatments of Terra-Pro were given to possible increase bee/brood production.

Wax moth control: During the summer all stored supers with "cleaned" frames were stacked at right angles to each other to prevent adult moth migration in the equipment room. In June - October, the lights in the equipment room were left on during working hours (8 hours; five days). All equipment removed from the field as "dead hives" were stored in the overwintering room at a temperature of 60° F. During

the summer, to prevent the air conditioning unit from overheating and stopping as in the past, all air exchange was turned off in the room.

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 crystallization of the HFCS in the large interior storage tank, the contents were circulated daily during the spring, fall and winter. In March, 852 gallons of HFCS were purchased for the supplement feeding of bees during the summer and 2018 spring. We use three 275 gallon bulk tanks to pick up the syrup. As syrup supply is depleted in the main tank, a bulk tank is transferred and emptied into the main tank, and five gallon buckets are used for refilling feed containers in the field to reduce container damage and syrup waste.

The Iowa Department of Agriculture and Land Stewardship (IDALS) created a new system for registering bee locations called "Fieldwatch". Fieldwatch allows registration of yards by plotting them directly onto Google maps. This system makes yard registration simpler, eliminating the need to calculate the Latitude/Longitude for registration, and is more accurate. The IDALS registry assists pesticide applicators in locating bee-yards and obtaining contact information of appropriate beekeepers prior to spraying.

Bombus pollination:

Forty-four "mini-research" colonies of *Bombus impatiens* were purchased from a commercial supplier and used to pollinate 77 field cages with 73 accessions. In July the supplier switched from a queen-right "mini-research" hive to a "queen-less" hive containing approximately 30 workers only. This new hive seemed to work better for our pollination demands than the "queen right" hive, however, we did have minor issues when switching the hive from cages in that not all individuals would re-enter the hive and had to be hand caught and relocated. A single *Bombus* hive can be used for pollinating more than one cage with a minimum lapse of 24 hours between sites to prevent pollen contamination. In the *Cucurbita* cages in 2017, because of a new cage design, only a single *Bombus* hive was used per cage unlike in the past two years when *Bombus* were combined with a honey bee nucleus hive.

**2017 *Bombus* Pollinator Deliveries to Regeneration Cages**

| Crop Group | Total # of Accessions | # of Genera | # Accessions/Genera |
|---|---|---|---|
| Horticulture | 16 | 5 | 6 *Staphylea*, 5 *Cornus*, 3 *Caragana*, 1 *Maackia*, 1 *Phlox* |
| Medicinal | 5 | 2 | 3 *Monarda*, 2 *Prunella* |
| Oilseeds | 32 | 1 | 32 *Helianthus* |
| Vegetable | 20 | 1 | 20 *Cucurbita* |
| **Total** | **73** | **9** | |

We use 60-quart protective plastic containers to house the cardboard *Bombus* hives while in field cages. Two water-filled quart containers are placed inside as weights to prevent the wind from blowing the container and hive off of the stand. The protective shelter, bottles and hive are placed on a full size honey bee hive body and lid for a stand in order to prevent the tub and hive from getting flooded in fields if standing water occurs.

<u>*Osmia cornifrons*/*O. lignaria* pollination</u>:
*Osmia* were used to pollinate a total of 19 field cages and 6 greenhouse cages with 23 accessions.

**2017 *Osmia* Bee Pollinator Deliveries to Regeneration Cages**

| Crop Group | # of Cages | Total # of Accessions | # of Genera | # Accessions/ Genera |
|---|---|---|---|---|
| Horticulture | 19 | 18 | 3 | 13 *Aronia,* 3 *Cornus,* 2 *Spiraea* |
| Oilseeds | 6 | 4 | 2 | 2 Brassica, 2 *Linum* |
| **Total** | **25** | **22** | **5** | |

In the 2016 growing season, we obtained an increase of ca. 360 *Osmia* pupae (18 domiciles at 20 bees/domicile) for use for pollination and increase during the 2017 pollination season. We purchased an additional 600 commercial cells in the spring of 2017. As in 2016, the pupa were shipped as loose cells. Prior to domicile placement in the field, 20 pupa (10 males and 10 females) were placed into specimen cup and were transferred into the domicile prior to hanging in the cage. For the greenhouse cages, 10 total pupa (5 male and 5 female) were placed into each cage.

The pupae were used to fill 43 two-inch domiciles and 24 three-inch domiciles. The two inch domiciles were divided in the following manner, 25 were used in pollination cages and 18 were used at three locations at a single "increase" site. The three inch domiciles were all placed at four locations at a single "increase" site.

In the fall of 2017, we collected ca. 408 pupae (20.5 domiciles at 20 bees) for use in the spring of 2018. Additional pupae will be ordered in the spring of 2018 to assure enough pollinators for the spring cages and for placing at "increase" sites.

Through the use of a GPS unit, we plotted and documented the 42 "increase domiciles" at the single location for retrieval later in the summer.

<u>Alfalfa leafcutting bee (ALC) *Megachile rotundata*</u>:
ALC bees were purchased as larvae in leaf cells from a single supplier for use in 2017, arriving in Ames, IA on February 24. 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 November 2016 through late October 2017. The 2017 greenhouse pollinations started in early November 2016, with bees collected

from the 2016 supply. In April - May, the 2016 pupae were supplemented with new 2017 pupae, after which 2017 pupae were used for the rest of the year. Because of increased cost, in 2017 we purchased 15 gallons of pupae rather than the 18 gallons ordered in the past. This had no effect during the pollination season, however, no pupae will be available in early 2018 for pollinations until our new supply is received.

**2017 Alfalfa Leafcutter Pollinator Deliveries to Regeneration Cages**

| Crop Group | # of Deliveries | # of Cages | # of Locations | # of Accessions | # of Genera | Time Period |
|---|---|---|---|---|---|---|
| Misc.Umbels | 204 | 26 | 2 | 22 | 9 | Nov (16) – Sept |
| Horticulture | 247 | 55 | 7 | 54 | 11 | March – Sept |
| Medicinal | 58 | 8 | 1 | 8 | 2 | May – July |
| Oilseeds | 380 | 56 | 4 | 56 | 8 | Jan – Oct |
| Vegetables | 1203 | 115 | 8 | 109 | 5 | Nov (16) – Oct |
| **Total** | **2092** | **260** | **22** | **249** | **35** | **Nov (16) – Oct** |

In 2017, 2092 total ALC deliveries were made to a total of eighteen fields and four greenhouses with 260 cages containing 249 accessions. No greenhouse cages were still receiving pollination at the transition from 2017 into 2018.

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 field during the summertime months. At the NCRPIS however, ALC are used outside of the normal time frame. From November 2016 - August 2017, greenhouse cages were supplied weekly with bees in the spring and summer and twice weekly during the winter. The 2017 field requests for ALC bees started in early May, with rapid increase in the number of weekly active cage through mid-August, and then declined with the final field cages supplied through mid-October.

In 2017 we received Canadian sourced cells, which have reduced numbers of parasites and parasitoids than found in U.S. cells. Because the Thermo-Scientific® environmental growth chamber (EGC) was being used by several projects from February - mid-July, emerging bees were relocated to a Precision® incubator. By late July-October, all bee emergence was relocated back to the EGC. During relocations, there was no observable decline in adult bee emergence (available for pollination), but storage space available for screen trays of pupa was reduced for most of the season.

From September to mid - October, ALC were placed into cages of *Helianthus sp*, *Alcea* sp, *Spirea* sp and several field vegetable cages. Under normal conditions ALC are not the major pollinator of some of these accessions nor used this late in the season in field cages. Because there were no fall greenhouse requests and a limited daily supply of adult bees, we chose to place them into field cages rather than discard them.

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 December 2016 through October 2017 for greenhouse and field pollinations. From early June - August, twenty-six orders of 10,000 house fly pupae were purchased. From November 2016 through September 2017, 244 cups of blue bottle fly pupae were purchased. In mid-December, additional blue bottle pupae were purchased for late season greenhouse pollinations that will continue into 2018. In 2017, 2154 fly deliveries were made to fifteen fields and three greenhouses for 230 cages containing 223 accessions representing 30 genera.

**2017 Fly Pollinator Deliveries to Regeneration Cages**

| Crop Group | # of Deliveries | # of Cages | # of Locations | # of Accessions | # of Genera | Time Period |
|---|---|---|---|---|---|---|
| Misc.Umbels | 207 | 25 | 2 | 25 | 9 | Dec (16) – Sept |
| Horticulture | 96 | 30 | 6 | 29 | 8 | March – July |
| Medicinal | 17 | 8 | 1 | 8 | 2 | June – July |
| Oilseed | 371 | 41 | 3 | 41 | 7 | Jan – Oct |
| Vegetables | 1463 | 126 | 6 | 120 | 4 | Feb – Oct |
| **Total** | **2154** | **230** | **18** | **223** | **30** | **Dec (16) – Oct** |

An average of 11 greenhouse cages and an average of 27 field cages received flies weekly from December 2016 -early October 2017. One greenhouse cage of *Coriandrum sp.* began getting blue bottle fly pupae in early December 2016 and transitioned into the 2017 season. Four cages of *Thlaspi sp.* were started in mid-December and will be transitioned into the 2018 season.

Because blue bottle flies work better at cooler temperatures and a greater number of cage requests were in a cooler greenhouse, only blue bottle flies were distributed weekly during the winter, spring and fall. During the summer, both blue bottle flies and houseflies were distributed weekly to greenhouse and field cages for pollination. Adult flies are re-supplied weekly to cages to ensure continued pollinator presence. Most cages that have fly pollinators introduced also have bee pollinators present to assure flower pollination, promoted by insect competition. During the summer, if there were excess fly pupae available, flies were introduced to some accessions which lack favorable flowers for fly pollinators. This decision was made by both the curators and the entomology staff in order to prevent the discarding of unused fly pupae.

**Tests:**

Winter feeding of over-wintered bees:

In the past two winters we have tried feeding the hives (stored inside) a commercial "winter patty" with limited success based on consumption of the patties over a specific time period. A method used by several local beekeepers for spring feeding is to place either sugar syrup or HFCS into a gallon plastic bag. The method consists of filling a

plastic bag with syrup, placing it over the cluster of bees and making a small slit in the top of the bag which allows bees access to the liquid feed. We chose to use quart feed containers we already had rather than purchase plastic bags, but reduced the amount of syrup fed so as to possible reduce syrup spillage. In February, all nucleus hives were checked for survival and all live hives were given a half a quart of HFCS weekly. We continued to feed the hives from February through early March using this method. Some excess syrup spills on the floor had to be cleaned up after the hives were removed from the over-wintering room. We observed that up to February we had a 65% hive loss, but after feeding hive loss was reduced to around 32%. We are not sure if these hives would have survived the remaining winter if not fed, but did observe that the majority of the syrup was used by the bees while in the over- wintering room and gave them sufficient food.

Creating and using a hand held device for GRIN-Global (GG) requests:
In 2016, with the assistance of K. Reitsma and P. Cyr a list of "pollination inventory actions" and "methods" were created in GG for making pollination requests. At that time, the hand held device was not available for assisting in making the requests and all work was accomplished via field notes at personal work stations. In January 2017, S. Hanlin, K. Reitsma and P. Cyr, began testing a "pollination tool" on a tablet device with a barcode scanner for making and capturing all requests. By April, the system was accessible to all curatorial personnel for making pollination requests during the growing season. Early in the summer, it was observed that the "original bar-codes" on the cage tags were not easily read in the field; a new type of bar-code was implemented and used for the remaining season. Most curatorial projects needed initial help in system use, but after a short tutorial period they were able to use the system with few mistakes or difficulties. In the fall there was still some minor manipulating of data in GG, but it took approximately a quarter of the time as spent in 2016 collecting and fixing requests. At the end of the 2017 season, improvements were made to both the "actions list" with the total of fourteen "original actions" reduced to four, and the "original three fly methods" (blue bottle, house and mixed) reduced to a single "fly" method. We will continue to use the tablets with the "pollination tool" in the 2018 season to make and fill all pollination requests.

**Safety:**
Chemical Inventory:
On February 9, S. Hanlin updated the Entomology chemical inventory and sent it to the "Safety Committee" for filling at ISU and the USDA.

Defensive Driving:
Because of the amount of time that the bee crew is off site and the amount of cumulative miles during the summer, annual driving training is needed to refresh good driving habits. Two courses were taken on AgLean to fill this requirement. S. Hanlin completed "Defensive Driving" and "Collision Avoidance".

Epi-pens:
Epi-pens are available for use at four NCRPIS locations in order to prevent anaphylactic shock if allergic reactions caused by bee stings or other allergens occur.

In late March, K. Grooms (nurse at ISU Occupational Medicine) was contacted for discussion and approval of the Epi-pen website and safety training materials on the signs of anaphylactic shock and the correct use of Epi-pens. On April 4, S. Hanlin sent the link to the Epi-pen website and training completion document to all permanent station staff to be completed at the end of April. Following completion of staff documentation of training and filing at ISU Occ. Med, we were able to exchange expired Epi-pens for new pens, with K. Grooms' assistance.

**Presentations and Outreach:**
On November 4, 2016, S. Hanlin went to Gilmore City Grade School in Gilmore City, IA and gave four half hour presentations to groups of students ranging from kindergarten to sixth grade. Students were told about the various pollinators used at the station and shown pinned and live specimens and given facts about each insect. The students had the opportunity to try on and use bee equipment that is used in keeping honey bees. Each session ended with a Q&A.

On February 2, I facilitated interaction between a local beekeeper and Kemin Industries to arrange the pollination of Chinese lantern plants (*Physalis alkekengi*). Kemin needed several colonies of bees for pollination and the beekeeper was willing to provide the pollinators, but needed guidance on the number of honey bees hives needed in the field to accomplish the pollination and their placement.

On April 5 and on April 20, S. Hanlin visited with Shungi Li a Post-Doc with Dr. Toth's lab about the purchasing and use of *Bombus* as a pollinator. Li was doing several lab studies, introducing several honey bee diseases to *Bombus* to observe if, in nature, bumble bee populations could be at risk through contact with honey bees. Li was also assisted by M. Bushman with the order form used by the supplier.

On May 11, K. Webber and S. Hanlin talked to approximately 160 sixth grade students about honey bees in eight half hour presentations at the Squirrel Hollow Outdoor Classroom in Jefferson, IA. The students were told about the makeup of the hive, how bees produce honey and wax, the equipment used in beekeeping and the possible benefits and harms of honey bees.

On September 9, S. Hanlin with the assistance of C. Hopkins gave a tour of the NCRPIS to approximately 32 members of the Central Iowa Beekeepers Association (CIBA). The tour group was driven to seven locations of different curatorial projects on station, and at each location a different pollinator or pollinator action was discussed. At the end of the tour we met in the building for a Q&A session.

**Plans for 2018:**
<u>Feeding sugar in the winter</u>:
In the winter of 2017, we observed that feeding of over-wintered nucleus hives improved hive survival, and that excess HFCS caused a potential safety hazard and had to be cleaned up in the spring. As a possible solution for introducing additional feed to the bees, but reducing the excess syrup we will try feeding granulated sugar. The documented method for feeding table sugar is to place one cup of sugar on a sheet of newspaper which is spread between the boxes of bees. Another method which could be implemented is to spray both sugar and paper with water in order to produce a

small amount of excess syrup which the bees can more easily take in as a food source and attracts them to the feed source. We will introduce dry sugar first and if it appears after a week that the bees are not feeding on this, we will moisten the paper and again observe. We hope that this method will supply feed and reduce the cleanup.

Branding equipment:
In October 2016, twelve colonies of honey bees were stolen from the station property. During the interviews by law enforcement personnel we were asked if any of the equipment had any unique identifiable markings, which they didn't. A solution was proposed to use a USDA stamp on all equipment placed in the field. In the spring of 2017 a custom wood branding iron was purchased with the USDA logo and the station phone number. In the winter of 2018 we will begin branding all supers, frames, lids and bottom boards or to identify equipment if found by the general public. Any new bee equipment built in 2018 will be branded prior to painting. A PPE (personal protective equipment) and JSA (job safety analysis) will need to be written, approved and filed prior to use of the branding equipment.

2nd year testing tablets with new GG pollinator actions and methods:
The improvements to the pollinator actions/request software tool were discussed above. The software and tablets will be tested again during the 2018 growing season and the system reevaluated in the fall/winter.

## B. Plant Pathology (N. Pal)

**The Plant Pathologist Category 1 Scientist position remains vacant.**

**Research:**
Real-time PCR assay for diagnosis of Stewart's wilt in corn:
Stewart's wilt of corn caused by the bacterium *Pantoea stewartii* subsp. *stewartii*, is a seed borne and seed transmitted disease of phytosanitary importance. Many countries have imposed quarantine restrictions on importation of corn seed from areas where the disease is known to occur in order to prevent introduction of the pathogen. Field inspection of seed parent plants and/or an ELISA laboratory seed test are largely used for seed certifications. Verifying freedom from *P. stewartii* subsp. *stewartii* in corn seed by the current laboratory tests including ELISA, is still a significant hurdle as the current lab methods (ELISA and PCR) cannot readily differentiate *P. stewartii* subsp. *stewartii* from the closely-related *P. stewartii* subsp. *indologenes*, which is neither pathogenic (on corn) nor a regulated pest in any country, but occasionally present on corn seeds of tropical or sub-tropical origin as part of the resident bacterial population and can yield false-positive test results. A real-time PCR targeting *cpsAB* intergenic sequence was developed to specifically detect *P. stewartii* subsp. *stewartii* in seed wash from corn without requiring pathogen isolation or DNA extraction. The assay was validated on *P. stewartii* subsp. *stewartii* naturally-infected and *P. stewartii* subsp. *indologenes* naturally-infested corn seed lots. Presence of subsp. *stewartii* or subsp. *indologenes* was further confirmed by a conventional PCR which differentiates between the two subspecies by the size of PCR products. By distinguishing between

the two subspecies, the assays developed support accurate identification and prevent unnecessary restrictions on international movement of corn seed.

A manuscript has been prepared for submission to Plant Disease journal.

Bacterial Fruit Blotch (BFB) disease in *Cucumis melo*:
Seeds of four *Cucumis melo* accessions known to be contaminated with the BFB pathogen, *Acidovorax citrulli* were prescreened by single seed wash real-time PCR and seedling grow-out assay. Healthy seedlings were transplanted in the field in summer of year 2017 and routinely inspected for any BFB symptoms throughout the growing season. No BFB disease symptoms were observed on any of the four *C. melo* accessions indicating that the prescreening approach was successful in identifying and removing the contaminated seeds so that only healthy seeds were used for seed increase. The project is underway and the goal is to test various seed treatments for their efficacy in eradicating the bacterial pathogen from the contaminated seed lots of *C. melo* accessions so that they can be grown for seed increase to obtain clean seed for distribution to the requestors.

Screening for resistance to anthracnose in American Sycamore:
Anthracnose disease on American sycamore (*Platanus occidentalis*) is caused by the fungus, *Apiognomonia veneta*. The fungus was isolated from the symptomatic leaves and twigs of affected American sycamore trees located in Iowa. After surface disinfection, symptomatic leaves were placed in humid chamber for sporulation. Conidia oozing from the fruiting structures called acervuli (Fig. 1A, B) present on the diseased leaves were transferred on to agar medium and incubated at 28 °C to obtain the pure culture (Fig. 1C). Mycelial and conidial suspensions prepared from the pure culture would be used for inoculating the seedlings grown from the open-pollinated seed of *P. occidentalis* and *P. occidentalis* var. *glabrata* mother trees, collected from Iowa and Texas respectively. Disease incidence and severity would be recorded. The objective of the screening experiment is to identify seed sources or progenies within a seed source more resistant to anthracnose.

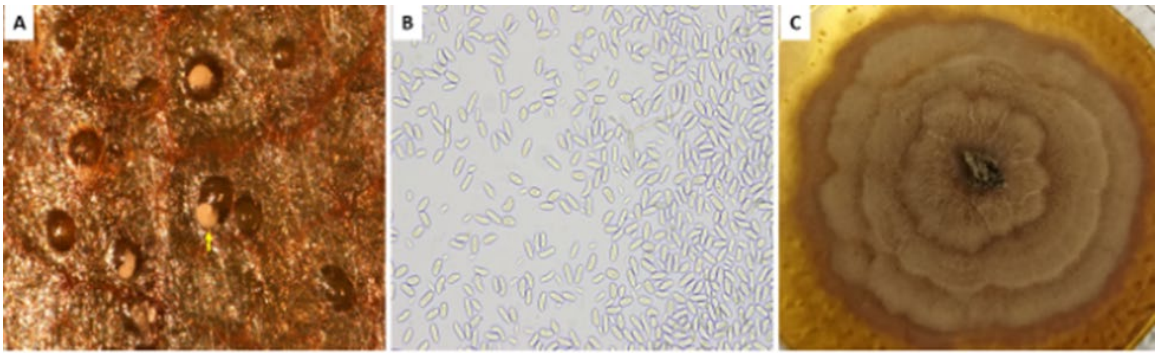



**Figure 1.** A) Fruiting structures called acervuli oozing spore mass (conidia) of the fungus, *Apiognomonia veneta*. B) Spores (conidia) of *A. veneta* as seen under the compound microscope. C) Colony of *A. veneta* on agar medium.

**Disease Observations on Seed Increase Crops:**
The plant pathology team provides support for curators and technicians on plant health questions and disease diagnosis. Plant health monitoring continued with field

inspections of seed parent plants for maize (curation and GEM), sunflowers, and cucurbits.

Maize:
During July and August, we made field inspections of 162 maize seed increase plots recording both presence and relative disease severity. Plots were inspected for 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, 1340 GEM plots were inspected for the same group of diseases. The incidence and severity of fungal leaf diseases found in 2017 was similar to what we saw during the year 2016. The dominant diseases in terms of incidence of infected plants were gray leaf spot (*Cercospora zeae-maydis*), common rust (*Puccinia sorghi*) and northern corn leaf blight (*Exserohilum turcicum*). Northern corn leaf spot (*Cochliobolus carbonum*) (Fig. 2E), physoderma brown spot (*Physoderma maydis*), eyespot (*Kabatiella zeae*), anthracnose leaf blight (*Colletotrichum graminicola*) and southern rust (*Puccinia polysora*) were observed on few accessions. Common smut (*Ustilago maydis*) was present in almost every plot. In terms of common diseases of phytosanitary concern, none were found – no Stewart's wilt, Goss's wilt, head smut, crazy top or other downy mildew diseases were observed.

Oilseeds:
Field inspections were carried out during the months of June, July and August for sunflower, flax and Brassica accessions. A total of 447 sunflower plots were inspected multiple times during the growing season for the presence of diseases caused by fungi, bacteria, viruses and phytoplasmas. No downy mildew (the main phytosanitary issue) was found. No other unusual disease problems were observed except that Alternaria leaf blight and stem spot (*Alternaria helianthi*) (Fig. 2C) and Phoma black stem (*Phoma macdonaldii*) (Fig. 2B) were observed on few accessions. Rust (*Puccinia helianthi*) (Fig. 2D) and powdery mildew were heavily present in all the plots late in the season (August).

Among the 14 flax (*Linum usitatissimum*) accessions, Cercospora leaf spot was observed on one while powdery mildew was present on five accessions later in the season.

Black rot (*Xanthomonas campestris pv. campestris*) was the main disease of phytosanitary importance, observed on 4 of the 12 *Brassica napus* accessions (Fig. 2A).

Cucurbits:
Routine disease testing for squash mosaic virus was conducted on all cucurbit seedlings prior to transplanting; annual testing has been done since 1993. Eighty three accessions and 2955 plants were sampled and tested by ELISA. Test results are summarized in Table 1. Five *Cucurbita pepo* accessions were found to have SqMV-infected plants. All but 6 plants of accession PI512851 00ncab01 were SqMV positive and the accession was not regenerated because of insufficient number of virus free seedlings. Field plantings were scouted every 2-3 weeks to monitor disease

development. The seedling screening combined with cage screening was successful in keeping SqMV out of the seed increase planting.

**Table 1: Squash mosaic virus testing results for 2017**

| Species | # of Accs tested | # of Accs with infected plants | # of Plants tested | # of pots with SqMV infected plants |
|---|---|---|---|---|
| *Cucumis spp. (melo, sativus)* | 54 | 0 | 2096 | 0 |
| *Cucurbita pepo* | 28 | 5 | 824 | 14 |
| *Cucurbita maxima* | 1 | 0 | 35 | 0 |
| **Total** | **83** | **5** | **2955** | **14** |

Multiple disease inspections of the cucurbit cages were conducted from late June through early September. A total of 206 cages that included 60 *Cucumis* spp., 23 *Cucurbita pepo*, 1 *Cucurbita maxima*, 12 *Pastinaca sativa*, 5 *Cichorium intybus*, 4 *Ocimum basilicum* and 101 *Daucus carota* were inspected. Phoma canker was observed on all the *P. sativa* accessions (Fig. 2G, H and I). Aster yellows was present in several *D. carota* accessions. Infected plants were removed immediately from all the cages to prevent acquisition of aster yellows phytoplasma from the infected plants and their transmission to healthy plants by the leafhoppers. Umbel blight (*Xanthomonas campestris pv. carotae*) was observed on one *Daucus* accession. Powdery mildew (*Erysiphe heraclei*) was observed on several umbels later in the growing season (Fig. 2J). For cucurbits, Cercospora leaf spot (*Cercospora citrullina*) was present on some accessions (Fig. 2K). Powdery mildew (*Podosphaera xanthii*) was a problem late in the season and was very severe on few accessions. Regular fungicide applications were made. Sclerotia of *Sclerotinia sclerotiorum* were found in harvested fruits of 5 *C. sativus* and 2 *C. pepo* accessions. However seeds of only one accession each of *C. sativus* and *C. pepo* were found to be contaminated.

*Amaranthus, Chenopodium, Melilotus, Panicum, Setaria, Eryngium* and Miscellaneous Apiaceae and Poaceae:
Disease inspections were conducted in the field and greenhouse. Other than powdery mildew on all *Melilotus* and minor leaf spots (*Phomopsis amaranthicola*) on *Amaranthus* accessions, no other unusual disease problems were observed in the field. Cercospora leaf spot (*Cercospora canescens*) was observed in the greenhouse on one *Amaranthus tricolor* accession (Fig. 2F) for the first time.

A total of 5223 field and 73 greenhouse observations were uploaded to GRIN database.

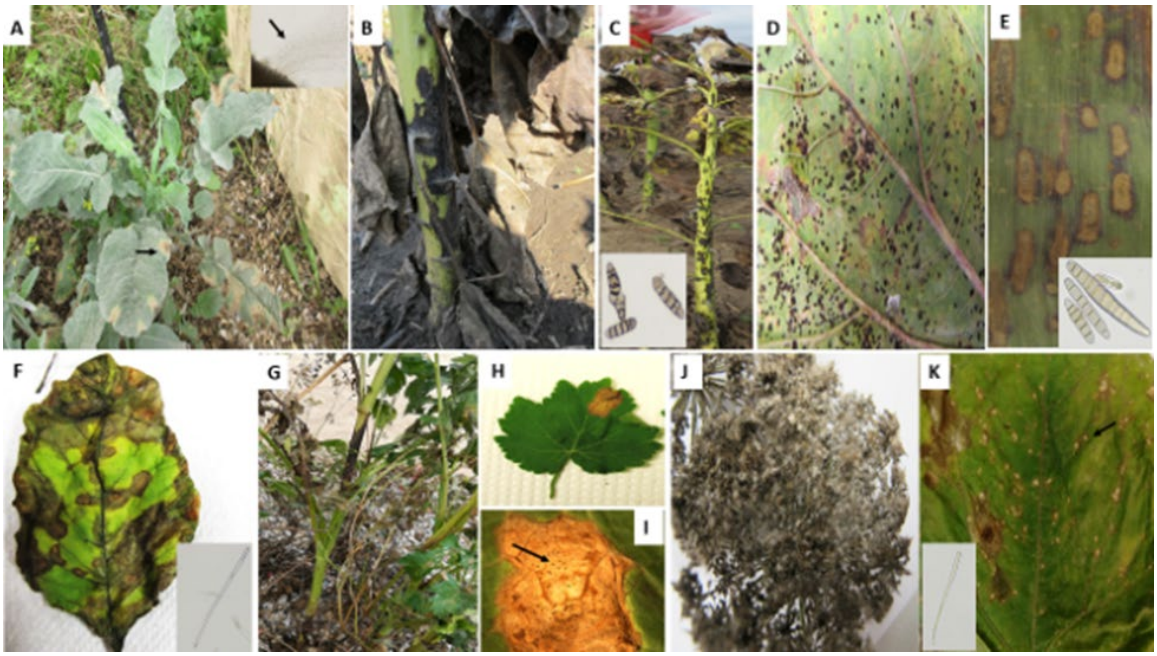



**Figure 2.** Images of symptoms and signs from field inspections. A) Black rot on Brassica (inset shows bacterial streaming under compound microscope). B) Phoma black stem lesions around dead and senescing petioles on sunflower. C) Alternaria stem lesions on sunflower (inset shows *Alternaria helianthi* conidia). D) Rust pustules on underside of sunflower leaf. E) Northern corn leaf spot (inset shows *Cochliobolus carbonum* conidia). F) Cercospora leaf spot on Amaranth (inset shows *Cercospora canescens* conidium). G) Phoma canker of parsnip. H) Leaf lesions of Phoma canker of parsnip. I) Dark pepperlike fungal fruiting bodies (pycnidia) present in the leaf lesions of Phoma canker of parsnip. J) Powdery mildew on carrot umbel. K) Cercospora leaf spot on cucurbit leaf (inset shows *Cercospora citrullina* conidium).

**Seed Health Testing/Seed Treatment:**

We carry out a seed health testing and seed treatment program to support international seed shipments – 2316 laboratory tests were run, 1840 for maize (primarily for Stewart's wilt), 188 for sunflower, 278 for Brassica and 10 for cucurbits. Results were added to the GRIN database. Phytosanitary documentation, i.e. freedom from specific pathogens, was provided to support seed shipments for 122 international seed orders.

1627 maize accessions were tested for Stewart's wilt, Goss's wilt, maize chlorotic mottle virus, wheat streak mosaic virus, various fungal (*Cercospora sorghi*, *Mycosphaerella zeae-maydis*, *Sclerophthora macrospora*, *Peronosclerospora maydis*, *Peronosclerospora philippinensis*, *Peronosclerospora sacchari*, *Sclerophthora rayssiae* var. *zeae*) pathogens or plant parasitic nematodes (*Ditylenchus dipsaci*). 99 Brassica accessions were tested for fungal (*Leptosphaeria maculans*, *Colletotrichum higginsianum*), or bacterial (*Pseudomonas viridiflava*, *Pseudomonas syringae* pv. *maculicola*, *Xanthomonas campestris* pv. *campestris*) pathogens and nematodes (*Ditylenchus dipsaci*). Sunflower accessions were tested for plant parasitic nematodes (*Ditylenchus dipsaci*, *Meloidogyne*, *Paratrichodorus*, *Pratylenchus* and *Longidorus* spp.), various bacterial (*Clavibacter michiganensis* subsp. *michiganensis* and *Burkholderia caryophylli*) and fungal (*Leptosphaeria lindquistii*, *Verticillium albo-atrum*, *Diaporthe helianthi*, and *Plasmopara halstedii*) pathogens. Eight *C. sativus* and

two *C. pepo* accessions were tested for *Sclerotinia sclerotiorum*. Seeds of two accessions were found contaminated (Fig. 3).

**Figure 3.** Sclerotia of *Sclerotinia sclerotiorum* present on the seeds of *Cucumis sativus* accession GY14M42 plated on potato dextrose agar medium as seen with naked eye (left) and under the dissecting microscope (right). Inset shows larger view of sclerotia.

A total of 6864 laboratory seed health testing records were uploaded to the GRIN database.

Dry heat seed treatments were done for 64 *Daucus* (50°C for 72 h in an incubator followed by slow rehydration at room temperature for 72 h) and 15 *Amaranth* (83°C for 10 min. in an incubator followed by slow rehydration at room temperature for 72 h) accessions to support international seed orders.

**Meetings (Poster presentation):**
Pal, N. and Block, C.C. 2017. A real-time PCR assay for the differentiation of *Pantoea stewartii* subsp. *stewartii* from *P. stewartii* subsp. *indologenes* in corn seed. American Phytopathological Society Annual Meeting August 5-9, 2017, San Antonio, Texas.

**Publications:**
Korus, K., Lang, J.M., Adesemoye, A.O., Block, C.C., Pal, N., Leach, J.E., and Jackson-Ziems, T.A. 2017. First Report of *Xanthomonas vasicola* causing Bacterial Leaf Streak on Corn in the United States. Plant Disease. 101(6):1030.

**Manuscripts Drafted:**
Pal, N., Gardner, C., and Block, C.C. 2018. A real-time PCR differentiating *Pantoea stewartii* subsp. *stewartii* from *P. stewartii* subsp. *indologenes* in corn seed (Submitted to Plant Disease).

Pal, N. and Block, C.C. 2018. Stewart's wilt of corn – a review of testing methods (For submission to Plant Health Progress).

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

**Acquisition:**
We acquired 35 accessions, including 4 *Amaranthus*, 8 *Chenopodium*, 4 *Dalea*, 4 *Echinochloa*, 1 *Gomphrena*, 1 *Polytaenia*, and 12 *Setaria*.

Our first cytoplasmic male sterile amaranth accession (PI 686465, DB 199313) was developed at the NCRPIS and donated without intellectual property restrictions by David Brenner and Iowa State University. This accession, an $F_1$ hybrid from a cross of PI 568125 and PI 568179, is 100% male sterile. We discovered in 2017 that crossing this cytoplasmic male sterile with PI 538323 restores male fertility. In other crops similar male sterility systems are useful for making $F_1$ hybrid cultivars, and someday could be useful for amaranth also.

PI 686465 cytoplasmic male sterile amaranth

A plant exploration by David Brenner and Gary Pederson in the Tampa, Florida area was funded by a USDA Plant Exploration grant, and resulted in 12 new accessions (Ames 34071 to Ames 34084). They are comprised of: two accessions of *Setaria corrugata*, and one of *Gomphrena serrata,* the first of those species in the NPGS, nine other accessions add diversity in species that are already represented, *Amaranthus blitum*, *A. dubius*, *A. hybridus*, *Chenopodium berlandieri*, *Echinochloa crus-gali*, *E. walteri*, *Portulaca oleracea*, *Setaria magna*, and *S. pumila*.

Seven accessions of wild *Chenopodium* species (Ames 34016 to Ames 34022) were donated by the research group at the University of New Hampshire, Erin Neff, a graduate student, and Dr. Thomas Davis, Project Leader. These accessions have carefully vetted taxonomic determinations verified by morphology, flow cytometry, and Rapid PCR.

Douglas Johnson, retired from the USDA, ARS in Logan, Utah, donated two accessions of *Dalea ornata* and two accessions of D. *searlsiae*. They are described as "natural-track selected pre-variety germplasms" (Ames 33912 to Ames 33915).

A pair of herbicide resistant and susceptible *Echinochloa colona* accessions (Ames 33910 and Ames 33911) were donated by Bradley Hansen, of UC Davis. He collected the seeds in the wild and screened them repeatedly for herbicide response during generations of single-seed self-pollinated decent.

One accession of *Polytaenia nuttallii* (Ames 33972) was donated by William Johnson of the Iowa Department of Natural Resources. This is a native Iowa prairie species with beautiful yellow flowers, suited for landscaping. Jeff Carstens arranged for the donation.

Dr. Jack Dekker donated 8 *Setaria parviflora* accessions with histories of use in published research that were accessioned in 2018 (Ames 333994 to Ames 34001).

A cultivar of *Setaria italica* from China 'Canggu 5' (PI 676976) was registered in The Journal of Plant Registrations (Tian et al. 2016) and was deposited in the NPGS at NLGRP. It has competitive yield, earlier maturity, and better grain quality, than other cultivars trialed in the Northern China foxtail millet production region. In September 2021 the NPGS will be allowed to distribute germplasm from the deposited voucher sample.

A change in the delineation in *Daucus* resulted in six accessions transferring from *Pseudorlaya* in the umbels maintenance policy to *Daucus* in the carrot maintenance policy under K. Reitsma curation. Eight of these accessions were either growing or harvested before the transfer was completed.

**Maintenance:**
Seventy-nine seed lots regenerated from 2010 to 2017 of our priority crops were stored in 2017, mostly *Chenopodium* and *Amaranthus*. See Table 2 for specifics. Our priority crops are very diverse, they include 448 taxa, in 96 genera, in 6 plant families.

An experimental cover crop of oats was planted by Brian Buzzell in our field, between the pollination cages and also in the millet observations field alleys. The oats were mowed during the growing season. The planting was very successful for improving the footing and reducing erosion.

*Melilotus*:
Four mutant *Melilotus albus* accessions were regenerated in 2017: PI 557517 (short petiole dwarf), PI 557526 (multifoliate leaf), PI 557527 (curled leaf), and PI 557528 (cotyledonary branching). We also regenerated a *Melilotus infestus* (PI 304843). All of these are annuals, and therefore did not need vernalization.

Curled leaf PI 557257


Cotyledonary branching PI 557528

Miscellaneous Apiaceae:
We had good 2017 field-cage grown seed increases of parsley, *Eryngium*, and *Zizia*. In 2016, the field-grown parsley failed due to a mysterious seed set problem that did not reoccur in 2017.

*Spinacia*:
Two wild spinach accessions were regenerated in our Ames greenhouses, and two more were planted for harvesting in 2018. One cultivated spinach accession was increased in a field-cage with an 80 plant population, and successfully set seed. In 2018 we will have a similar scale spinach effort with two greenhouse increase of wild spinach accessions, and a field increase of a cultivated spinach.

**Characterization/evaluation/taxonomy:**
*Amaranthus*:
A male sterile accession of *Amaranthus cruentus*, PI 576471, was found in the collection. We have many observations of male sterility in *Amaranthus hyupochondriacus*, and rarely in *Amaranthus caudatus*, but none previously of *Amaranthus cruentus*. The 1991 seed lot of PI 576471 was observed to have a high frequency of crop-weed hybrids in a 2016 planting to evaluate accession purity. The reason for the hybrids is high outcrossing because the accession is male sterile. The 2017 planting failed because all 26 plants, grown from the original seeds, were male sterile, and therefore could not pollinate. Conserving the male sterility genetics of PI 576471 may require crossing with another accession that is male fertile.

Millets:
There is increased research interest in *Setaria* genetics resulting in more new research articles than can be cited here, a new book (Doust and Xianmin 2017), and a specialized *Setaria* genetics conference at the Danforth Plant Science Center, St. Louis, MO in 2017 (Zhu et al. 2017). The loci of many traits are now mapped.

Researchers found that an accession of *Setaria viridis* (PI 687376, ME034V) has high *Agrobacterium tumefaciens* transformation efficiency (Acharya et al. 2017, Jaing et al. 2017). The observation and citations are entered in GRIN. Unfortunately the accession is no longer available because demand has depleted our seed supply. We plant to regenerate more seeds request a PI number for this accession.

We evaluated the little millet (*Panicum sumatrense*) collection of 205 available accessions in a field planting. Data was collected on adaptation for seed maturity and other field traits. We learned that most of our little millet accessions are adapted in Iowa, 160 (78 %) accessions reached seed maturity before October, but other accessions mature later. Observations (675) on adaptation for seed maturity, plant height, and other traits, are posted in GRIN from this millet field.

**Outlying Accessions in the 2017 Little Millet Observation Field**

| | |
|---|---|
| PI 463515 I.PM.4 | Short, 45 cm tall |
| PI 463696 I.PM.410 | Tall, 170 cm tall |
| PI 463711 I.PM.433 | Early, seeds matured on August 4 |
| PI 463568 I.PMr.127 | Uniform erect plants with heavy seed production |

Visitors from China were very interested in the millet field planting.

A new foxtail millet descriptor for morphological groups was developed by David Brenner, approved by the Grass Crop Germplasm Committee, and is in GRIN with the first 4 observations. This descriptor is based on descriptions of single-stem versus multi-stemmed morphological groups published by Prasad Rao and others in 1987. Field evaluations are more valuable than greenhouse evaluations for these morphological groups because the greenhouse environment can influence plant structure.

*Spinacia*:
The spinach cultivar Monnopa (Ames 32890) was acquired in 2015 because it was reported to be have a high frequency of bisexual plants. It was grown in 2017, in a field cage, and was confirmed to indeed have a high frequency of monecy (28.9%). This observation was posted in GRIN.

"Monnopa" spinach plants characterized as male, female, or bisexual.

Taxonomy:
In 2018, David Brenner made nine taxonomic re-identifications, involving six genera: *Amaranthus, Ammi, Angelica, Chenopodium, Coriandrum, and Panicum*.

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, Crop Germplasm Committees (CGCs).

Service:
David serves on the Board of the Amaranth Institute. In early 2016 David was elected as Crop Science Society of America, Division C-8 Chair-Elect which progresses to service as Division Chair-Elect in 2017, Division Chair in 2018, and Past Chair in 2019. The tasks in 2018 include choosing symposium topics, inviting speakers scheduling secessions, and communicating with the Genetic Resources Section members. Activities are planned to emphasize crop wild relatives, and landscape genomics.

**Outreach and Presentations:**
David originated and led a field trip titled: Germplasm Foray to Fort De Soto, as an official part of the American Society of Agronomy conference in Tampa, Florida. The participants were helpful in locating a population of *Setaria corrugata* which was later collected and accessioned as Ames 34082.

David made three germplasm-related presentations to the 4th grade class taught by Enid Rumbeiha at the Beloit elementary school in Ames, Iowa. The topics included

threshing and winnowing amaranth seeds, and dissecting corn plants to teach about grass morphology.

**Plans for 2018:**
The six Operations Manual appendices for our crops will be amended with new sections on Best Management Practices and quality control points. For example information will be added on: how to detect and cull out crop-weed hybrids during *Amaranthus* regenerations.

A cytoplasmic male sterile amaranth line (PI 686465) was developed by David at the NCRPIS, and was made publically available in early 2018. A publication about it is intended for the Journal of Crop Registrations in 2018.

David and co-authors wrote a book chapter on North American crop wild relatives of the cereal and pseudo cereal crops. The volume should be published in late 2018.

We would like to acquire more herbicide resistant weed accessions of diverse genera because they are useful to plant breeders, and they are generally poorly vouchered by the weed scientists that work with herbicide resistance.

A millet observation field similar to the field of 2017 will be grown to help fill information gaps for the millet crops. Approximately 200 accessions will be included.

The fall 2018 greenhouse regeneration planting will include many foxtail millet accessions. Seed lots from the 1970s emerged poorly in the 2017 observation field. In early 2018 Lisa Pfiffner conducted viability tests on the older foxtail millet seed lots and confirmed that viability had declined in the 15 year interval since viability was last tested. Of 100 seed lots tested, 72 have viability of less than 90%. We will request viable seeds from back-up storage at NCGRP in Fort Collins, CO.

We will try to control western flower thrips in our campus greenhouse with beneficial rove beetles *Dalotia coriaria* (=*Atheta coriaria*). The ISU Agronomy Department's Greenhouse Manager, Aaron Brand, is already doing this successfully in his other greenhouse areas, rearing the beetles in plastic tubs, fed with commercial poultry food. Thrips are a problem for us especially on *Chenopodium pallidicaule* plants which suffer injury from the pesticides used to control them.

**Publications about our germplasm:**
Five-hundred-twenty-eight literature citations were loaded in GRIN. The GRIN citation technology connects bibliographic citations with accessions studied, and via doi links with the publications and genomic data. For example, the Jarvis et al (2017) publication cited below now links to the six accessions studied on GRIN; it identifies the transcription factor controlling bitter seed saponins. The publication's genomic data is archived on the Phytozome online site.

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## D. Horticulture (J. Carstens, N. Ouellette)

The Horticulture project currently holds 3,680 accessions representing 186 genera (Table 1.0). Significant NC7-medicinal collections includes: *Actaea* (41), *Agastache* (70), *Echinacea* (184), *Calendula* (83), *Hypericum* (224), *Monarda* (100), *Prunella* (52), and *Tanacetum* (53). Significant NC7-ornamentals collections includes: *Alcea* (34), *Malva* (53), *Phacelia* (52), *Potentilla* (106), Sphaeralcea (90), and *Thalictrum* (52). Significant NC7-woody.landscape collections includes: *Aronia* (100), *Betula* (152), *Cornus* (200), *Euonymus* (59), *Fraxinus* (248), *Gymnocladus* (88), *Rhus* (75), *Salix* (60), *Spiraea,* (95), *Staphylea* (44), and *Ulmus* (39). Jeff Carstens serves as curator with Nickolis Ouellette serving as horticulture technician. Jeff Carstens focused efforts on continued collaboration with the Brenton Arboretum in assembling a comprehensive collection of *Gymnocladus;* research on flowering of *Prunella vulgaris;* and establishment of a common garden evaluation of NCRPIS *Gymnocladus dioicus* accessions.

**Table 1. Active accessions maintained in the NC7 horticulture collections (medicinals, ornamentals, and woody landscape) as of December 31, 2017**

| Management group | Genera | Accessions |
|---|---|---|
| NC7-medicinals | 35 | 1000 |
| NC7-ornamentals | 54 | 721 |
| NC7-woody landscape | 97 | 1959 |
| **Total** | **186** | **3680** |

**Acquisitions:**
During 2017, we acquired a total of 111 accessions including 29 medicinal, one herbaceous ornamental, and 81 woody landscape accessions to the horticulture collections.

Collection trips were completed by Jeff Carstens and Nick Ouellette in Tennessee, Kentucky and Ohio sampling *Fraxinus quadrangulata* (16) and Iowa sampling *Betula alleghaniensis* (1) and also Carstens and Andrew Schmitz in Nebraska sampling *Pinus* (1), *Betula* (1), *Echinacea* (1), and *Tilia* (1).

Significant contributions from other cooperators included *Fraxinus* (4) from Julian Campbell (Bluegrass Woodland Restoration Center); *Symphoricarpos* (8), *Betula* (3), and *Cornus* (1) from Joseph Zeleznik (North Dakota State University); *Fraxinus* (5), *Actaea* (1), and *Monarda* (2) from Kevin Conrad (Woody Landscape Crop Germplasm Repository); *Diervilla* (1), *Juglans* (7), *Monarda* (1) and *Viburnum* (1) from Andrew Schmitz (Brenton Arboretum); *Monarda* (4) from Clara Holmes and Molly Marquand (Mid-Atlantic Regional Seed Bank); and *Spiraea* (2) from Melanie Schori (National Germplasm Resources Laboratory).

**Maintenance:**

Regeneration:

Existing plantings that mostly consisted of *Aronia, Cornus, Diervilla, Euonymus, Hypericum, Prunella, Spiraea, Staphylea* were harvested via controlled pollinations. A total of 68 accessions were harvested.

We attempted germination for future regeneration on 45 accessions focused on *Betula, Monarda, Spiraea,* and *Ulmus* accessions.

A total of 84 accessions were transplanted to the field mostly focused on *Aronia, Betula, Cornus, Monarda, Spiraea,* and *Ulmus* accessions.

Availability and Backup:

Currently, approximately 71% of the medicinals, 73% of the herbaceous ornamentals, and 53% of the woody landscape accessions are available.

Currently, approximately 74% of the medicinals, 77% of the ornamentals, and 42% of the woody landscape accessions are backed up at the National Center for Genetic Resources Preservation in Ft. Collins, Colorado.

Two new offsite locations (e.g. 10 miles south and 10 miles west of Ames, IA) were established with wind-pollinated accessions so that isolated regenerations can be executed without the involvement of time-consuming hand pollinations. A total of 15 accessions totaling 525 plants were transplanted in 2017. These offsite locations will potentially result in greater seed quantities harvested and also the number of accessions regenerated per year.

Viability Testing:

A total of 221 seed viability assessments were made for the horticulture collections including maintenance (3), increase (35) and original (183).

**Distribution:**

Distribution figures for the horticulture collections are summarized in Table 2 and 3, below, and Appendix Table 3. For the combined horticulture program, we distributed 166 external orders to 132 requestors totaling 473 items from 328 accessions. We cancelled 264 orders from 205 requestors representing 1,171 items. Most of the orders were cancelled because they were requested for home gardening or other non-research use and/or commercial sources could meet the needs of the request. Leaf tissue from 141 *G. dioicus* samples were treated with sulfuric acid in order to break dormancy,

established, harvested, processed, packaged and distributed to Dr. Joanna Freeland (Trent University) in order to genetically characterize *G. dioicus*.

**Table 2. Taxa most distributed from the NC7 horticulture program in 2017**

| Taxa | Most distributed (greatest to least) |
|---|---|
| Medicinals | *Hypericum* |
| | *Origanum* |
| | *Echinacea* |
| | *Calendula* |
| | *Tanacetum* |
| | |
| Ornamentals | *Malva* |
| | *Drymocallis* |
| | *Alcea* |
| | *Phacelia* |
| | *Thalictrum* |
| | |
| Woody landscape | *Gymnocladus* |
| | *Ulmus* |
| | *Betula* |
| | *Fraxinus* |
| | *Aronia* |

**Table 3. External domestic and foreign germplasm distributions for the NCRPIS horticulture program during 2017**

| Crop | Year | No. of Orders | No. of Recipients | No. of Items Distributed | No. of Accs Distributed |
|---|---|---|---|---|---|
| Medicinals* | 2013 | 31 | 30 | 150 | 94 |
| | 2014 | 21 | 18 | 133 | 87 |
| | 2015 | 39 | 39 | 218 | 174 |
| | 2016 | 36 | 33 | 99 | 99 |
| | 2017 | 53 | 44 | 387 | 233 |
| | **Average** | 36 | 33 | 197 | 137 |
| | | | | | |
| Ornamentals* | 2013 | 45 | 41 | 190 | 154 |
| | 2014 | 41 | 40 | 186 | 160 |
| | 2015 | 21 | 20 | 78 | 74 |
| | 2016 | 33 | 30 | 72 | 61 |
| | 2017 | 27 | 26 | 174 | 160 |
| | **Average** | 33 | 31 | 140 | 122 |
| | | | | | |
| Woody Landscape | 2013 | 76 | 63 | 265 | 186 |
| | 2014 | 73 | 58 | 230 | 139 |
| | 2015 | 95 | 66 | 335 | 191 |
| | 2016 | 97 | 69 | 302 | 168 |
| | 2017 | 71 | 56 | 367 | 146 |
| | **Average** | 82 | 62 | 300 | 166 |

* During 2015, all NC7-mints accessions were reassigned to either the NC7-medicinals or NC7-ornamentals collections.

**Characterization/taxonomy:**
During 2017, ten horticulture accessions (*Fraxinus, Aronia* and *Ceanothus*), were renamed based on morphological characteristics and/or ploidy analysis. No PI numbers were assigned.

**Evaluation:**
In 2017, observation data collected included seed diameters on *Gymnocladus dioicus,* oil and fatty acid contents on *Gymnocladus dioicus,* seed length and widths on *Maclura pomifera* and *Fraxinus quadrangulata,* ploidy levels on *Aronia, Ulmus* and *Fraxinus,* totaling 711 observations loaded to GRIN. Ploidy level data determined by Dr. Mark Brand (University of Connecticut) for *Aronia* (1 accession) and Dr. Alan Whittemore (USDA-ARS National Arboretum) for *Ulmus* (3 accession) and *Fraxinus* (4 accessions) were also loaded in GRIN.

A common garden study/evaluation plot of select *Gymnocladus dioicus* accessions was established in 2017. This evaluation plot includes 52 wild collected accessions from across the species native range with typically 3 mother trees from each accession, replicated 5 times totaling 720 trees. The main goal is to identify superior accessions of *G. dioicus* germplasm. *G. dioicus* has recently become one of the more popular, widely-planted, urban street trees.

Evaluations of 12 *Prunella vulgaris* accessions (600 plants), established in 2017, were conducted. Following initial NCRPIS preliminary data, we hoped to determine the feasibility of subjecting small seedlings to various vernalization treatments in hopes to treat this crop as an annual rather than a biennial, cutting the length of time for a successful regeneration process in half.

We continue to capture observation data on nine *Betula nigra* accessions (145 trees), a common garden study hoping to identify elite lines for the Midwest. Data captured to date includes chlorophyll concentration, caliper, and tree height.

In 2017, we shipped samples of *Ulmus* to The National Center for Genetic Resources Preservation in order to better understand optimum storage regimes by testing moisture and temperature variables. Historically, *Ulmus* has always been accessioned clonally as we know that seeds are short-lived (10 years or less) under 4C conditions. Use of cryo and -18C may result in successful preservation of *Ulmus* seeds.

Data and photos of select *Salix* accessions growing at NCRPIS were captured 10 years after planting. Observation data included plant form, height, width, and peak flowering.

**Enhancement:**
A second generation grow out of *Quercus prinoides* (Ames 23752) established in 2016 and totaling approximately 150 seedlings continues to be maintained. Seedlings will be screened for mildew resistance and superior growth habit.

**Coordination of the NC-7 Regional Ornamental Trials:**
In 2017, the horticulture project distributed 42 plants of five *Quercus muehlenbergii* accessions to four sites for long-term evaluation. An additional 36 plants were shipped to three sites.

**Posters, Presentations, and Seminars:**
In 2017, Jeff Carstens hosted a tour of the NCRPIS and gave a presentation on viability testing to the Iowa State University Horticulture (Plant Propagation) class to approximately 40 students and also to the Iowa State University Agroforestry class to approximately 10 students. Carstens also gave two presentation on germplasm collection development at the 2017 Genetic Resources for Plant Breeders Short Course held at Iowa State University. Carstens provided a hands on demonstration to the Association for the Advancement of Industrial Crops on how to process *Prunella* seed using select seed cleaning equipment. Ouellette gave a presentation on environmental sustainability to an Iowa State University Leadership Studies class.

**Conclusions and Plans for 2018:**
The 2017 growing season was generally productive in terms of overall regeneration of the horticulture collections. Progress continued in the acquisition and curation of *Gymnocladus, Fraxinus, Monarda, Spiraea, Aronia,* and *Echinacea* germplasm. Future acquisitions will switch to sampling of western *Fraxinus* species, *Monarda* spp., Midwest *Aronia,* collaboration with Kevin Conrad to sample *Cladrastis kentukea.*

Curation:
For 2018, we will attempt to obtain seed increases from 20 medicinal and ornamental accessions. We will attempt to obtain seed increases from approximately 40 NC7-woody landscape accessions. Our recently constructed, four large (50x30x15) pollination cages proved their efficiency in 2017 resulting in the successful increase of three *Cornus* accessions averaging 39,000 seeds per accession. These *Cornus* accessions that normally take 7-8 years to regenerate took only four years.

## E. Maize Curation (M. Millard, B. North, D. Zimmerman)

**Personnel:**
The maize curatorial tech team is fully staffed. David Zimmerman joined the staff in March 2015 as an Iowa State University Ag. Specialist II. Brady North returned to the maize project on November 30, 2015 as a Federal Biological Technician. The team now has enough experience to manage regeneration nurseries and data acquisition on those nurseries efficiently. In addition to regular collection maintenance duties, David continues to develop, refine, and maintain computer applications specific to the

maize project. He has begun to work with Pete Cyr, the GRIN-Global Curator Tool developer to work on maize workflow specific "wizard" applications to work within and in interaction with the Curator Tool. Brady has continued his regular interactions with the CIMMYT staff. Vivian Bernau, a former Ames genebank employee who is now working on her PhD at the Ohio State University, and currently conducting a project at CIMMYT, worked with Mr. Zavala and CIMMYT staff to incorporate ideas about maize processing from Ames. As a result, the CIMMYT group is now redesigning and refurbishing their maize processing room at CIMMYT. They will soon be testing a GRIN-Global viability application developed and utilized at Ames for viability monitoring. Brady has served as the main contact person from the maize team in that collaboration. A trip is planned for Brady to visit our large (4000 row) contracted nursery at Semillas y Agroproductos Moreno Retis S. de P. R. de R. L., Nayarit, Mexico in 2018.

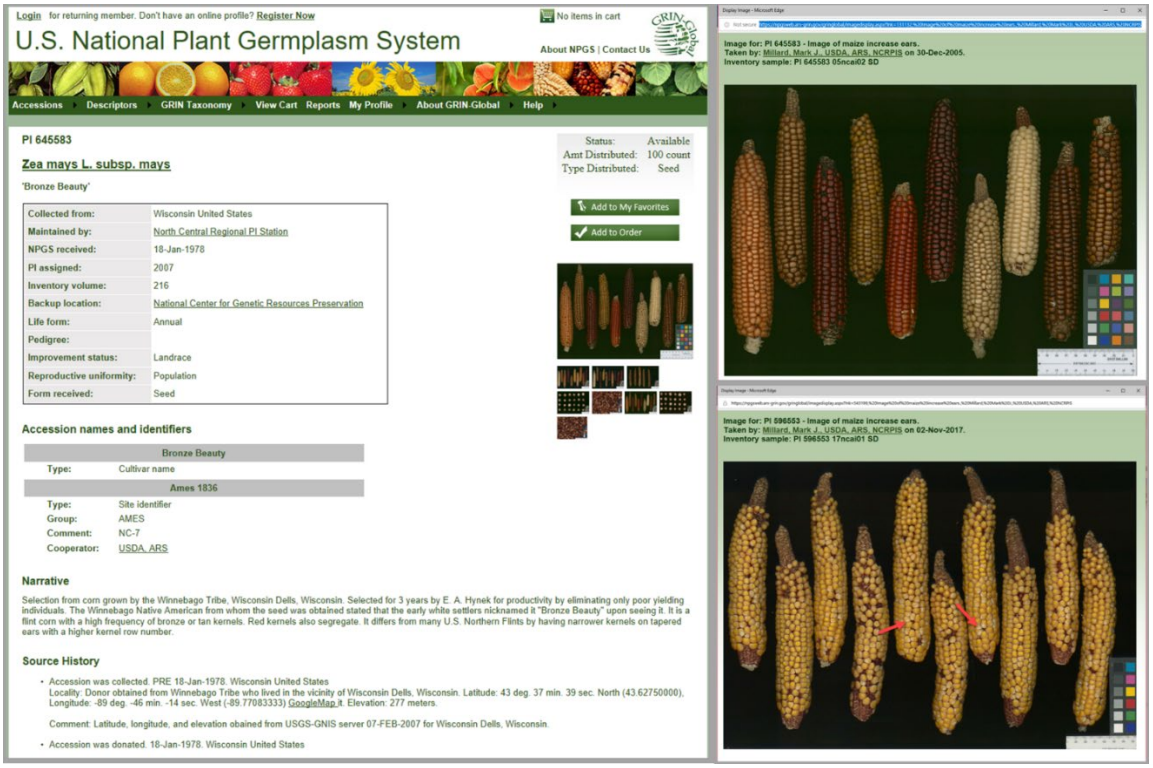



**Figure 1** Accession Report with examples of larger images spawned from thumbnails. The lower left shows LH283 inverted embryos.

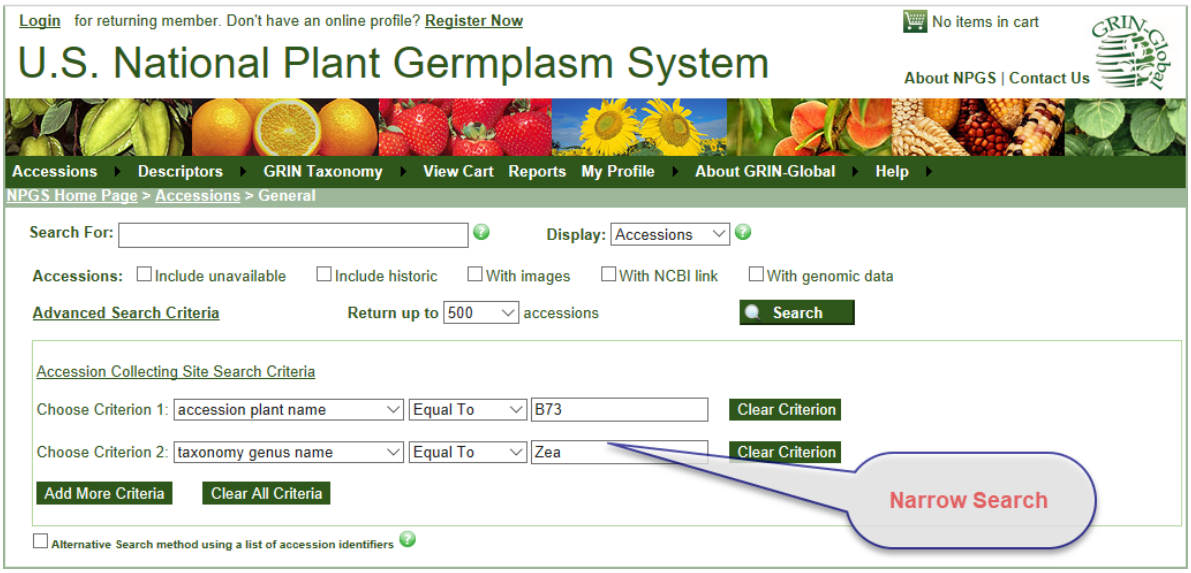
## Research Progress:

GRIN-Global continues to be developed. I continue to provide input and testing of new features being added to the software. One of the most important tools added to the Curator Tool inventory was a new Attachment (Image) Wizard put into production in 2017. Use of this tool allows faster image loading, giving more examples like those above.

In regards to imaging procedure, the maize team started evaluating scanning at a much higher resolution of 1200 dpi instead of 400 dpi and providing archival tif images to researchers rather than jpg images. At this time, 1200 dpi images of the bed size

currently used take much more time and are much larger than practical. Currently on average, three images of ears, one image of ear cross sections, one image of bulk kernels and one image of isolated kernels are taken for each increase to document changes in the accession. Slowing down processing by going to a much higher resolution is not practical using current resources. Providing such large tif images to the average GRIN public user will severely degrade the user experience. In 2018, a compromise will be sought that will permit higher resolution while maintaining processing capacity, provide a good public interface experience and good images for research applications.

The Google-like search was broadened in 2017 to search database indexed large text fields. This will allow more hits with this search. Words like "B73" or "virus" will provide many more hits by searching for these within pedigree and accession note description fields. Users will be encouraged to use advanced searches to target terms in a particular field. For an example, the broad search "Zea B73" gives 324 hits when both available and unavailable accessions are presented mainly because B73 is in many inbred pedigrees. Only one hit occurs when "Accession Plant Name" equals "B73" and "Genus Name" equals "Zea".

**Acquisition:**
We received 105 new accessions in 2017. These included 15 GEM accessions from the Raleigh location, 13 GEM accessions from the Ames location and 30 BGEM inbreds from the doubled haploid diversity inbred GEM program. We received an old inbred line N3-2-3-3 from Dr. Krakowsky that originated in Zimbabwe. There were 26 expired or soon to be expiring PVPs received. Dr. Jim Holland alerted us to "Sea Island White Flint", an old open-pollinated variety from South Carolina. It was mentioned in a book by David Shield called "Southern Provisions". We obtained seed from Ted Chewning and Dr. Holland regenerated the accession for distribution from Ames. We received 14 inbred lines and two populations from Dr. Sansern Jampatong in Thailand that were grown under APHIS quarantine in winter 2017. Finally, we received seed of three registered Texas inbred lines, Tx736, Tx739, and Tx740.

**Regeneration:**
The Zea program had 338 regeneration attempts in 2017 (1.6% of the collection). This compares with 442 regeneration attempts in 2016 (2.1% of the collection), 555 (2.7%) in 2015 and 555 accessions (2.7%) in 2014. The big reduction in the Ames nursery size was due to difficulties in hiring an adequate summer pollination crew. The breakdown of the regeneration nurseries are as follows:

1. The Ames summer nursery was maintained at 120 accessions in 2017. This compares to 267 in 2016, 259 in 2015, 247 in 2014 (1,726 vs. 3,110 vs. 2,674 vs. 2,860 25-foot rows). The nursery was composed of 52 expired or soon to be expired PVPs, 30 BGEM inbreds, 11 other inbreds, 9 GEM populations, and 17 other populations. Nursery size was reduced due to budget uncertainty until late in the spring and difficulty in hiring temporary labor in the summer. Temporary wages will increase for summer 2018 in order to recruit students competitively.

   Three planting dates occurred on May 7, May 16, and June 2, 2017 in order to spread out the pollination season and to allow time for nursery size to be determined as hiring progressed. After an early summer irrigation, no further irrigation was required. After an easy peak, the pace rapidly relaxed as later maturities were well distributed through the latter half of the season, and the maize curation crew was able to help GEM complete pollination, as the shortage of help was. Harvest followed the same non-pressured cycle assisted by a long fall similar to those experienced the last few years.

   No Stewart's wilt was observed in any increase plots in 2017, as in every year since 2010. ELISA testing is still necessary on Ames increase lots to meet phytosanitary requirements because the state cannot be declared Stewart's wilt free. Seasonable weather during almost all of the growing season and a long fall is giving good quality seed, especially for longer season accessions. The summer's regeneration is rated as above average.

2. Twelve GEM lines were regenerated by the Ames GEM team for the maize collection.

3. 3rd Millennium Genetics was contracted in September 2016 to plant, pollinate, and harvest 67 tropical populations. These were planted on October 8, 2016. Progeny

were received on February 22, 2017 and processed. Lowland tropical accessions from Central and South America from the Goodman racial collection were targeted 3rd Millennium. There were no accessions being regenerated at 3rd Millennium at the time of the hurricanes.

4. Nine GEMs were regenerated by the Raleigh GEM team in 2016 were received and were processed in 2017.

5. Six GEMs were regenerated in 2017 by the Raleigh GEM team and have been processed.

6. One old South Carolina population was regenerated by Dr. Holland at NC State. He has an interest in creating a white food corn population.

7. Ames greenhouse increases consisted of six population accessions planted at the end of 2016 and harvested in 2017. Populations consisting of one *Coix*, two *Tripsacum*, and one *Zea mays subsp. huehuetenangensis* (teosinte) were planted in the fall of 2016 for a spring 2017 harvest. The teosinte is the only accession of this subspecies in the collection.

8. **Quarantine maize is being grown in a NCRPIS winter greenhouse for the first time**. We received 14 inbreds and 2 populations under APHIS quarantine permit from Dr. Sansern Jampatong at Kasetsart University, Thailand. Pathologist Dr. Charles Block at Iowa State University oversees the growout. These can only be increased in an inspected greenhouse room that meets quarantine requirements during the winter months in Ames. St. Croix's APHIS permit does not allow for growing maize from SE Asia.

9. **A large nursery funded by ARS was planted in Mexico**. This is the first time the NCRPIS has contracted directly for tropical maize regenerations in a foreign country. Other tropical regenerations have been done in Puerto Rico or through in-kind support by other organizations. Phytosanitary issues are the largest hurdle, followed by contractual logistics and funding. It is hoped that regeneration quality will improve for accessions that have been difficult to increase in higher disease and insect pressure environments. Four thousand rows were planted this fall to regenerate 250 mid-altitude to lowland accessions from all over the tropics by Semillas y Agroproductos Moreno Retis S. de P. R. de R. L., Nayarit, Mexico.

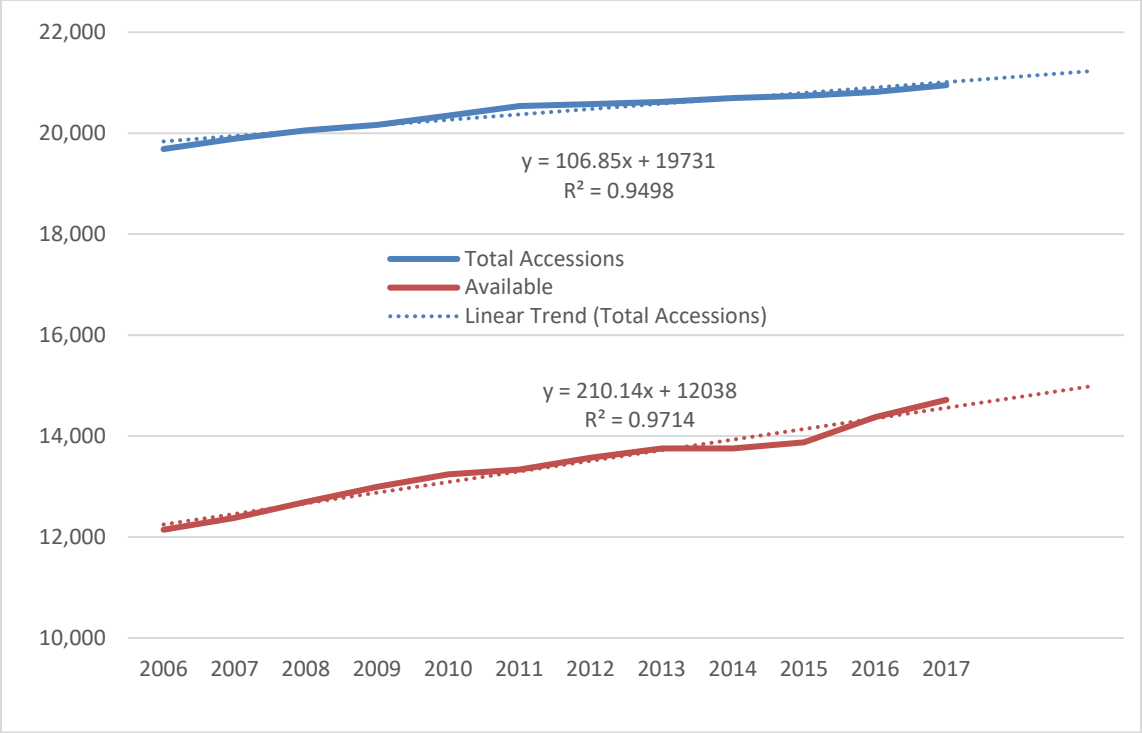
**Maintenance:**
There were 20,952 accessions of *Zea* held at the NCRPIS as of December 31, 2017. This compares with 20,819 in 2016, 20,744 in 2015 and 20,694 in 2014. GEMs and expiring PVPs made up the majority of the additions. The maize curator maintains an additional 101 accessions from the *Coix* and *Tripsacum* genera.

There were 14,718 available *Zea* accessions held at the end of 2017 (70% of the total). This compares with 14,376 (69%) in 2016, 14,144 (68%) in 2015 and 13,876 (67%) in 2014. Improvement in the number of available accessions continues even though the average age of distribution lots in the collection continues to increase. Progress would not be possible without in past in kind regeneration assistance of Monsanto, DuPont

Pioneer, and GEM programs at North Carolina and Iowa. Having enough funding to contract tropical nurseries is also critical to future progress.

| Yearly Accession Availability | | | | |
|---|---|---|---|---|
| **Year** | **Total Accessions** | **Available Accessions** | **% Available** | **New Accessions** |
| **2008** | 20,057 | 12,997 | 64.80% | 150 |
| **2009** | 20,166 | 12,239 | 65.70% | 105 |
| **2010** | 20,347 | 13,338 | 65.60% | 178 |
| **2011** | 20,540 | 13,572 | 66.10% | 180 |
| **2012** | 20,579 | 13,753 | 66.80% | 39 |
| **2013** | 20,624 | 13,757 | 66.70% | 39 |
| **2014** | 20,694 | 13,876 | 67.70% | 98 |
| **2015** | 20,744 | 14,144 | 68.20% | 53 |
| **2016** | 20,819 | 14,144 | 69.10% | 110 |
| **2017** | 20,952 | 14,718 | 70.25% | 105 |

**Figure 4.** Maize Collection Holdings and Availability Statistics, December 31, 2017




This table indicates that Zea accession availability continues to improve though the collection grows and accessions become unavailable. Efforts in recent years have been focused on increasing inbreds and expired PVPs to meet demand.

Viability testing continued at levels tested in recent years. There were 1,177 maize accessions tested in 2017 (6% of the collection). Most accessions are tested on a 10 year plan. Recently we have found some elite inbred accessions that appear to deteriorate faster and will be put on a 5 year plan after regeneration. Plans are to do many indicator tests of two reps of 10 seeds on older lots of unavailable accessions

with few seeds. This will assist in determining regeneration priorities and needed overplanting. A benefit of going to Mexico for tropical regenerations is that they can overplant population. Some past contracted nursery providers and in kind growers could not overplant and thin because of the type of mechanical planters they use.

Ninety-seven accessions were backed up at the NLGRP in 2017. This compares with 56 in 2016, 101 in 2015, and 71 in 2014. The percent of the collection backed up held at 73%. Currently, NLGRP needs are not the highest priority for regenerating, but are considered. Since there is a large backlog of regenerations needed, viability of the Ames inventory and availability are the more important priority setting factors. At storage of the new increase, NLGRP holdings are reviewed for each accession and seed is sent to NLGRP if their backup is considered substandard.

All GEM and BGEM accessions with temporary Ames numbers in the collection were assigned permanent PI numbers in 2017. Since the SOP for GEM is that all GEM releases are moved to the collection after two years, it is planned that at transfer there will be a PI number on the accession for the first distributions from the maize collection.

**Distribution:**
Orders for all accessions that are maintained by the maize curator including those of the genera *Tripsacum* and *Coix* increased 7.2% in 2017 compared to a 15.7% increase in 2016, a decrease of 12.4% in 2015, and a 20% decrease in 2014. Almost all orders are now entered by requestors in GRIN-Global. 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. It appears that more targeted requests for fewer accessions are being made as exemplified by fewer packets on fewer accessions.

| Annual Distribution Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **Total Packets** | **Foreign Packets** | **Total Accs** | **Foreign Accs** | **Orders** | **Foreign Orders** | **Requestors** | **Foreign Requestors** |
| 2013 | 13,786 | 3,811 | 3,573 | 1,582 | 755 | 93 | 593 | 83 |
| 2014 | 15,136 | 4,456 | 3,556 | 1,900 | 603 | 102 | 477 | 93 |
| 2015 | 13,860 | 3,427 | 4,444 | 2,008 | 528 | 87 | 414 | 80 |
| 2016 | 13,541 | 4,252 | 4,572 | 2,707 | 611 | 121 | 473 | 106 |
| **2017** | **12,541** | **2,095** | **4,137** | **1,042** | **655** | **99** | **451** | **73** |
| **Averages 2013-17** | 13,773 | 3,608 | 4,056 | 1,848 | 630 | 100 | 482 | 87 |

Orders for expired PVPs were sent to 150 requestors (33% of all *Zea* requestors). Expired PVPs made up some portion of 38% of all Zea orders shipped.

**Characterization:**
There were 11,324 data points on 1,279 accessions loaded into GRIN in 2017. This compares with 9,715 data points on 1,718 accessions loaded in 2016, 11,791 data points on 346 accession in 2015, and 5,099 points on 332 in 2014.

We imaged 499 accessions in 2017 compared to 527 accessions in 2016, 420 in 2015 and 365 in 2014. Image loading to GRIN will accelerate using the new GRIN-Global imaging (attachment) wizard in 2018. Currently there are 8,729 images on 5,222 accessions in GRIN.

**Evaluation:**
Two disease-screening nurseries were distributed in 2017. Rick Blum, DuPont Pioneer Hi-Bred, attempted to screen 200 accessions for northern leaf blight resistance at Johnston, Iowa. Dr. Marc Mancl screened 336 accessions for fusarium resistance. Many thanks are extended to DuPont/Pioneer Hi-Bred for this long-term, continuing contribution. ARS pathology technician Narinder Pal observed all nurseries in Ames for disease occurrence during the growing season for phytosanitary purposes.

**Plans for 2018:**
In 2018 as in recent years, attending to regenerations and regeneration processing will need to take precedence. Regeneration remains my first priority because without viable seed, distribution and resulting research cannot be done.

We will start transferring seed of the tropical increases initiated by Major Goodman in the 1990's and only deposited at the NGRL at Fort Collins to Ames for distribution and management.

We will be funding at least three tropical increase nurseries of at least ~500 rows each.

During 2018 additional tools will be made available in GRIN-Global and will utilized to enter new and pending data.

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 2018. GRIN-Global should greatly assist in this PI assignment project.

We will continue acquiring germplasm from public collections.

I will co augment the collection of images currently on GRIN of 5,000 accessions with images of additional accessions in 2018. The new image loader (attachment wizard) will be used.

A second maize curator will be recruited in 2018 for additional support, barring resource decreases and if approved for inclusion in Agency hiring plans.

## F. Oilseed Crops (L. Marek, G. Welke)

**Project management:**
Curator Dr. Laura Marek is assisted by full time Agronomy Department staff, Grace Welke, ISU Agronomy Assistant Scientist. John Reinhardt, ISU Farm Equipment Operator, works full time for the NCRPIS Oilseed Project November through March.

The project is also supported by a team of hourly student workers. The ARS Agricultural Research Technician position attached to the project has been empty since late March 2016 and remains unfilled due to a USDA hiring freeze. In addition, the NCRPIS and other central Iowa employers have experienced a shortage of temporary labor applicants during the past few years. As a result of the staffing shortage, permanent and temporary, regenerations were scaled back and simplified, decreasing the number of genera attempted and resulting in more uniformity in regeneration protocols and other management concerns.

**Acquisitions:**
The oilseed project received 10 new accessions in 2017.

Brassicaceae:
Two new *Thlaspi arvense* accessions, wild collected in Colorado and filling geographic gaps in the collection, were received from Dr. Von Mark Cruz.

*Helianthus*:
Five cultivated *H. annuus* pre-breeding lines were received from Dr. Loren Rieseberg, University of British Columbia, Vancouver, Canada, completing the main pre-breeding line collection received in 2016. The UBC pre-breeding collection of 360 lines contains introgressions from eleven different crop wild relative annual *Helianthus* taxa crossed in a standard cultivated breeding line background.

Two cultivated *H. annuus* oilseed inbred lines were received from their developers in Fargo, ND. Both lines are fertility restorers; one is downy mildew resistant and tolerant of imidazolinone herbicide and one has high oleic oil content.

One new wild perennial *H. divaricatus* sunflower accession, which filled a geographic gap in the species representation in Illinois, was received from the Brenton Arboretum in Iowa, collected by Andrew Schmitz in the Trail of Tears State Forest in Illinois.

**Collection Maintenance:**
General statistics about availability and management of the collections are presented in Tables 1 and 2 in the appendix. Selected details for oil seed accessions increased during 2017 are noted below. Due to reduced Oilseed Project staffing, regenerations and their complexity were reduced.

*Helianthus*, Ames regenerations:
Cultivated *H. annuus* accessions are 70% available for distribution. The collection includes two specialized subsets, an association mapping population, UGA-SAM1, and the previously mentioned set of 360 pre-breeding lines developed in Canada. These 648 accessions are only available with special curator permission until after regeneration lots from the 2017 growing season are processed and stored. We expect 95% of the subset of lines to become freely available during 2018 which will restore cultivated H. annuus availability. We manage regenerations to ensure that core collection accessions and other accession subsets of interest to specific stakeholder groups are available.

In 2017, 450 cultivated *H. annuus* accessions were regenerated in the field. Fifty-seven accessions of the UGA-SAM1 association mapping population were grown in screened seven by seven by twenty foot cages (50 accessions) or 10 by 10 by 20 foot cages (6 accessions). In addition, one 10 by 20 by 20 foot cage (Figure 1) was constructed by the team with assistance from the Farm Maintenance Crew to accommodate regeneration of a land race accession which grows taller than can be appropriately managed in a standard cage. All 360 pre-breeding lines were regenerated in ten foot single row plots with plants bagged for sib pollination in each row (Figure 2). The remaining 30 cultivated accessions were grown in seven foot (16 accessions) and 20 foot (14 accessions) cages. Seed was harvested from all of the cultivated sunflower plots and processing of the harvest is under way.

**Figure 1.** 20x20x10 foot cage constructed to accommodate tall sunflower.

**Figure 2.** Pre-breeding lines regeneration, early June above; late July below.

Wild annual *Helianthus* accessions are 96% available and wild perennial accessions are 83% available. No new wild sunflower regenerations were started in Ames 2017. Thirteen previously established perennial plots were re-caged and seed was harvested from all of the populations.

Typically, two or three cultivated sunflower accessions requiring long seasons or short days to flower are increased in an NCRPIS greenhouse during the winter. Three accessions were successfully grown during winter 2016-2017. For winter 2017-2018, we are growing accessions of two wild species, one of which was a mixed population in a Parlier 2017 grow-out, mentioned in the Parlier section below. We grew the accession at the NCRPIS to monitor it and select seedlings of the correct species to grow to maturity.

Miscellaneous asters:
The miscellaneous asters are 33% available. No miscellaneous asters were grown at the NCRPIS in 2017.

*Helianthus*, Miscellaneous asters, Parlier alternate grow-out site regenerations:
We continue to partner with the National Arid Lands Plant Genetic Resources Unit (NALPGRU), Parlier, CA to regenerate wild taxa requiring a longer growing season than is 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 cages purchased by NCRPIS, and can grow up to 40 NCRPIS oilseed accessions per year. We germinate seeds in Ames and ship live seedlings to Parlier in late March and early April. The Parlier staff transplant the seedlings and manage plant growth. Following our Ames protocol, plots are caged before flowering, pollinator insects are introduced (Ames funds the pollinator services), and seed heads are harvested as they mature. Harvested material is shipped to Ames for threshing and processing.

In 2017, seedlings for 38 wild sunflower accessions and two miscellaneous asters were shipped to Parlier. Heads were harvested from 39 of the accessions and shipped to Ames for processing. Plants of one of the miscellaneous asters accessions did not survive to produce mature seeds.

The Parlier staff record basic field data (transplant, flowering and harvest dates and takes some images) but does not have the personnel to record standard descriptor data such as ray and disc flower color, plant height, and branching characteristics nor to take all images. Phenotypic information is a valuable component associated with each accession and it is important to capture the observation data. In early October 2017, Ms. Welke and I traveled to Parlier to record descriptor information and to take images.

During the 2017 field visit, I observed that one plot was not the expected species, *H. heterophyllus*, but was instead *H. angustifolius*. A close examination of all plants revealed two plants of *H. heterophyllus* hidden among the much larger *H. angustifolius*. I decided to remove the *H. heterophyllus* plants and request a new Ames number for the *H. angustifolius* as a separation from the original collection. The *H. angustifolius* plants began to flower about a week after the field visit. The mistaken identity would have been very easy to miss when the seedlings were small and as the plants grew, *H. angustifolius* became much larger than the two *H. heterophyllus* plants, which is one of just a few Helianthus species which remain as rosettes until the nights reach a certain length and reproductive growth is initiated. The *H. heterophyllus* accession became part of the 2017-2018 winter greenhouse increase so that we could monitor and select only plants of the correct species to grow to maturity. This case illustrates one of the important reasons for the annual field visit of the curator and technician to Parlier.

We have an excellent partnership with the NALPGRU staff, ensuring successful regenerations of many taxa. We are most grateful for the dedicated efforts of Dr.

Claire Heintz, curator, and Mr. Jerry Serimian, Parlier field technician, and their staff.

Brassicaceae regenerations:
Brassicaceae accessions are 83% available. Availability is lower than in past years because 2016 and 2017 viability maintenance testing of distribution lots of *Brassica* accessions determined an unexpected drop off in viability resulting in 205 accessions of *B. napus* and *B. rapa* changing from status "Available" to "Low germination". This was most unfortunate because the average on hand seed quantity for these accessions is almost 100,000.

The majority of the 205 accessions were *B. napus* (96%). The NCRPIS *B. napus* collection is 80% winter type. The B. rapa collection has not been evaluated for winter vs spring flowering type (see Research Activities: Brassicaceae, below). Consistent, full population flowering requires a 10-12 week vernalization period after the plants have, ideally, four true leaves. We have experimented with direct seeding winter type *B. napus* accessions in the fall and letting them vernalize in the field because such a process involves much less labor and many studies have shown that yield is superior. However, in the four years we have trialed this technique, only 20% of the winter type accessions have also been winter hardy at the Ames latitude. Because winter hardiness is an environmentally dependent variable that is largely unknown for each accession, and because winter conditions vary from year to year, we cannot efficiently replace failing distribution lots using fall field planting. We need to grow and vernalize winter type brassica accessions in the greenhouse and in a NCRPIS vernalization space. Between project scheduling of other oilseed crops and vernalization logistics and capacity, we are limited to a maximum of 80 winter type accessions per year. Testing coordinated by Lisa Pfiffner (viability) and Lisa Burke (seed storage) determined that freezer stored seed had higher viability than samples of the same seed lot kept at 4C for 39 of 62 accessions of five *Brassica* species (*B. carinata*, *B. juncea*, *B. napus*, *B. rapa*, and *B. tournefortii*). *B. napus* accessions had the highest percentage of viability loss as well as the lowest viability and our replacement regenerations will initially focus on this species. Loss of viability is sure to be a complex issue and could involve seed characteristics (geneotypes) as well as seed age and storage temperature history (including how many times the lot was moved in and out of cold storage to fill orders or for other maintenance issues). Seed age was not a reliable predictor of viability loss. Fortunately freezer stored seed lots are available for most of the low viability *Brassica* to support regeneration efforts.

The 2016 maintenance viability testing data were completed too late in the year to allow regenerations of winter type *B. napus* for 2017 harvest. We were able to grow a selected group of 12 spring type *B. napus* in the field in 2017, most of which were chosen based on low viability of the distribution lot. As resources allow, we are planning to regenerate a greater than average number of *Brassica* accessions each year for the next several years.

In mid-December 2017, we started 76 winter type *B. napus* accessions which will be vernalized for ten to twelve weeks, winter into spring 2018, before transplant into the field for flowering and harvest.

In fall 2016, five *Brassica napus* winter type accessions were direct seeded in the field to overwinter as young plants and vernalize in the field. Two of the accessions overwintered with high survival and were harvested in early summer 2017. Plants for three accessions were dug from the field in the fall and overwintered in the greenhouse because of poor stand establishment and lack of additional original seed; seed was harvested in May and June. One accession germinated very slowly and as a result was transplanted directly to pots in the greenhouse. It was harvested in late spring and early summer 2017.

Ten of the twelve spring type *Brassica napus* accessions transplanted to the field in late May were harvested beginning in August. Two accessions flowered late and harvesting did not begin until October.

FGH-2 is managed to provide conditions that approximate a Mediterranean climate allowing us to regenerate Brassicaceae accessions native to that region, and to grow other Brassicaceae taxa which flower very early in the growing season. Because of the interest in *Thlaspi arvense* as an alternate crop for biofuel production, we have been focused on making all accessions of this species available. *T. arvense* flowers very early in the season in Iowa and is present in all NCRPIS farm fields as a weed. To obtain reasonable regenerations and to ensure the genetic integrity of each accession, we have been increasing *T. arvense* in FGH-2. *Crambe glabrata* (1), *Isatis costata* (1), *Lepidium sativum* (1), *Mathiola incana* (5), and *T. arvense* (1) accessions were grown in the 2016-2017 winter greenhouse. All accessions flowered and were harvested in mid-spring into early summer 2017 except flowers of one *M. incana* accession did not produce seeds. One *Crambe laevigata*, one *Isatis boissieriana* and nine *T. arvense* accessions were started in fall 2017 for harvest in 2018. If all 2017-2018 *T. arvense* accessions produce seeds, we will reach our goal of having the *T. arvense*, collection 100% available.

<u>*Linum* regenerations</u>:
Cultivated flax accessions are 99% available. Wild flax accessions are 81% available. The cultivated flax collection was transferred to Ames in 1998 with uniform seed age. The viability group in Ames determined that seed viability had started to decline for some distribution lots and increased their maintenance germination efforts. Based on their data, we are regenerating 10 to 15 accessions of cultivated flax every year, first to ensure all accessions have distribution lots with viability above 50% and then, over the next few years, that viability exceeds 70% for all accessions. Fourteen cultivated flax accessions were successfully regenerated in 2017. No wild flax accessions were attempted in 2017.

<u>*Cuphea* regenerations</u>:
No *Cuphea* regenerations were attempted in 2017. 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 agronomic development efforts by members of the National *Cuphea* Consortium. Thirteen accessions of *Cuphea* are maintained as clones in FGH-1 and distributed as vegetative cuttings. Over all, the *Cuphea* collection is 80% available.

*Euphorbia* regenerations:
The *Euphorbia* collection is 49% available. No *Euphorbia* accessions were grown in 2017. The taxon within this genus of greatest interest for seed oil production is *E. lagascae* and accessions of this species are 89% available. *E. lagascae* grows reasonably well during an average Iowa growing season; we were growing five to six accessions annually with a goal of having all accessions available. However, *Euphorbia* seed pods shatter as they mature making this genus more difficult to manage than other oilseeds. Because there is not currently an active *E. lagascae* effort in the United States, as part of the simplification of processes due to reduced staffing we did not grow *Euphorbia* in 2017.

**Distributions:**
General statistics about oil seed distributions are presented in Table 3 in the appendix.

*Helianthus*:
In 2017, 12,586 sunflower items were distributed to 119 requesters in 151 orders, 54 of which (58% of the items) were sent internationally. Roughly 13% of the distributed items were packets of the 288 line UGA-SAM1 mapping population sent in six complete and eight partial distributions to nine researchers at eight different research institutions for evaluations of drought, salt and flooding tolerance as well as to a researcher investigating heliotropism and circadian rhythm in cultivated sunflower and to one looking at plant architecture and its effect on yield. Other large distributions included sending all available wild and cultivated sunflower accessions (3800) to plant breeders in France responsible for sunflower breeding at a large international seed and chemical company. Sunflower breeders for a second international seed company based in France requested more than 1075 cultivated and wild accessions. All available wild perennial and annual accessions not including wild *H. annuus* (1178), were sent to a sunflower breeding company in China. A total of 644 accessions were send to two breeding programs in Turkey.

Brassicaceae:
In 2017, 111 orders containing 5929 packets of Brassicaceae germplasm were sent to 103 researchers around the world; 40 international distributions contained 48% of the packets. Forty-seven of the orders contained only accessions of the genus *Brassica*, 32 orders contained only samples of other Brassicaceae genera, and the remaining orders contained samples of both *Brassica* and other genera in the family and/or samples of other crops curated at the NCRPIS. The largest individual distribution, 1932 accessions encompassing 16 Brassicaceae taxa and representing 33% of the 2017 distributions, was sent to a researcher developing varieties for forage and cover crops at the Noble Institute in Oklahoma. The four next largest orders contained 2417 items (41% of the 2017 distributions) and were all sent to international destinations. Three orders were for pathology research in Spain (556 *B. napus* accessions), Holland (821 Brassicacae accessions) and Canada (447 *B. napus* accessions) and one order was sent to support breeding efforts in China (593 *B. napus* accessions). The diversity present in the Brassicaceae collection (262 taxa in 21 genera) supports a wide range of research purposes.

*Linum*:
Seventeen orders containing 1071 flax packets were distributed in 2017 to 17 researchers, 95% of which were cultivated flax accessions. Thirty-six percent of the packets were sent to nine international researchers. The largest cultivated flax distribution, 500 packets, was sent to the new flax breeder at North Dakota State University for his varietal development program. Other requesters indicated a focus on varietal development and taxonomic investigations.

*Cuphea*:
One order containing 1 cuphea accession was distributed in 2017 to be part of a reference identification collection in an archaeological investigation.

*Euphorbia*:
Seven orders containing 71 packets of *Euphorbia* were distributed to seven researchers, two at international locations (90% of the packets). The international requesters received accessions for a breeding project to improve field germination of *E. lagascae* and for specimen boxes in a National Seed Herbarium.

Miscellaneous asters:
Thirteen orders containing 40 packets of miscellaneous aster seeds for 13 requesters were filled in 2017 and shipped to two international locations (four accessions) and 11 domestic locations (36 accessions). Stated research purposes included botanic and taxonomic investigations, anthropological research, seed herbarium specimens and varietal development.

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

*Helianthus*:
SAM evaluations/Pre-breeding lines
We cooperate with the NSF and Genome Canada projects which involve field and greenhouse evaluations using the UGA-SAM1 association mapping population and the UBC developed pre-breeding lines. The projects are managed by Dr. John Burke and Dr. Lisa Donovan, UGA, USA and Dr. Loren Rieseberg, UBC, Canada. We provided seeds for evaluations in drought environments in southern California and Uganda, a salt environment in central Canada and a nutrient stress environment in Israel as well as greenhouse and laboratory based studies at UGA and UBC. We recorded and contributed field observation data for Iowa grown pre-breeding lines. Additional international cooperators include Chile, India and Argentina.

Pre-breeding Lines:
The Global Crop Diversity Trust funded an international evaluation project managed by the University of British Columbia laboratory which developed the pre-breeding lines with partners in Chile, Argentina, Africa, India, Israel and Ames. Our contribution to the partnership involves providing seeds for the international locations and recording the descriptor data that we typically record for sunflower regenerations for the project funded 2017 and 2018 grow-outs.

Cultivated sunflower self fertility evaluations:
We continued to partner with Dr. Jessica Barb, ISU Agronomy Department, and helped manage 134 ten foot single row plots for an introductory agronomy class field laboratory experience (about 60 students) including harvesting 32 plots planted to supply seed for the 2018 field laboratory event.

Brassicaceae:
We are starting evaluations of the 544 accession *B. rapa* collection for winter/spring type determinations in January 2018. There was some decrease in viability of *B. rapa* distribution lots in recent maintenance germinations as described above (Collection Maintenance: Brassicaceae regenerations) for *B. napus* but at a much lower rate: only 1% of the distribution lots (six accessions) had less than 20% viability and only 6% (34 accessions) were less than 50% viable. To inform regeneration management, the accessions selected for the initial winter/spring evaluation were those with the lowest viability scores. Regenerations will be much more efficient if we know before we start whether or not vernalization will be required to initiate flowering.

**Professional Activities:**
Meetings and Presentations:
January: I attended the Plant and Animal Genome XXIV Conference in San Diego and the one day satellite meeting of the Genome Canada and NSF groups working with sunflower. I made a presentation about regenerations, seed stocks and seed order processes for the UGA-SAM1 association mapping population which both groups are using for trait evaluations. I traveled with a subgroup of the team to the field location in southeastern CA where drought response is being assessed.

March: I attended the RF Baker Plant Breeding Symposium, ISU.

September: I attended the AAIC meeting in Ames, IA and presented a report on oilseed crops of interest the New Crops CGC to CGC members, Brassicaceae, *Euphorbia*, *Cuphea* and on miscellaneous asters genus (*Centrapalus* ssp).

November: I attended the CSSA/ASA/SSSA annual meetings, in Tampa, FL. As chairperson of the C08 (plant genetic resources) Division of the Crop Science Society of America, I was responsible for the C08 program, organizing and leading the business meeting, and organized and led two four speaker symposia, described in the "Service" section below, as well as the general oral and poster sessions.

Training:
Throughout the year, I completed safety trainings as required including Tractor and Gator Safety, Epipen use, Fire Extinguisher use, first aid/CPR certification and various AgLearn modules.

**Publications:**
Peer reviewed journal articles:
Isbell, T.A., Cermak, S.C., Marek, L.F. 2017. Registration of Elizabeth *Thlaspi arvense* L. (Pennycress) with Improved Non-dormant Traits. Journal of Plant Registrations. 11:311-314. doi:10.3198/pr2016.12.0073crg.

Seiler, G.J., Qi, L.L., Marek, L.F. 2017. Utilization of Sunflower Crop Wild Relatives for Cultivated Sunflower Improvement. Crop Sci. 57:1083-1101. doi:10.2135/cropsci2016.10.0860.

Warburton, M.L., Rauf, S., Marek, L., Hussain, M., Ogunola, O., Sanchez Gonzales, J.D.J. 2017. The use of crop wild relatives in maize and sunflower breeding. Crop Sci. 57:1227-1240. doi:10.2135/cropsci2016.10.0855.

Mathew, F., Olson, T., Marek, L., Gulya, T., Markell, S. Identification of sunflower (*Helianthus annuus*) accessions resistant to *Diaporthe helianthi and Diaporthe gulyae*. Plant Health Progress. (PHP10-17-0060-RS; *Accepted* 06-Dec-2017).

Book chapters:
I finished writing two book chapters, "Practicalities of Collecting Wild Plants in North America: Insights from the United States" and "Crop Wild Relatives of Sunflower in North America", which will be in a two volume book about North American Crop Wild Relatives being published by Springer. The book is expected to be published by mid-2018.

**Active Grants:**
In 2017 the Oilseeds project received a $25,000 grant from the Global Crop Diversity Trust administered through the University of British Columbia to support regenerations of the Canadian developed sunflower pre-breeding lines received in 2016 and for partial support of curator travel to the project's annual meeting at the Plant and Animal Genome meeting in San Diego, CA in January.

**Service Activities:**
Journal peer review:
I served as a peer reviewer for submissions to Crop Science and the Journal of Plant Registrations.

Peer review:
I served as an in-house peer reviewer for two USDA projects National Program 301 plans.

Plant Germplasm Operating Committee (PGOC):
I serve as a member of the PGOC GIS and Geo-referencing Subcommittee and the Molecular Subcommittee.

CSSA:
On January 1, 2017, I took over as chair of the C08 division (Plant Genetic Resources) of the Crop Science Society of America. My responsibilities for 2017 included serving on the Calvin Sperling Lectureship committee, running the business meeting and developing and leading the C08 program. As part of the program, I organized two symposia each with four invited speakers: "the Prominent Role of Plant Genetic Resources: Endophytes and Discovering the Plant Microbiome" and "Phenotyping Plant Genetic Resources to Support Climate Smart Agriculture".

## G. Vegetables (K. Reitsma, L. Clark, C. Hopkins)

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:**
Six new accessions were received for the Vegetable Project in 2017. Three expired PVPs *Cucumis melo* ('Sweet Delight'), *Cucurbita pepo* ('Tom Fox'), and *Ocimum basilicum* ('Sweet Dani', derived from PI 358465) were received from NLGRP; and three accessions of *Cucumis melo* were transferred from Griffin, Georgia due to taxonomic reidentification from *Citrullus lanatus*.

**Maintenance:**
Data for vegetable crop regenerations attempted and number of accessions harvested in 2017 are summarized in the appendices in "Table 2: NCRPIS Accessions (Accs) Germinated, Regenerated, Made Available, Backed Up."

*Cichorium* increases in 2017 were of plants that failed to bolt during the 2016 regeneration process. Plants of five accessions were dug from the 2016 fields, transplanted to the greenhouse, vernalized and transplanted to field cages in 2017. Resulting seed increases will be viability tested and bulked with seeds harvested from the 2016 cage increases, and made available for distribution.

*Cucumis* increases included both greenhouse and field regenerations of 64 accessions, primarily focusing on accessions with low seed quantities or distribution lots 20+ years old. Three *C. melo* accessions were planted in the greenhouse, one was later transplanted to a field cage and successfully regenerated. Regenerations of the other two accessions were not successful as one produced no fruit and the other produced only four fruit with very few seeds in each. Of the 54 *C. sativus* accessions attempted, four failed to germinate and six flowered late resulting in low fruit/seed development. Seven accessions of *Cucumis spp.* were planted in January 2017 for greenhouse regeneration with plants of six of these accessions being transplanted to field cages in June 2017 when they did not thrive in the greenhouse. Four of the seven accessions were successfully regenerated. We will attempt to regenerate the three accessions which produced low fruit/seed quantities again in 2018. The 2017 regeneration seed lots will be stored and made available for distribution after viability testing in April.

*Cucurbita pepo* field regenerations focused on accessions with low seed quantities or distribution lots 20+ years old. Fifteen of 27 accessions were successfully regenerated in field cages, two failed to germinate, five had no fruit at harvest (though insect pollinators were introduced when male and female flowers were present), three had low fruit/seed production, one accession had only three plants which failed to thrive, and plants of one accession were found to be infested with squash mosaic virus (SqMV) and destroyed. The accession with SqMV will be regenerated in 2019 and the parent

seed will be heat treated to eradicate the virus prior to planting. The increase lots will be inventoried and stored after viability testing. Two additional late-maturing accessions were planted for regeneration in the greenhouse, but plants failed to thrive and died after a malfunction in the greenhouse ventilation system subjected the plants to freezing temperatures overnight. These accessions were replanted late in 2017 for regeneration, and are currently setting fruit which will be harvested in 2018.

NCRPIS *Daucus* regeneration efforts focused primarily on Ames-numbered wild, annual species and on old PI-numbered accessions having lower seed quantities. Forty-four accessions were planted as biennials for regeneration, and seeds were harvested from all accessions. We were also able to use the caged plots of the 2017 *Daucus* Observation planting as regenerations for 47 accessions from the 2016 Spain collection. We should have sufficient seed increases on 39 of these accessions which includes accessions of the new subspecies *D. carota* subsp. *majoricus*. David Brenner attempted regenerations of two *D. minusculus* and seven *D. pumilus* (formerly identified as *Pseudorlaya minusucla* and *P. pumila*), with successful harvests on four accessions. In addition to the Ames, IA *Daucus* 2017 regenerations, we received seed increases of six accessions from Sage McClintick-Friddle, Seminis Vegetable Seeds (Monsanto), Idaho and five accessions from Rob Maxwell, Bejo Seeds, Idaho.

*Pastinaca* regenerations focused on 12 accessions with low viability. Harvests were made on ten accessions, and seed quantities appear to be sufficient on eight accessions for distribution and to provide new backup lots to NLGRP. Two accessions failed to germinate and will be replanted using alternative parent seed lots for regeneration in 2018. Increase seed lots will be inventoried and stored after viability testing.

Four accessions of *Ocimum* were regenerated in 2017 and included two accessions with low distribution quantities, one accession with a 40+ year old distribution lot, and one newly expired PVP ('Sweet Dani' lemon basil) received from NLGRP. These seed lots should be made available after germination tests are completed.

The Vegetable Project continued the use of biologicals to control insect pests inside greenhouse and field regeneration cages. We have seen improved control of thrips, whiteflies, and aphids with the use of Nemasys Beneficial Nematodes, Encarsia formosa, and lady bugs. We plan to continue to use these biologicals in the future and also look for additional/alternative options and applications in our program.

As NCRPIS accessions are regenerated, backup seed samples are sent to NLGRP in Ft. Collins. Overall, 84% 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 NLGRP (Appendix Table 2). The NCRPIS also sent 189 accessions of *Cucumis* and 203 accessions of *Daucus* seed samples to the Svalbard Global Seed Vault.

**Distribution:**
Packet and accession distributions for research and education for the vegetable collections are summarized in the appendices in "Table 3A: External NCRPIS Distributions". In 2017, 9770 items (packets) involving 3963 accessions were distributed to fulfill 191 orders (121 domestic, 70 foreign) equaling 164 recipients.

Vegetable research requests received in 2017 specified objective topics as disease evaluations, breeding for specific traits and disease resistances, genetic and molecular studies, and diversity assessment for biotic and abiotic stress tolerance. A significant number of the vegetable collection distributions were for Dr. Philipp Simon's (USDA-ARS) *Daucus* SCRI (Specialty Crops Research Initiative) and the Crop Trust project.

Non Research Requests (NRR), i.e., home gardener requests, continue to make up a significant portion of the Vegetable Project requests.

**Germinations:**
In 2017, 512 vegetable accessions were tested for viability (Appendix Table 2), with the majority of the testing attributed to maintenance germinations on distribution lots and initial viabilities on original seed lots for the new *Daucus* germplasm collected in Spain in 2016.

**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 2017 will be loaded to GRIN-Global. Images are taken to document plant, leaf, flower, fruit, or root characteristics. A *Daucus* Observation field was planted to capture descriptor data and images on 48 accessions collected by Dr. David Spooner, Dr. Philipp Simon, and Dr. Fernando Martinez Flores in Spain in 2016. These data and images will be made available via GRIN-Global.

Taxonomic identities are reviewed and confirmed as each accession is regenerated. The 2017 reidentifications included: three *Citrullus lanatus* accessions transferred from Griffin, Georgia as *Cucumis melo*; three *Daucus carota* reidentified to *D. guttatus*; one *Daucus littoralis* reidentified to *D. conchitae*; 33 *Daucus guttatus* reidentified to six *D. bicolor*, 11 *D. conchitae*, and 16 *D. setulosus*; 14 *Daucus spp.* reidentified to two *D. bicolor*, six *D. conchitae*, three *D. guttatus*, and three *D. setulosus*. The *Daucus* reidentifications were due to Dr. David Spooner's molecular work revising the taxonomy of the genus *Daucus* and allied species.

**Evaluation/Utilization:**
We continue 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 cages. Seedling screening has been conducted since 1993. All cucurbit field plantings are visually inspected 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. The Vegetable Project is working with Dr. Narinder Pal (NCRPIS Pathology Project) and Dr. Charles Block (Iowa State University, Seed Science Center) to develop a method to prevent seed transmission of the bacterial fruit blotch pathogen during the regeneration process which will enable us to secure disease-free seed lots for distribution.

Research continues on the taxonomic revision of the genus *Daucus* and allied species; and also on two newer evaluation projects related to NCRPIS vegetable collections, the CucCAP (Cucurbit Coordinated Agricultural Project) and the *Daucus* SCRI (Specialty Crops Research Initiative) projects.

- Dr. David Spooner and Dr. Philipp Simon are working with colleagues in Spain and in genebanks in England and France on two projects:
    - A genotyping-by-sequencing (GBS) analysis of subspecies variation in *Daucus* carota using many new accessions collected in Spain, and germplasm from these two genebanks,
    - A multiple nuclear ortholog DNA sequence analysis of additional wild species from the collections mentioned above.

- The *Daucus* SCRI Project (initiated in 2017) lead by Dr. Philipp Simon (USDA-ARS) has a goal to use applied genomics to develop enhanced *Daucus carota* breeding lines based on evaluations of the NPGS cultivated *Daucus carota* accessions for nematode resistance, heat tolerance, flavor and diversity analysis, stand establishment, cavity spot evaluation, and bolting. Thus far, ~700 cultivated PIs, and a few wild PIs, have been evaluated in Wisconsin and California fields for flowering time, stand establishment, top size, nematode and alternaria resistance, flavor, root nutritional pigments, and root appearance (shape, external and internal color). Images of typical roots are also being collected.

- Dr. Simon's work for the Crop Trust project included evaluation of several hundred *Daucus* PIs for salinity and heat stress tolerance in the Wisconsin lab and greenhouse. These two stressors as well as drought stress were also evaluated by collaborators in plantings in Bangladesh and Pakistan fields.

- The SCRI and the Crop Trust projects are developing breeding pools by intercrossing plants with superior performance for traits mentioned above. They are also genotyping phenotyped plants for both projects, and developing a database.

- The CucCAP Project (started in 2016) has three objectives: develop genomic approaches and tools for cucurbit species, perform genomic-assisted breeding to introgress disease resistance into cucurbit cultivars, and perform economic impact analyses of cost of production and disease control and provide readily accessible information to facilitate disease control. NPGS crop specific curator participation in the project is to provide information and guidance with regard to the germplasm collections and the NPGS. For the NCRPIS germplasm collections, the CucCAP evaluations will focus on disease resistance in *Cucumis sativus* (downy mildew, Phytophthora), *Cucumis melo* (powdery mildew, Fusarium, Cucumber Yellow Stunting Disorder Virus, Cucumber Mosaic Virus), and *Cucurbita pepo* (powdery mildew, Phytophthora, Papaya Ring Spot Virus, Cucumber Mosaic Virus). It was reported that all GBS has been completed for the NPGS cucumber, melon and watermelon collections during the third annual meeting of the CucCAP in Raleigh, NC April 4-5, 2018.

The GBS of the NPGS Cucurbita collections will be completed within a month. Core collections of ~300 PIs and a mix of ~100 breeding lines, cultivars, and heirloom varieties will be established to best capture the genetic variability as determined by the GBS. These cores will be grown for re-sequencing and self-pollination to create enhanced lines to be made available through the NPGS. Phenotypic characterization of the cores is also planned but may have to be pursued under CucCAP II. The project's website, https://cuccap.org/, posts a list of publications resulting from the research, and provides access to cucurbit genomics tools and databases via the Cucurbit Genomics Database website. All phenotypic data generated in the evaluation process will be referenced in or made available via the GRIN-Global database, and enhanced lines developed through the process may be made available through the NPGS.

**Publications/Posters:**
No new publications at this time.

**Plans for 2018:**
Regenerations:
The 2018 vegetable regenerations will include approximately 20 *Cichorium endivia*, 20 annual *Daucus*, and as yet an undetermined number of cucurbits in the summer field cages. Regenerations of wild *Cucumis* species and hard-to-handle *Cucumis* will continue in the greenhouse as time, space, and other resources permit.

Characterization:
Image loading to GRIN "Classic" was suspended in 2013 in preparation for the launch of the new GRIN-Global database. With the development of the new Inventory Attachment Wizard for GRIN-Global, the Vegetable Project will be able to begin loading the following backlog of images during the summer of 2018: images acquired as part of the regeneration process, images from the 2013 and 2017 *Daucus* observation planting, images provided by cooperators for cucurbits and *Ocimum*, and images taken during the 2016 *Daucus* collection trip in Spain.

Review of accession passport data will continue on the cucurbit and *Daucus* collections in preparation for assigning PI numbers to many of the Ames-numbered accessions in the collections (414 *Cucumis*, 88 *Cucurbita*, and 99 *Daucus*).

Evaluation:
We are awaiting receipt of evaluation and characterization data resulting from the NPGS funded proposal "Phenotypic and molecular marker evaluation of carrot and wild *Daucus carota* germplasm recently added to the NPGS" submitted by Drs. Philipp Simon and David Spooner (USDA-ARS, Madison, WI) through the Root and Bulb Vegetable Crop Germplasm Committee (RBV-CGC) 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 phenotypic data collected will be loaded into GRIN-Global.

Data generated by the CucCAP (Project Director: Dr. Rebecca Grumet, Professor, Dept. of Horticulture, Michigan State Univ., East Lansing, MI) and the *Daucus* SCRI (Project Director: Dr. Philipp Simon, USDA-ARS, Vegetable Crops Research Unit, Madison, WI) will be loaded to GRIN-Global with the completion of the projects.

| Site Crop (Maintenance Policy) | Number Accs | Number Accs Acquired | Number Available | Percent Available | Percent Avail Last Year | PI Numbered Accs | Ames Numbered Accs | NSL Numbered Accs | Backup | Percent Backed up NCGRP | Svalbard |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NC7-chicory | 279 | 0 | 212 | 76 | 76 | 230 | 23 | 26 | 244 | 87 | 114 |
| NC7-cucumis.cucs | 1388 | 0 | 1322 | 95 | 95 | 1230 | 143 | 15 | 1320 | 95 | 985 |
| NC7-cucumis.melo | 3214 | 4 | 1972 | 61 | 64 | 2904 | 279 | 27 | 2593 | 81 | 551 |
| NC7-cucumis.wilds | 320 | 0 | 203 | 88 | 58 | 247 | 73 | 0 | 196 | 61 | 51 |
| NC7-cucurbita | 979 | 1 | 730 | 75 | 75 | 884 | 90 | 5 | 823 | 84 | 298 |
| NC7-daucus | 1483 | 0 | 1179 | 80 | 79 | 967 | 486 | 30 | 1229 | 83 | 940 |
| NC7-ocimum | 105 | 1 | 98 | 93 | 94 | 92 | 13 | 0 | 99 | 94 | 76 |
| NC7-parsnips | 73 | 0 | 56 | 77 | 68 | 52 | 19 | 2 | 50 | 68 | 33 |
| Totals | 7841 | 6 | 5772 | 74 | 74 | 6606 | 1126 | 105 | 6554 | 84 | 3048 |

## H. Research Leader Activities (C. Gardner)

**Administration and Leadership Activities:**
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. New five year project plans for the NC-7 Project and both of the ARS CRIS projects were approved in 2017.

Budgetary anomalies due to changing 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. Making timely decisions for work plans for many taxa that require germination and vernalization treatments in the winter is challenging under these circumstances. The GEM Project CRIS continues to be leveraged to support maize curatorial activities as well, not a permanent solution.

In August, 2017, she co-taught a two day course on plant genetic resource conservation and utilization for ISU Agronomy graduate students with collaborator Stephen Smith. This is part of an initial effort to develop training programs for future curatorial personnel.

Gardner serves on the advisory group for the Daucus SCRI Project. She served as leader of the review team for the USDA-ARS Soybean Genebank Review in Urbana, IL in March, 2018.

About 10% of her time was devoted to assisting GRIN-Global System development team members, about 15% to the GEM maize geneticist/Coordinator transition, and about 75% to genebank issues and writing in the past year.

**2018 Plans:**
With the purchase of the QSorter from the Swiss company, QualySense with USDA-ARS Midwest Area and HQ support, we have a unique instrument capable of capturing 3D images and NIR spectra from seeds, and sorting seeds based on calibrations developed for specific traits or size/color parameters. To date, effort has been devoted just to getting the instrument ready for research activity. We anticipate testing a variety of seeds of taxa, starting with maize in 2018, and learning to develop algorithms that facilitate characterization.

We will continue to focus on recruiting and filling vacant PIRU and NCRPIS positions with outstanding individuals and facilitate smooth transitions, and to assist graduate students in completion and publication of their work. We will continue to use the ORISE program to hire contract employees to cover some aspects of our activities.

**Publications:**
Hu, S., Sanchez, D., Wang, C., Lipka, A.E., Yin, Y., Gardner, C.A., Lubberstedt, T. 2017. Brassinosteroid and Gibberellin control of seedling traits in maize (Zea mays L.). Plant Science. 263:132-141.

Vanous, A., Gardner, C.A., Blanco, M., Martin-Schwarze, A., Lipka, A.E., Flint Garcia, S.A., Bohn, M., Edwards, J.W., Lübberstedt, T. 2018. Association mapping of flowering and height traits in Germplasm Enhancement of Maize doubled haploid (GEM-DH) lines. The Plant Genome. doi:10.3835/plantgenome2017.09.0083.

| Year 2017 Table 1. 01/01/2017 to 12/31/2017 | | NCRPIS Accessions (Accs), Acquired, Available | | | | | |
|---|---|---|---|---|---|---|---|
| **CURATOR** | **GENUS_CROP** | **Number Accs** | **Number Accs Acquired** | **Percent Acquired** | **Number Available** | **Percent Available** | **Percent Avail Last Year** |
| **Brenner** | NC7-amaranth | 3341 | 4 | 0% | 3218 | 96% | 97% |
| | NC7-celosia | 59 | 1 | 2% | 38 | 64% | 66% |
| | NC7-echinochloa | 310 | 4 | 1% | 277 | 89% | 91% |
| | NC7-grasses | 133 | 0 | 0% | 86 | 65% | 64% |
| | NC7-legumes | 298 | 4 | 1% | 159 | 53% | 40% |
| | NC7-melilotus | 1004 | 0 | 0% | 891 | 89% | 89% |
| | NC7-panicum | 936 | 0 | 0% | 911 | 97% | 97% |
| | NC7-perilla | 25 | 0 | 0% | 22 | 88% | 72% |
| | NC7-portulaca | 12 | 1 | 8% | 9 | 75% | 82% |
| | NC7-quinoa | 432 | 8 | 2% | 303 | 70% | 70% |
| | NC7-setaria | 1089 | 4 | 0% | 1006 | 92% | 94% |
| | NC7-spinach | 413 | 0 | 0% | 393 | 95% | 98% |
| | NC7-umbels | 1188 | 1 | 0% | 745 | 63% | 63% |
| | **Total:** | **9240** | **27** | **0%** | 8058 | 87% | **87%** |
| | NC7-medicinals | 1000 | 29 | 3% | 710 | 71% | 71% |
| | NC7-ornamentals | 721 | 1 | 0% | 529 | 73% | 74% |
| **Carstens** | NC7-woody.landscape | 1954 | 69 | 4% | 1015 | 52% | 52% |
| | **Total:** | **3675** | **99** | **3%** | 2254 | 61% | **61%** |
| **Marek** | NC7-asters | 432 | 0 | 0% | 144 | 33% | 31% |
| | NC7-brassica | 2011 | 2 | 0% | 1867 | 93% | 93% |
| | NC7-brassica.pvp | 6 | 0 | 0% | 0 | 0% | 0% |
| | NC7-crucifers | 1269 | 2 | 0% | 1138 | 90% | 87% |
| | NC7-crucifers.pvp | 1 | 0 | 0% | 0 | 0% | 0% |
| | NC7-cuphea | 638 | 0 | 0% | 510 | 80% | 78% |
| | NC7-euphorbia | 209 | 0 | 0% | 103 | 49% | 42% |
| | NC7-flax | 2834 | 0 | 0% | 2821 | 100% | 99% |
| | NC7-flax.wilds | 147 | 0 | 0% | 118 | 80% | 78% |
| | NC7-sun.cults | 2246 | 8 | 0% | 1774 | 79% | 82% |
| | NC7-sun.cults.SAM | 289 | 0 | 0% | 1 | 0% | 0% |
| | NC7-sun.wilds.ann | 1665 | 0 | 0% | 1592 | 96% | 86% |
| | NC7-sun.wilds.per | 888 | 1 | 0% | 737 | 83% | 83% |
| | NC7-sun.wilds.sp | 2 | 0 | 0% | 0 | 0% | 0% |
| | **Total:** | **12637** | **13** | **0%** | 10805 | 86% | **84%** |
| **Millard** | NC7-corn.kin | 101 | 0 | 0% | 9 | 9% | 10% |
| | NC7-maize.gems | 316 | 58 | 18% | 244 | 77% | 92% |
| | NC7-maize.inb | 2613 | 18 | 1% | 2225 | 85% | 83% |
| | NC7-maize.pop | 17121 | 3 | 0% | 11724 | 68% | 67% |
| | NC7-maize.pvp | 463 | 26 | 6% | 439 | 95% | 100% |
| | NC7-maize.wilds | 439 | 0 | 0% | 77 | 18% | 19% |
| | NC7-zea.totals | 20952 | 105 | 1% | 14709 | 70% | 69% |
| | **Total:** | **21053** | **105** | **0%** | 14718 | 70% | **69%** |
| **Reitsma** | NC7-chicory | 279 | 0 | 0% | 214 | 77% | 75% |
| | NC7-cucumis.cucs | 1388 | 0 | 0% | 1322 | 95% | 95% |
| | NC7-cucumis.melo | 3212 | 4 | 0% | 1997 | 62% | 63% |
| | NC7-cucumis.wilds | 320 | 0 | 0% | 205 | 64% | 60% |
| | NC7-cucurbita | 979 | 1 | 0% | 731 | 75% | 75% |
| | NC7-daucus | 1483 | 0 | 0% | 1179 | 80% | 78% |
| | NC7-ocimum | 105 | 1 | 1% | 98 | 93% | 94% |
| | NC7-parsnips | 73 | 0 | 0% | 56 | 77% | 77% |
| | **Total:** | **7839** | **6** | **0%** | 5802 | 74% | **74%** |
| NCRPIS Total: | | **54444** | **250** | **0%** | 41637 | 76% | **76%** |

| Year 2017 Table 2.<br>01/01/2017 to 12/31/2017 | | NCRPIS Accessions (Accs) Germinated, Regenerated, Made Available, Backed Up | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CURATOR** | **GENUS_CROP** | **Number Accs** | **Number Accs Germed** | **Percent Accs Germed** | **Number Attempted Regen** | **Number Harvested Regen** | **Number Perm Perennial** | **Number Perennial Harvested (Vegetative)** | **Number Accs Growing** | **Number Accs Made Available** | **Number Accs Backed Up at NLGRP for YR** | **Number Accs Backed Up at Svalbard for YR** | **Number Accs Backed Up at Other Locations for YR** | **Total Number Accs Backed Up** | **Percent Accs Backed Up** |
| **Brenner** | NC7-amaranth | 3341 | 235 | 7% | 102 | 69 | 0 | 0 | 0 | 27 | 33 | 126 | 0 | 3260 | 98% |
| | NC7-celosia | 59 | 1 | 2% | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 | 71% |
| | NC7-echinochloa | 310 | 0 | 0% | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 18 | 0 | 275 | 89% |
| | NC7-grasses | 133 | 1 | 1% | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 90 | 68% |
| | NC7-legumes | 298 | 42 | 14% | 0 | 2 | 0 | 0 | 0 | 41 | 34 | 0 | 0 | 213 | 71% |
| | NC7-melilotus | 1004 | 0 | 0% | 5 | 6 | 0 | 0 | 0 | 0 | 0 | 34 | 0 | 929 | 93% |
| | NC7-panicum | 936 | 0 | 0% | 209 | 2 | 0 | 0 | 0 | 0 | 0 | 19 | 0 | 916 | 98% |
| | NC7-perilla | 25 | 6 | 24% | 0 | 0 | 0 | 0 | 0 | 6 | 5 | 0 | 0 | 24 | 96% |
| | NC7-portulaca | 12 | 0 | 0% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 83% |
| | NC7-quinoa | 432 | 45 | 10% | 47 | 32 | 0 | 0 | 0 | 41 | 32 | 54 | 0 | 323 | 75% |
| | NC7-setaria | 1089 | 0 | 0% | 12 | 1 | 0 | 0 | 0 | 0 | 0 | 60 | 0 | 973 | 89% |
| | NC7-spinach | 413 | 242 | 59% | 5 | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 399 | 97% |
| | NC7-umbels | 1188 | 49 | 4% | 7 | 23 | 0 | 0 | 0 | 5 | 1 | 91 | 0 | 770 | 65% |
| | **Total:** | **9240** | **621** | **7%** | **394** | **141** | **0** | **0** | **0** | **123** | **105** | **402** | **0** | **8224** | **89%** |
| **Carstens** | NC7-medicinals | 1000 | 15 | 2% | 24 | 42 | 0 | 0 | 0 | 34 | 34 | 0 | 0 | 757 | 76% |
| | NC7-ornamentals | 721 | 3 | 0% | 0 | 4 | 0 | 0 | 0 | 5 | 2 | 0 | 0 | 555 | 77% |
| | NC7-woody.landscape | 1954 | 60 | 3% | 28 | 120 | 128 | 54 | 0 | 57 | 73 | 0 | 0 | 885 | 45% |
| | **Total:** | **3675** | **78** | **2%** | **52** | **166** | **128** | **54** | **0** | **96** | **109** | **0** | **0** | **2197** | **60%** |
| **Marek** | NC7-asters | 432 | 1 | 0% | 3 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 154 | 36% |
| | NC7-brassica | 2011 | 383 | 19% | 88 | 12 | 0 | 0 | 0 | 0 | 0 | 327 | 0 | 1983 | 99% |
| | NC7-brassica.pvp | 6 | 0 | 0% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 100% |
| | NC7-crucifers | 1269 | 9 | 1% | 0 | 0 | 0 | 0 | 0 | 24 | 3 | 200 | 0 | 1137 | 90% |
| | NC7-crucifers.pvp | 1 | 0 | 0% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 100% |
| | NC7-cuphea | 638 | 0 | 0% | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 583 | 91% |
| | NC7-euphorbia | 209 | 7 | 3% | 0 | 0 | 0 | 6 | 0 | 13 | 13 | 0 | 0 | 98 | 47% |
| | NC7-flax | 2834 | 115 | 4% | 14 | 14 | 0 | 0 | 0 | 17 | 13 | 375 | 0 | 2832 | 100% |
| | NC7-flax.wilds | 147 | 0 | 0% | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 123 | 84% |
| | NC7-sun.cults | 2246 | 113 | 5% | 390 | 390 | 0 | 0 | 0 | 24 | 11 | 125 | 0 | 1827 | 81% |
| | NC7-sun.cults.SAM | 289 | 84 | 29% | 56 | 57 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0% |
| | NC7-sun.wilds.ann | 1665 | 32 | 2% | 26 | 0 | 0 | 0 | 0 | 167 | 109 | 177 | 0 | 1544 | 93% |
| | NC7-sun.wilds.per | 888 | 45 | 5% | 14 | 14 | 0 | 0 | 6 | 17 | 9 | 45 | 0 | 737 | 83% |
| | NC7-sun.wilds.sp | 2 | 0 | 0% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0% |
| | **Total:** | **12637** | **789** | **6%** | **591** | **487** | **0** | **19** | **6** | **277** | **158** | **1249** | **0** | **11025** | **87%** |
| **Millard** | NC7-corn.kin | 101 | 2 | 2% | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 12% |
| | NC7-maize.gems | 316 | 85 | 27% | 39 | 58 | 0 | 0 | 0 | 9 | 3 | 0 | 0 | 74 | 23% |
| | NC7-maize.inb | 2613 | 390 | 15% | 25 | 12 | 0 | 0 | 0 | 95 | 19 | 0 | 0 | 1592 | 61% |
| | NC7-maize.pop | 17121 | 598 | 3% | 267 | 90 | 0 | 0 | 0 | 306 | 61 | 0 | 0 | 13154 | 77% |
| | NC7-maize.pvp | 463 | 104 | 22% | 52 | 52 | 0 | 0 | 0 | 57 | 14 | 0 | 0 | 463 | 100% |
| | NC7-maize.wilds | 439 | 0 | 0% | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 44 | 10% |
| | *NC7-zea.totals* | *20952* | *1177* | *6%* | *384* | *212* | *0* | *0* | *0* | *467* | *97* | *0* | *0* | *15327* | *73%* |
| | **Total:** | **21053** | **1179** | **6%** | **388** | **214** | **0** | **0** | **0** | **467** | **97** | **0** | **0** | **15339** | **73%** |
| **Reitsma** | NC7-chicory | 279 | 30 | 11% | 0 | 5 | 0 | 0 | 0 | 21 | 21 | 0 | 0 | 246 | 88% |
| | NC7-cucumis.cucs | 1388 | 142 | 10% | 49 | 48 | 0 | 0 | 0 | 44 | 35 | 189 | 0 | 1321 | 95% |
| | NC7-cucumis.melo | 3212 | 1 | 0% | 8 | 9 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2593 | 81% |
| | NC7-cucumis.wilds | 320 | 14 | 4% | 24 | 7 | 0 | 0 | 0 | 14 | 12 | 0 | 0 | 207 | 65% |
| | NC7-cucurbita | 979 | 19 | 2% | 27 | 24 | 0 | 0 | 0 | 19 | 12 | 0 | 0 | 823 | 84% |
| | NC7-daucus | 1483 | 46 | 3% | 64 | 95 | 0 | 0 | 0 | 61 | 46 | 203 | 0 | 1258 | 85% |
| | NC7-ocimum | 105 | 91 | 87% | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 99 | 94% |
| | NC7-parsnips | 73 | 9 | 12% | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 74% |
| | **Total:** | **7839** | **352** | **4%** | **176** | **202** | **0** | **0** | **0** | **160** | **126** | **392** | **0** | **6601** | **84%** |
| **NCRPIS Total:** | | **54444** | **3019** | **6%** | **1601** | **1210** | **128** | **73** | **6** | **1123** | **595** | **2043** | **0** | **43386** | **80%** |

| Year 2017 Table 3.<br>01/01/2017 to 12/31/2017 | | | External NCRPIS Distributions - Includes both DI (research and education), RP (Repatriation), OB (Observation), and NR (home garden) order types | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | External Domestic Distributions | | | | Foreign Distributions | | | | External Domestic and Foreign Distributions | | | |
| CURATOR | GENUS_CROP | Number Accs in Collection | Number Items | Number Accs | Number Orders | Number Recipients | Number Items | Number Accs | Number Orders | Number Recipients | Number Items | Number Accs | Number Orders | Number Recipients |
| **Brenner** | NC7-amaranth | 3341 | 3360 | 3100 | 45 | 34 | 498 | 427 | 19 | 17 | 3858 | 3107 | 64 | 51 |
| | NC7-celosia | 59 | 8 | 5 | 7 | 6 | 1 | 1 | 1 | 1 | 9 | 6 | 8 | 7 |
| | NC7-echinochloa | 310 | 14 | 12 | 8 | 8 | 12 | 12 | 1 | 1 | 26 | 22 | 9 | 9 |
| | NC7-grasses | 133 | 7 | 7 | 6 | 6 | 1 | 1 | 1 | 1 | 8 | 8 | 7 | 7 |
| | NC7-legumes | 298 | 21 | 17 | 9 | 9 | 8 | 8 | 2 | 2 | 29 | 21 | 11 | 11 |
| | NC7-melilotus | 1004 | 39 | 38 | 4 | 4 | 29 | 29 | 1 | 1 | 68 | 42 | 5 | 5 |
| | NC7-panicum | 936 | 937 | 911 | 12 | 12 | 110 | 104 | 4 | 4 | 1047 | 912 | 16 | 16 |
| | NC7-perilla | 25 | 26 | 18 | 2 | 2 | 6 | 6 | 1 | 1 | 32 | 18 | 3 | 3 |
| | NC7-portulaca | 12 | 10 | 8 | 4 | 4 | 5 | 4 | 2 | 2 | 15 | 8 | 6 | 6 |
| | NC7-quinoa | 432 | 728 | 305 | 46 | 42 | 1530 | 288 | 27 | 26 | 2258 | 318 | 73 | 68 |
| | NC7-setaria | 1089 | 101 | 64 | 33 | 28 | 973 | 836 | 19 | 16 | 1074 | 849 | 52 | 44 |
| | NC7-spinach | 413 | 3335 | 404 | 26 | 22 | 53 | 53 | 6 | 6 | 3388 | 404 | 32 | 28 |
| | NC7-umbels | 1188 | 645 | 286 | 29 | 29 | 215 | 213 | 14 | 14 | 860 | 425 | 43 | 43 |
| | **Total:** | **9240** | **9231** | **5175** | **181** | **151** | **3441** | **1982** | **90** | **81** | **12672** | **6140** | **271** | **232** |
| **Carstens** | NC7-medicinals | 1000 | 213 | 136 | 46 | 41 | 202 | 157 | 12 | 10 | 415 | 255 | 58 | 51 |
| | NC7-ornamentals | 721 | 89 | 83 | 23 | 22 | 93 | 93 | 5 | 5 | 182 | 166 | 28 | 27 |
| | NC7-woody.landscape | 1954 | 267 | 126 | 80 | 63 | 283 | 51 | 6 | 3 | 550 | 161 | 86 | 66 |
| | **Total:** | **3675** | **569** | **345** | **138** | **111** | **578** | **301** | **22** | **16** | **1147** | **582** | **160** | **127** |
| **Marek** | NC7-asters | 432 | 45 | 34 | 13 | 12 | 2 | 2 | 1 | 1 | 47 | 36 | 14 | 13 |
| | NC7-brassica.pvp | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | NC7-brassica | 2011 | 2640 | 1813 | 43 | 40 | 1934 | 1817 | 23 | 21 | 4574 | 1851 | 66 | 61 |
| | NC7-crucifers | 1269 | 430 | 351 | 36 | 30 | 367 | 298 | 15 | 14 | 797 | 581 | 51 | 44 |
| | NC7-crucifers.pvp | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | NC7-cuphea | 638 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| | NC7-euphorbia | 209 | 7 | 6 | 5 | 5 | 56 | 56 | 1 | 1 | 63 | 61 | 6 | 6 |
| | NC7-flax | 2834 | 667 | 606 | 8 | 8 | 100 | 88 | 8 | 8 | 767 | 635 | 16 | 16 |
| | NC7-flax.wilds | 147 | 98 | 87 | 5 | 5 | 52 | 43 | 3 | 3 | 150 | 102 | 8 | 8 |
| | NC7-sun.cults | 2246 | 1733 | 1324 | 60 | 51 | 3913 | 2081 | 38 | 27 | 5646 | 2086 | 98 | 78 |
| | NC7-sun.cults.SAM | 289 | 945 | 288 | 10 | 6 | 832 | 288 | 3 | 3 | 1777 | 288 | 13 | 9 |
| | NC7-sun.wilds.ann | 1665 | 421 | 323 | 34 | 27 | 2483 | 1503 | 25 | 16 | 2904 | 1546 | 59 | 43 |
| | NC7-sun.wilds.per | 888 | 488 | 420 | 22 | 20 | 2049 | 734 | 11 | 10 | 2537 | 747 | 33 | 30 |
| | NC7-sun.wilds.sp | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **Total:** | **12637** | **7475** | **5253** | **190** | **146** | **11788** | **6910** | **96** | **78** | **19263** | **7934** | **286** | **224** |
| **Millard** | NC7-corn.kin | 101 | 30 | 10 | 11 | 10 | 1 | 1 | 1 | 1 | 31 | 10 | 12 | 11 |
| | NC7-maize.gems | 316 | 441 | 163 | 34 | 25 | 177 | 101 | 5 | 4 | 618 | 192 | 39 | 29 |
| | NC7-maize.inb | 2613 | 3290 | 1218 | 252 | 199 | 462 | 283 | 54 | 50 | 3752 | 1267 | 306 | 249 |
| | NC7-maize.pop | 17121 | 2815 | 1991 | 178 | 146 | 301 | 280 | 20 | 20 | 3116 | 2146 | 198 | 166 |
| | NC7-maize.pvp | 463 | 3523 | 426 | 210 | 113 | 1123 | 351 | 43 | 37 | 4646 | 439 | 253 | 150 |
| | NC7-maize.wilds | 439 | 347 | 83 | 56 | 49 | 31 | 26 | 7 | 7 | 378 | 83 | 63 | 56 |
| | *NC7-zea.totals* | *20952* | *10416* | *3881* | *420* | *264* | *2094* | *1041* | *85* | *73* | *12510* | *4127* | *505* | *337* |
| | **Total:** | **21053** | **10446** | **3891** | **556** | **364** | **2095** | **1042** | **99** | **87** | **12541** | **4137** | **655** | **451** |
| **Reitsma** | NC7-chicory | 279 | 281 | 132 | 8 | 7 | 150 | 126 | 3 | 3 | 431 | 133 | 11 | 10 |
| | NC7-cucumis.cucs | 1388 | 816 | 698 | 25 | 24 | 1122 | 734 | 16 | 14 | 1938 | 1024 | 41 | 38 |
| | NC7-cucumis.melo | 3212 | 677 | 623 | 13 | 13 | 436 | 372 | 22 | 19 | 1113 | 867 | 35 | 32 |
| | NC7-cucumis.wilds | 320 | 9 | 9 | 2 | 2 | 94 | 88 | 6 | 6 | 103 | 93 | 8 | 8 |
| | NC7-cucurbita | 979 | 852 | 702 | 22 | 20 | 78 | 73 | 8 | 8 | 930 | 711 | 30 | 28 |
| | NC7-daucus | 1483 | 3880 | 922 | 39 | 24 | 1078 | 761 | 13 | 11 | 4958 | 1076 | 52 | 35 |
| | NC7-ocimum | 105 | 230 | 98 | 19 | 17 | 141 | 91 | 5 | 5 | 371 | 98 | 24 | 22 |
| | NC7-parsnips | 73 | 7 | 6 | 2 | 2 | 0 | 0 | 0 | 0 | 7 | 6 | 2 | 2 |
| | **Total:** | **7839** | **6752** | **3190** | **111** | **88** | **3099** | **2245** | **60** | **53** | **9851** | **4008** | **171** | **141** |
| NCRPIS Total: | | **54444** | **34473** | **17854** | **1067** | **734** | **21001** | **12480** | **343** | **285** | **55474** | **22801** | **1410** | **1019** |

| Year 2017 Table 4. 01/01/2017 to 12/31/2017 | | NCRPIS Accessions (Accs) Observations (Obs) in GRIN, Images in GRIN | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CURATOR | GENUS_CROP | Number Accs in Collection | Number of Accs Obs Trials | Number of Obs in GRIN for Year | Number of Accs with Obs in GRIN for Year | Number of Obs In GRIN Last Year | Number of Accs with Obs In GRIN Last Year | Number of Obs in GRIN (all years) | Number of Acc with Obs in GRIN (all years) | Number of Accs Imaged | Number of Accs with Images in GRIN for Year | Number of Images in GRIN for Year | Number of Acc Images in GRIN (all years) | Number of Images in GRIN (all years) |
| **Brenner** | NC7-amaranth | 3341 | 18 | 31 | 31 | 363 | 27 | 53359 | 3337 | 0 | 0 | 0 | 743 | 1166 |
| | NC7-celosia | 59 | 1 | 0 | 0 | 0 | 0 | 164 | 56 | 0 | 0 | 0 | 16 | 39 |
| | NC7-echinochloa | 310 | 0 | 6 | 2 | 1 | 1 | 1164 | 306 | 0 | 0 | 0 | 64 | 130 |
| | NC7-grasses | 133 | 0 | 0 | 0 | 0 | 0 | 281 | 113 | 0 | 0 | 0 | 21 | 23 |
| | NC7-legumes | 298 | 0 | 0 | 0 | 0 | 0 | 547 | 244 | 0 | 0 | 0 | 29 | 41 |
| | NC7-melilotus | 1004 | 0 | 0 | 0 | 347 | 61 | 7235 | 996 | 0 | 0 | 0 | 190 | 244 |
| | NC7-panicum | 936 | 0 | 629 | 206 | 4 | 4 | 4000 | 935 | 0 | 0 | 0 | 125 | 240 |
| | NC7-perilla | 25 | 0 | 0 | 0 | 0 | 0 | 86 | 25 | 0 | 0 | 0 | 10 | 17 |
| | NC7-portulaca | 12 | 0 | 0 | 0 | 0 | 0 | 10 | 4 | 0 | 0 | 0 | 2 | 6 |
| | NC7-quinoa | 432 | 4 | 0 | 0 | 12 | 6 | 1391 | 372 | 0 | 0 | 0 | 149 | 203 |
| | NC7-setaria | 1089 | 0 | 40 | 12 | 10 | 4 | 4086 | 1073 | 0 | 0 | 0 | 156 | 309 |
| | NC7-spinach | 413 | 0 | 29 | 5 | 0 | 0 | 8039 | 403 | 0 | 0 | 0 | 17 | 49 |
| | NC7-umbels | 1188 | 1 | 1 | 1 | 0 | 0 | 6144 | 1146 | 0 | 0 | 0 | 199 | 339 |
| | **Total:** | **9240** | **24** | **736** | **257** | **737** | **103** | **86506** | **9010** | **0** | **0** | **0** | **1721** | **2806** |
| **Carstens** | NC7-medicinals | 1000 | 13 | 0 | 0 | 0 | 0 | 11956 | 447 | 0 | 0 | 0 | 414 | 815 |
| | NC7-ornamentals | 721 | 0 | 0 | 0 | 0 | 0 | 152 | 101 | 0 | 0 | 0 | 101 | 153 |
| | NC7-woody.landscape | 1954 | 74 | 707 | 41 | 150 | 35 | 5010 | 841 | 1 | 130 | 726 | 816 | 2275 |
| | **Total:** | **3675** | **87** | **707** | **41** | **150** | **35** | **17118** | **1389** | **1** | **130** | **726** | **1331** | **3243** |
| **Marek** | NC7-asters | 432 | 0 | 0 | 0 | 0 | 0 | 8 | 1 | 0 | 0 | 0 | 0 | 0 |
| | NC7-brassica | 2011 | 0 | 0 | 0 | 3794 | 295 | 40507 | 1996 | 0 | 0 | 0 | 332 | 922 |
| | NC7-brassica.pvp | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | NC7-crucifers | 1269 | 0 | 386 | 79 | 574 | 48 | 7311 | 886 | 0 | 0 | 0 | 329 | 798 |
| | NC7-crucifers.pvp | 1 | 0 | 0 | 0 | 0 | 0 | 10 | 1 | 0 | 0 | 0 | 0 | 0 |
| | NC7-cuphea | 638 | 0 | 0 | 0 | 0 | 0 | 4260 | 278 | 0 | 0 | 0 | 13 | 34 |
| | NC7-euphorbia | 209 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | NC7-flax | 2834 | 0 | 0 | 0 | 0 | 0 | 1717 | 285 | 0 | 0 | 0 | 1 | 1 |
| | NC7-flax.wilds | 147 | 0 | 0 | 0 | 0 | 0 | 852 | 82 | 0 | 0 | 0 | 2 | 2 |
| | NC7-sun.cults | 2246 | 5 | 0 | 0 | 0 | 0 | 104316 | 1826 | 0 | 0 | 0 | 253 | 662 |
| | NC7-sun.cults.SAM | 289 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | NC7-sun.wilds.ann | 1665 | 4 | 0 | 0 | 0 | 0 | 40118 | 1307 | 0 | 0 | 0 | 64 | 120 |
| | NC7-sun.wilds.per | 888 | 3 | 0 | 0 | 0 | 0 | 13850 | 630 | 1 | 0 | 0 | 124 | 329 |
| | NC7-sun.wilds.sp | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **Total:** | **12637** | **12** | **386** | **79** | **4368** | **343** | **212949** | **7292** | **1** | **0** | **0** | **1118** | **2868** |
| **Millard** | NC7-corn.kin | 101 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 7 | 7 |
| | NC7-maize.gems | 316 | 46 | 1115 | 49 | 228 | 123 | 7744 | 312 | 36 | 0 | 0 | 103 | 412 |
| | NC7-maize.inb | 2613 | 80 | 1291 | 269 | 4714 | 899 | 79889 | 2476 | 71 | 0 | 0 | 588 | 1113 |
| | NC7-maize.pop | 17121 | 363 | 7230 | 845 | 3083 | 343 | 178754 | 13299 | 342 | 0 | 0 | 4198 | 6464 |
| | NC7-maize.pvp | 463 | 128 | 1688 | 116 | 1690 | 353 | 16644 | 463 | 50 | 0 | 0 | 219 | 618 |
| | NC7-maize.wilds | 439 | 0 | 0 | 0 | 0 | 0 | 331 | 200 | 0 | 0 | 0 | 107 | 115 |
| | *NC7-zea.totals* | *20952* | *617* | *11324* | *1279* | *9715* | *1718* | *283362* | *16750* | *499* | *0* | *0* | *5215* | *8722* |
| | **Total:** | **21053** | **618** | **11324** | **1279** | **9715** | **1718** | **283362** | **16750** | **502** | **0** | **0** | **5222** | **8729** |
| **Reitsma** | NC7-chicory | 279 | 1 | 0 | 0 | 0 | 0 | 4700 | 279 | 5 | 0 | 0 | 257 | 913 |
| | NC7-cucumis.cucs | 1388 | 2 | 0 | 0 | 148 | 72 | 26149 | 1377 | 48 | 0 | 0 | 920 | 1231 |
| | NC7-cucumis.melo | 3212 | 9 | 0 | 0 | 1 | 1 | 12285 | 3195 | 1 | 0 | 0 | 649 | 1074 |
| | NC7-cucumis.wilds | 320 | 0 | 0 | 0 | 0 | 0 | 681 | 287 | 7 | 0 | 0 | 75 | 110 |
| | NC7-cucurbita | 979 | 3 | 0 | 0 | 0 | 0 | 5667 | 970 | 24 | 0 | 0 | 150 | 326 |
| | NC7-daucus | 1483 | 51 | 0 | 0 | 470 | 20 | 19505 | 1361 | 99 | 0 | 0 | 681 | 3153 |
| | NC7-ocimum | 105 | 0 | 0 | 0 | 0 | 0 | 635 | 98 | 3 | 0 | 0 | 13 | 17 |
| | NC7-parsnips | 73 | 0 | 0 | 0 | 0 | 0 | 153 | 71 | 10 | 0 | 0 | 1 | 1 |
| | **Total:** | **7839** | **66** | **0** | **0** | **619** | **93** | **69775** | **7638** | **197** | **0** | **0** | **2746** | **6825** |
| **NCRPIS Total:** | | **54444** | **807** | **13153** | **1656** | **15589** | **2292** | **669710** | **42079** | **701** | **130** | **726** | **12138** | **24471** |

| Year 2017 Table 5. | | Five Year Summary of Collection Statistics | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Number Accs Acquired | Number Tested Viability | Percent Tested Viability | Number Grown | Number Harvested | Number Backed Up at NLGRP | Number Backed Up at Svalbard | Number Obs in GRIN | Number Accns Observed | Number Items Distributed | Number Accs Distributed | Number Orders Distributed | Number Recipients Distributed |
| 2017 | 250 | 3019 | 6 | 1601 | 1210 | 595 | 2043 | 13153 | 1656 | 55474 | 22801 | 1410 | 1019 |
| 2016 | 780 | 735 | 11 | 1033 | 1067 | 428 | | 15589 | 2292 | 39520 | 18093 | 1254 | 963 |
| 2015 | 229 | 1627 | 7 | 1627 | 1160 | 431 | 830 | 35153 | 8038 | 34188 | 14279 | 1186 | 945 |
| 2014 | 766 | 3024 | 6 | 1230 | 1085 | 1231 | | 48792 | 6869 | 41655 | 17558 | 1285 | 993 |
| 2013 | 192 | 1122 | 2 | 1184 | 1048 | 781 | | 14151 | 1685 | 40409 | 17788 | 1523 | 1204 |
| **NCRPIS Totals:** | **2217** | **9527** | **32** | **6675** | **5570** | **3466** | **2873** | **126838** | **20540** | **211246** | **90519** | **6658** | **5124** |

**Appendix Figure 1**