NCRPIS Annual Report - 2004
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NORTH CENTRAL REGIONAL PLANT INTRODUCTION STATION
NC-7 ANNUAL REPORT, JANUARY 1 - DECEMBER 31, 2004

I. PROJECT TITLE: NC-7 "Plant Germplasm and Information Management and Utilization."

II. COOPERATING AGENCIES AND PRINCIPAL LEADERS (current):

A. Administrative Advisor C.E. Woteki, Iowa
B. Regional Coordinator *C.A. Gardner, Iowa
C. State Experiment Stations Representatives

1.	Illinois	*T. Hymowitz	7. Missouri	*D. Sleper
2.	Indiana	*J. Janick	8. Nebraska	*D. Baltensperger
3.	Iowa	*C. Brummer	9. N. Dakota	*B. Johnson
4.	Kansas	*	10. Ohio	*D. Francis
5.	Michigan	*A. Iezzoni	11. S. Dakota	*A. Boe, Chmn.
6.	Minnesota	*S. Hokanson	12. Wisconsin	*W. Tracy

*Voting members

D. U. S. Department of Agriculture

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

E. North Central Regional Plant Introduction Station, Ames, Iowa
See organizational chart, Appendix 1.

III. PROGRESS OF WORK AND PRINCIPAL ACCOMPLISHMENTS:

Our mission continues to focus on acquisition, documentation, regeneration, characterization, evaluation, and distribution of germplasm and associated information. The world's biological diversity and plant genetic resources (PGR) continue to be threatened by climatic, social, political and environmental pressures. Demand for genetic diversity and development of supporting technologies to increase the availability of PGR continues to increase.

Available resources (approximately $2.6 M from ARS and $0.53 M from NC7 funds) were devoted to this mission, in order to secure the plant genetic resources entrusted to us and the safety of our staff, to modify supporting processes, and to research designed to provide information which improves the quality, value and utility of the collections.

The NC-7 Ornamental Trials marked their 50th anniversary in 2004, which was celebrated at the 2004 METRIA Conference. Progress on updating the Operations Manual continues, in order to improve practices based on new technologies and learning. The Operations Manual provides relevant reference and/or training materials to guide our staff in their curatorial operations and procedures, ensuring high standards and quality of operations. NCRPIS Staff contributed to the revision of the Acquisition and Distribution Policies for the NPGS, and to the Active Site section of the revised NPGS Operations Manual.

Personnel changes: May, 2004 – June, 2005
Departures:
Jaryd Sunstrom, USDA-ARS Student Computer Intern, June, 2004.
Mary Block, ISU Temporary Seed Storage Tech., September, 2004.

June Smith, USDA-ARS Research Unit Secretary, January, 2005.
Mindy Weishaar, USDA-ARS Agri. Res. Science Tech, Maize Curation, May, 2005.
Gaylan Crim, ISU Field Lab Technician II, Maize Curation, June, 2005.

New Hires:
Mindy Weishaar, USDA-ARS Agri. Res. Science Technician, Maize Curation, August, 2004.
Andy Smelser, USDA-ARS Term Agri. Res. Science Technician, GEM Project, September, 2004.
Josh Davis, USDA-ARS LA Computer Intern, October, 2004.
June Smith, USDA-ARS Research Unit Secretary, October, 2004.

Transition:
Stacey Winter, previously USDA-ARS Office Automation Assistant, assumed the role of Research Unit Secretary, May, 2005.

Visiting Scientist
Ana Gulbani, Academy of Agricultural Sciences of Georgia, Tbilisi, Republic of Georgia arrived on October 31, 2004. Ms. Gulbani is learning all phases of germplasm management and curatorial activities, and will depart in early 2006.

Management of Federal STEP (Student Temporary Employees):
Approximately 60 ISU students were hired to fill 29 FTE positions which supported curatorial projects, viability testing, IT support and development, and farm and facilities operation. Students were interviewed and selected by ISU Program Manager Larry Lockhart or ARS IT Specialist Peter Cyr. Cris Nass and Stacey Winter managed all hiring processes, with support and guidance by Ames ARS HR Specialist Janae Lentz.

Construction and Facilities:

Highlights include renovation of office space, conversion of office space to a modern viability testing laboratory, installation and implementation of a keycard access security system, and completion of remodeling/construction in an existing office to convert its use to a computer server room. The south seed storage room exterior was coated with Icynene insulation; this resolved a long-standing condensation problem in that area. The shop was reorganized so space could be used more efficiently and equipment could better be secured. Office space was added to the shop for Brian Buzzell and Lloyd Crim. Their former office in the HQ building was converted for use by new curatorial staff.

Design was completed for a 60 x 100 machinery storage shed, to be built in the spring of 2005. The greenhouse committee (Chaired by Larry Lockhart and Curator Kathy Reitsma) developed plans for a 25,000 sq ft greenhouse facility and a 10,000 sq ft headhouse facility, which remains unfunded. An NPGS initiative across locations is under development to secure needed greenhouse facilities at multiple genebank sites.

Equipment:

New equipment acquisitions included two new tractors, two vehicles, a wood chipper, fork-lift, twenty large cucurbit cages and a tilt-bed trailer for hauling organic debris to the composting area. Twelve PC workstations were replaced based on life cycle needs; a new large format printer was purchased for staff use; workstations were updated with Microsoft Office 2003 and Altiris 6.0 systems management software; the backup system was rebuilt to improve reliability and security.

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

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

Acquisition:

Total acquisitions in 2004 numbered 450 accessions, including wild *Helianthus* from the southwestern US,; *Hypericum* (St. John's wort), Brassica from other collections; vegetable germplasm; maize and its relatives from existing collections and other researchers; Brassica species with phytoremediation applications.

Our medicinal/nutriceutical curator, JoeAnn McCoy, acquired 138 new accessions of medicinal species, representing 44% of the current collection. Nineteen accessions of black cohosh (*Actaea racemosa*) from its native range were acquired through a research donor.

The Maize collection grew by 35 accessions, including 12 newly expired PVP lines; six CSR-registered inbred lines; one Onaveno landrace collection from Mexico; five sweet corn populations from William Tracy, Univ. of Wisconsin; two Arizona landrace collections via Matt Krakowsky, the USDA breeding collection at Tifton, GA; one apomictic maize line from Bryan Kindiger, USDA-ARS, El Reno, OK.

Ornamental and mint family acquisitions consisted of 58 accessions including 16 collected from wild populations in MN by Mark Widrlechner and Jeff Carstens; 10 from the Ozarks and Carolinas made by J. McCoy; 8 from the Republic of Georgia, and 10 which were re-obtained from original sources.,

The *Helianthus* collection received 13 *H. californicus* from Tom Gulya and Gerald Seiler, USDA-ARS, Fargo, ND; 14 accessions from the SE US; three *H. niveus* ssp. *tephroides* from CA collected by BLM collaborator Chris Knauf; 19 from four species collected in southern CA by Gulya and Marek. These new accessions include 10 species which have not previously been available for distribution. Increased interest by the sunflower research community in wild *Helianthus* germplasm has led to a CGC approved goal of acquiring representation of the geographic distribution of all 66 *Helianthus* species.

The *Eruca* (arugula) collection received 62 new accessions from Jules Janick, Purdue Univ., IN, which he collected in the Mediterranean area of Europe; one *Alyssum murale* accession was received from Rufus Cheney, USDA, Beltsville, MD, which is capable of Ni hyper-accumulation and may be useful for phytoremediation. Nine accessions of *Linum usitatissimum* (flax) were received from an ICARDA/NPGS collection trip in Tajikistan; one *L. lewisii* accessions received from the NRCS Plant Materials Center in Aberdeen, ID through Shawn Belt, NRCS Beltsville, as a selected ecotype for restoration of disturbed sites in the central intermountain west. One *Cuphea viscosissima* accession was collected in Missouri by McCoy.

Twenty-two accessions of *Melilotus* were received from a joint ICARDA/USDA-ARS plant exploration project in Tajikistan; five millet accessions transferred from NCGRP; and a small number of amaranth, quinoa and umbel accessions.

Forty new vegetable accessions were received, including seven *Daucus* varieties transferred from the NCGRP in Ft. Collins, CO and incorporated into the collection following regeneration by cooperators; four *Cucumis melo* varieties and one Greek *Cucumis* landrace through California researchers; one *Cucumis melo* and 22 *Daucus* collected from Uzbekistan by Paul Simon, USDA-ARS, Madison, WI; one *Cucumis melo* and two *Cucurbita pepo* from NCGRP as expired PVP lines.

Regeneration and Maintenance:
J. McCoy determined that Black cohosh, goldenseal (*Hydrastic candensis*), blood root (*Sanguinaria canadensis*) and fairywand (*Chamaelirium luteum*) were able to survive the winter and successfully reproduce in Iowa.

Over 1600 total accessions were grown for regeneration with 1,363 harvested. Approximately 1,197 accessions were made available to the public. Over 3,000 accessions were tested for viability, approximately 6% of our holdings. About 615 accessions were backed up at the NCGRP; 76% of our holdings are currently backed up, and 71% are available.

An accession of *Ferula communis* (Ames 23700) matured seeds for the first time. This species is unusual for having summer dormancy. It dies back to the ground in the summer then grows in the fall and flowers in March.

Distribution:
Nearly 197 plants of five accessions were distributed to approximately 20 sites for evaluation in the Regional NC-7 woody ornamental trial evaluations across the Midwestern U.S.

2004 distributions included 17,983 seed packets or plants in 809 orders to external germplasm requestors. These represented 10,481 accessions, consistent with an annual 20-25% distribution of all holdings. Approximately 69% of these were to U.S. and 31% to international requestors. Additionally, 8,238 items were distributed within the NCRPIS. Approximately 20-25% of the collection continues to be distributed each year. Seed order numbers have increased (15%) due to interest from home gardeners; although our resources cannot support maintaining and distributing the collections to home gardeners, we have tried to use this development to educate the public about plant genetic resource conservation and encourage interested individuals to save seeds, conserve and share germplasm and associated information.

Two multiple disease-resistant sunflower germplasm populations, SAM-1 and SAM-2, released in 2004, have been widely distributed. Other heavily demanded crops for research purposes include oilseed brassica and crucifers for disease screening (black stem rot and white mold), crop improvement, and phytoremediation; sunflower for disease resistance, oil quality traits, and adaptation; maize for many purposes; vegetables for disease traits, flavor and aesthetic traits, and general crop improvement; millets for crop improvement; prairie coneflower for nutriceutical and ornamental traits; woody and herbaceous ornamentals for ornamental research and varietal improvement.

Evaluation and Characterization:

Over 4,500 accessions were observed and characterized for a wide array of descriptor information; over 18,600 observations were transferred to the GRIN database in 2004.

NC-7 Ornamental Trial Cooperator data was summarized for 1,5, and 10 year periods. These included tree seedlings grown from the seeds collected during the 1999 Ukraine exploration.

DNA extractions of coriander were followed by isozyme and SSR analyses by graduate student Pedro Lopez; the information will be analyzed together with previously collected morphological, phenotypic and biochemical traits to establish phylogenetic associations. Initial analyses were completed in 2004, final analyses are expected to be complete prior to December, 2005.

Graduate student Von Mark Cruz completed morphological and flowering data characterization of the *Brassica napus* collection, extraction of DNA, and is in the process of sequencing introns of flowering gene loci Flc 1 and 3. A project to assess SSR profiles of bulked *B. napus* accessions, and incorporate morphological data into analyses to determine the appropriateness of bulking accessions is in progress.

DNA capture on Whatman FTA paper storage media has been investigated by Laura Marek; development will continue this winter in cooperation with the ISU Seed Science Center. Dr. Marek utilizes this media to capture tissue DNA during plant explorations; it has also been used to capture Brassica DNA by graduate student Von Mark Cruz and by C. Gardner and D. Muenchrath for the Southwestern U.S. Maize Project.

Hypericum and *Echinacea* are being evaluated and characterized as they are regenerated.

Data analysis was completed on cultivated sunflower accessions for resistance to sunflower moth feeding.

Information management and computers:

Digital image capture continued to be a major area of focus, resulting in capture of over 3,120 images of almost 1700 accessions in 2004. Efficient capture and transfer of digital images to GRIN required development of standards, protocols and software to automate the naming, capture, management and mass-loading of the images to GRIN. The standards were developed by our internal Imaging Committee, led by Maize Curator Mark Millard, over a period of years. ARS IT Specialist Peter Cyr and ISU Maize Curator Mark Millard completed software development in May, 2005. NCRPIS crop curation teams have implemented its use and it is will be provided via the Database Management Unit (ARS, Beltsville, MD) to interested NPGS genebank personnel.

Maize GDB now links molecular genetic information to accession information located in the GRIN database; its order module enables genomic researchers to order maize accessions referenced in the GRIN database.

Digital capture of the Races of Maize Volumes was nearly completed in 2004; capture of the Spanish versions of the volumes will complete the project in ‘05.

Testing germplasm’s germination, viability, and health:

L. Towil of ARS-NCGRP successfully collaborated with M. Widrlechner to develop and evaluate methods of storing *Salix* (willow) clones via cryogenic conditions.

Germination methods developed by Crane & Walters (NCGRP) in collaboration with NCRPIS Oilseeds Curator Laura Marek (ISU) for *Cuphea sp*. were successfully implemented by the NCRPIS oilseeds curation team. This enabled regeneration of some accessions which previously could not be germinated adequately. Methods developed by Dave Kovach (ARS) and Marek to break dormancy in wild *Helianthus*, *Cuphea* and *Linum* were tested and implemented to promote germination of these taxa.

C. Block and K. Reitsma authored a manuscript describing evaluations of 977 cucumber accessions for powdery mildew resistance, caused by *Podosphaera xanthii* (syn. *Sphaerotheca fuliginea*). Seventeen of the 20 most-resistant accessions came from Asian sources.

Field observations for disease resistance were made for sunflowers resistant to Septoria leaf blight; maize for artificially infested Stewart's wilt and naturally occurring common rust and gray leaf spot; vegetables for viruses and bacterial diseases. Monitoring for naturally occurring pathogens to preclude accidental distribution of infested seed is an ongoing part of germplasm maintenance and distribution activities.

ARS Pathologist Charlie Block developed real-time PCR primers for *Pantoea stewartii*, the causal agent of Stewart's bacterial wilt of maize, in cooperation with ISU Seed Science researchers.

Insect management:
Our entomologists are developing methods to better utilize alfalfa leaf cutter bees in our regeneration programs. Use of alfalfa leaf cutter bees (ALC) for sunflower, Brassica and vegetable curation programs was evaluated in the field and greenhouse in 2004-2005, and for some ornamental species in the field in 2005. Seed production using ALC's is being evaluated to compare their efficacy with honeybee, fly and bumblebee use in seed regeneration efforts. More extensive use of non-stinging, solitary ALC bees could improve worker safety and decrease program costs. In-house fly rearing was terminated in 2004; fly pupae are now purchased, resulting in cost-savings and enabling our researchers to spend their time more effectively.

Enhancement:
Charles Block released two wild *Helianthus annuus* populations with multiple disease resistance to Alternaria leaf blight, Septoria leaf blight and powdery mildew. The populations, SAM-1 and SAM-2, were added to the sunflower germplasm collection.

Outreach and Scholarship:
Over 320 visitors toured the NCRPIS during 2004. Our staff participated in teaching students from the grade K to postgraduate level, provided outreach events to civic and other organizations about germplasm conservation and management, and the work done at the NCRPIS. Scientific and technical staff members continue to publish scholarly journal articles and make presentations at scientific meetings, and to supervise graduate research programs.

Current and future foci:
Horticulturist M. Widrlechner serves as chair of a national Technical Review Committee that provides technical direction and oversight to a new ARS project to update the USDA Plant Hardiness Zone Map, using the best available technologies and data sets, and make it accessible via the Internet.

V.M. Cruz will conduct a study in 2005 designed to assess whether gene flow occurs between *B. napus* accessions using established NCRPIS regeneration procedures.

Real-time PCR analysis was adopted by Pathologist C. Block's team for routine detection and identification of *Acidovorax avenae* subsp. *citrulli* (Aac), the bacterial fruit blotch pathogen of melons. This allows monitoring and rapid identification of the organism directly from field or greenhouse leaves in one day. Cooperative research with Dr. Ron Walcott, Univ. of Georgia, is focused on developing real-time PCR methods for the simultaneous detection of multiple pathogens from seeds. Efforts continue to identify vectors of cucurbit viruses that may infest plants through screen cages.

In addition to wild spinach, the genera *Monolepis* and *Suckleya* were assigned as priority crops at the NCRPIS since they are believed to be the closest related to *Spinacia*. As yet we have no germplasm of these genera, but we plan to acquire them from wild sources within the United States.

In 2005-2006, our curators will focus on assigning PI numbers to Ames numbered accessions, in addition to their normal duties. *Helianthus* core collection analysis was temporarily stopped due to personnel changes and will be re-initiated in 2005. Methods continue to be developed by Lisa Burke and Mark Widrlechner to analyze and anticipate collection demands, improving our ability to rapidly respond to requests.

Our Accession Performance Reporting format is undergoing revision and will be made available to requestors via a web-delivery format. This is part of an effort to improve our ability to assess the impact of our efforts.

Software which will support data capture on handheld PC's will be developed in 2005-2006. Use of servers and software to manage digital image and document image files will be implemented.

Several of our staff members contributed to advanced GRIN training of Ornamental Plant Germplasm Center (OPGC) personnel, in Columbus, OH during the past three years; as the new genebank matures, the expertise of its personnel increases and their technical needs become more sophisticated. We are happy to contribute to their growth.

V IMPACTS OF GERMPLASM USE BY NORTH CENTRAL REGIONAL RESEARCHERS

Impacts of germplasm use by the researchers at the NCR institutions: Following is a brief snapshot (by state) of examples of germplasm use in research being conducted at NCR institutions. All NCR states participate in the NC-7 woody ornamental trials, which marked their 50th anniversary in 2004. These trials represent the longest running evaluation trials in the U.S.; they are a key component for identification of useful materials for the ornamentals industry which have the necessary traits for adaptation in our cold, arid winters, and highly variable summers. This program effectively links the institutions of the NCR and beyond.

Illinois: NC-7 RTAC member Dr. Theodore Hymowitz screened the collection holdings (*Glycine*) of the soybean germplasm collection from the Champaign-Urbana soybean germplasm bank and successfully identified accessions free of the protein responsible for allergenicity to soybean. These accessions will provide alternative genetic resources for development of non-transgenic products designed to eliminate the problem of allergenicity to soy protein. Elimination

of potential allergenicity from soy products is of tremendous benefit to human health and nutrition; his research has determined PGR which will be useful for studies designed to understand the basis of the allergic response and will provide for improved human nutrition.

Dr. Win Phippen, Macomb, IL, has utilized the Cuphea collections for his research efforts to develop Cuphea varieties adapted to the Mid-West. Dr. Phippen serves as part of a multi-institution team focused on developing Cuphea into a new crop which can be rotated with corn an beans. It serves as a source of capric acid (and potentially lauric acid) and may replace the need for palm kernel oil as a source of these valuable fatty acids.

Researchers Volenberg and Wassom utilized the amaranth collections for weed science research, particularly for herbicide efficacy screening. E.T. Johnson utilized the Perilla collection for evaluations of plant-based chemicals for insecticidal or insect-damage reducing activities.

Indiana: NC-7 RTAC member Jules Janick collected 83 accessions of *Eurica*, *Diplotaxis* and *Foeniculum* sp. from Italy and Crete, Greece in 2004. This work is in conjunction with identifying improved sources of arrugula for fresh consumption in the U.S. They were obtained via exchanges with seed companies or Italian agencies, and retail purchases.

James Simon's group is investigating a variety of aromatic plant compounds for the herbal industry, including those from *Coriandrum* and *Perilla*.

Iowa: An on-going NIH research project designed to elicit the basis of pharmacological activity of Echinacea is led by principal investigator Diane Birt and involves a number of ISU and Univ. of Iowa researchers. ARS Curators Mark Widrlechner and Joe-Ann McCoy are responsible for providing needed germplasm.

Researcher David Senchina's lab compared the efficacy of extracts from roots of five species of *Echinacea* in 2003 in modulating specific immune parameters of human white blood cells in vitro. Publication of results is pending.

Loren Stephens investigated self-incompatibility systems (SI) in *Echinacea*, and studied the feasibility of developing an inbreeding method using a self incompatibility system, in order to make uniform F1 hybrids. Results have enabled the focus to be narrowed to the progeny of two accessions from Louisiana (*E. purpurea* Ames 25104 079) and Missouri (*E. purpurea* Ames 23959 053) with fairly strong self-incompatibility systems.

Amaranthus tuberculatus germplasm has been provided to researcher Ramon Leon for use in identifying genes controlling seed dormancy regulation.
Matt Liebman utilized various accessions of *Amaranthus*, *Brassica*, and *Setaria* for determining the relationship between seed weight and susceptibility to phytoxins extracted from red clover and alfalfa shoots.

Ian Zelaya studied the inheritance and evolution of herbicide resistance in *Amaranthus* and other genera. Curator David Brenner provided seed lots of accessions collected prior the introduction of specific herbicides, which are useful as base-line vouchers prior to evolution of herbicide resistance.

Donald Pratt's work at ISU focused on evolutionary relationships in *Amaranthus* and related taxa; he collected and provided unique accessions to the collection to be used for molecular research in this area.

William Graves and Mark Widrlechner studied the phytosynthetic and growth responses of birch and alder in response to drought and flooding stresses.

Jeffery Iles and M. Widrlechner assessed the risk of naturalization of non-native woody plants in Iowa.

Pedro Lopez utilized 139 *Coriandrum* accessions from 36 countries for his characterization of morphological, molecular, phenological and biochemical traits, including chemical analysis of the volatile compounds from leaves and essential oil performed at the USDA-NCAUR Lab in Peoria, IL. DNA markers (AFLPs) from 60 accessions are being developed to compare the findings from morphological, phenological, and chemical studies with molecular markers.

ISU Extension Researchers utilized historic maize germplasm (George Cummins) and alternative crops such as amaranth (Bernie Havlovich) to provide a useful forum for discussion and transfer of knowledge. Germplasm for historical demonstration has been used by local 4-H clubs who learn about their use (Daniel Burkhart.

James Oelson utilized maize inbreds for insecticide efficacy tests with grape colaspis. Grape colaspis stunts inbreds grown in production fields by feeding on the smaller inbred root systems; the problem is restricted to growers involved in seed production but is periodically a significant issue.

Maize germplasm from Uruguay and Argentina is being evaluated by ISU and ARS maize researchers for native resistance to feeding by corn rootworm larval. Diabrotica species are believed to have originated in this area; native maize germplasm which co-evolved with the insect is a potential source of non-transgenic resistance to insect feeding.

Amalio Santacruz-Varela and ISU and ARS researchers established phylogenetic relationships among North American popcorns and their evolutionary links to Mexican and South American popcorns and proposed new taxonomic racial distinctions based on isozyme and SSR allelic analyses as well as characteristic traits.

Two wild sunflower populations with resistance to Alternaria and Septoria leaf blights, SAM-1 and SAM-2, were released by ARS researcher Charles Block. These blights are problematic in sunflower production fields in many parts of the world. These populations incorporated resistance genes from 28 wild sunflower accessions over five cycles of selection.

Kansas: Researcher Donald Stuteville used NC-7 *Melilotus* germplasm in host range studies to determine plant disease differentials.

RTAC member Charlie Rife used Brassica germplasm in screening studies and breeding programs designed to develop new canola varieties with needed traits.

Michigan: Rebecca Grumet screened 150 accessions of cucumber germplasm for novel architectural types which would reduce Phytophthora crown and root rot, and for resistance to direct fruit infection by *Phytophora capsici* in 2003. Several types are being evaluated further. Dr. Amanda Gevens' quantified sporulation in direct fruit challenges with *P. capsici*; this research is in conjunction with a grant with the Pickle Seed Research Fund, Pickle Packers International.

Fernando Goffman's efforts to determine relationships between oil content of Brassica germplasm and the efficiency of biomass accumulation are in progress, as is work examining the relationship between sunflower embryo oil content and germination, growth and flowering characteristics.

Dr. Robert Schutzki continues to evaluate ornamental woody germplasm as part of the NC-7 ornamental trials, and is involved in efforts to address risk assessment of invasive species.

Minnesota:
Minnesota researchers participate in the NC-7 ornamental trials, designed to identify woody ornamental germplasm suitable for the upper Mid-West, and have conducted classical and molecular genetic research on many species, particularly maize.

Missouri: Patti Wright has utilized a number of NCRPIS species in her research studying the effects of carbonization to assist in the interpretation of carbonized archeological remains.

Elizabeth Kellogg and others at the Univ. of Missouri - St. Louis have requested an array of species for use in plant anatomical research, especially grasses such as Setaria.

USDA-ARS maize researchers (Darrah, McMullen, and Coe) at the Univ. of MO - Columbia have requested maize and teosinte for use in molecular investigations and corn rootworm research. Mike McMullen is part of an NSF grant with John Doebley of Wisconsin.

Chris Starbuck utilized woody ornamental varieties for the NC-7 trials.

Nebraska: RTAC member Dr. David Baltensperger continues to work on improved amaranth variety development with ISU Curator David Brenner. Baltensperger's work on breeding of millets and amaranths is designed to diversity the agriculture of the High Plains.

Robert Graybosch characterized proso millet starch types and identified a rare, waxy starch type which is of interest for Asian export markets.

Ken Russell evaluated maize germplasm for short growing season potential.

North Dakota:
Burton Johnson and other researchers conducted valuable research on variables affecting agricultural production of crops suitable for the Northern Great Plains. These efforts included studies on row spacing, plant population, cultivar effects, and water use patterns on production of grain amaranth, niger seed, and canola.

Ohio: The new Ornamental Plant Germplasm Center (OPGC) was established at the Ohio State University; this is a result of collaboration between the university and USDA-ARS.

South Dakota:
Arvid Boe and other South Dakota researchers work to understand the genetic x environmental interactions of key species of grasses and clovers, and to introduce varieties suitable for agricultural production practices in the Plains.

Wisconsin: James Coors developed corn breeding populations of great value for a silage breeding program; these populations contain germplasm obtained from the PI station at Ames. In cooperation with the Germplasm Enhancement of Maize project at Ames, accessions continue to be evaluated and introgressed that greatly improve forage yield and nutritional quality of the releases from his breeding program. This germplasm is unique for both its forage characteristics and genetic background, and is essential to the success of the Univ. of Wisconsin silage breeding program.

Bill Tracy released ten sh2 sweet corn inbreds that derived from 50% Mexican Dent germplasm. These lines had excellent resistance to MDMV (Maize Dwarf Mosaic Virus) and common rust (*Puccinia sorghi*). The source of the Mexican Dent germplasm was a population that Everett Gerrish at Cargill had developed and donated to the PI collection at Ames. In 2004, Dr. Tracy also identified three sugary1 alleles in germplasm received from NCRPIS.

Melilotus research efforts include breeding for low coumarin forage use (Heathcliffe Riday and Frisch) and characterization of chloroplast DNA sequences (John Raasch). If commercially viable, seed production of forage *Melilotus* would be less expensive than alfalfa.

Phil Simon's vegetable research program includes work with *Coriandrum*, *Petroselinum*, *Eryngium*, *Kalopanax*, *Anethum*, and *Daucus*. Simon has collected extensively throughout the world, and made significant contributions to the quality and content of the NCRPIS vegetable and umbel collections. His 1999 Plant Breeding Reviews article is a classic analysis of how germplasm was domesticated and developed, and how the PGR collections continue to significantly contribute to modern improvement.

Jack Staub's lab, in conjunction with ISU Vegetable Curator Kathy Reitsma, developed a core collection of *Cucumis sativus* using phenotypic and molecular marker data. He has released recombinant cucumber inbred lines during the period of this review.

Linkages among project participants and with other projects/agencies and contributions of the technical 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 use germplasm provided by the NCRPIS; some states have collaborative research efforts.

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, who they benefit, and how benefits are realized, which are essential for determining the impact and value of the project
- 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 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.

Specifically, the RTAC suggested in 2004 that a system be implemented to track journal publications, varietal releases and other examples of technology transfer resulting from germplasm distributions or research activities, particularly those impacts resulting from activities of NCR institutional members. Linking the impact of germplasm distributions to the NC-7 project has been difficult to track in the past. This is partially due to the nature of germplasm research and the lengthy time periods involved and partially due to lack of necessary database linkages. A new web-based tracking procedure has been developed by NCRPIS personnel; it will be released in February, 2005. It will be reviewed by the RTAC in 2005, and also by GRIN database personnel for potential export to other NPGS sites.

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.

VI. SUPPORT TEAM REPORTS

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

We supervised and coordinated daily operations at the NCRPIS farm, including management of all facilities, fields, and greenhouse space. We supervised or conducted pesticide applications in the field and campus greenhouses. We responded to maintenance requests from staff members at the farm and the campus location. We selected, coordinated and scheduled the student labor force of 26.0 FTE's. We coordinated and completed facility construction and upgrades.

Labor:
During 2004, 147 applications for hourly employment were received and reviewed. There were 70 interviews, resulting in 58 hourly employees hired. Currently there are 57 Biological Science Aides (20.0 FTE) working at the NCRPIS.

NCRPIS FARM CREW Personnel:

Larry Lockhart (Program manager II) has been on staff since 1985.
Lloyd Crim (Equipment Operator III) joined the staff in March 1998.
Brian Buzzell (Farm Mechanic) joined the staff in May 2002.

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

1) Coordinated the installation of the Security Access System.
2) Remodeled shop and machine shed to provide office space for Farm Mechanic and Equipment Operator
3) Converted office space to a new, modern viability testing laboratory.
4) Remodeled Support Staff offices to facilitate office sharing and security systems.

5) Installed spray-on insulation to the South Seed Storage Room
6) Designed and marked out new field plots on 30 Acres of newly acquired land.
7) Re-shingled Cave vernalization facility
8) Installed reverse osmosis/de-ionization systems for germinators and growth chambers.
9) Planned and Designed new 60 x 100 equipment storage shed.
10) Constructed a secure server room in former office space.

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

1) Two vehicles.
2) Two tractors.
3) Large Cucurbit Cages
4) ZTR Mower
5) Office furniture for remodeled areas
6) Wood Chipper
7) Growth Chambers for Alfalfa Leaf Cutter rearing

Tours:
This past year, we organized and conducted 17 tours. There were 353 visitors to the NCRPIS during 2004.

Staff Training:
We conducted two Tractor Safety training sessions and several Worker Protection Standard training sessions for the new student employees and existing staff.

Future Plans:
1) Construction of new Machinery Storage Shed
2) Remodel Horticulturalist Office
3) Remodel and upgrade germination lab/curators office

b. <u>Computers and Telecommunications (P. Cyr)</u>

In March, 2004, Pete Cyr assumed the duties of the NCRPIS IT Specialist. During the 2004 period, he supervised a student intern, Jaryd Sunstrom. The following list outlined the progress made during FY 2004 at NCRPIS.

Equipment:
As of December 2004 NCRPIS has 72 workstations installed for use by permanent staff members and part-time temporary student help. There were 12 new workstations deployed in 2004 to permanent staff based on a prioritized needs-based list. Where possible the displaced computers were re-commissioned for light duty work in other areas of NCRPIS and/or donated to local community school systems.

The backup server was rebuilt from scratch to enable higher reliability backup services for the NCRPIS servers and shared file systems.

A new workstation for capturing weather data was built when catastrophic disk failure rendered the original weather workstation useless. A new workstation and scanner were installed in the front office for general NCRPIS community scanning needs, creation of electronic versions of the Races of Maize library, and archival of NCRPIS accession APRs.

Software:
All of the workstations at NCRPIS are standardized on Windows XP with Service Pack 2 installed for increased security and reliability. Daily updates to anti-virus and periodic updates to anti spy-ware definitions help to ensure that these workstations stay healthy and productive.

All workstations at NCRPIS were upgraded to Microsoft Office 2003. In order to more efficiently use NCRPIS budget resources, we migrated from individual Adobe PhotoShop licensing for the imaging lab and curator workstations to a 7-user concurrent license of Adobe Creative Suite which allows us to have PhotoShop installed on any computer but only 7 users can simultaneously use the software.

All workstations were upgraded to Altiris 6.0 systems management software.

New software was written for the rebuilt weather-station which replaced 4 individual software products that were loosely coupled with one in-house application written for the Microsoft .NET framework.

In 2004 NCRPIS upgraded several administrative workstations with standard USDA/ARS software packages including ARIS, CATS and PCMS.
Assisted the Database Management Unit (DBMU) in Beltsville, D. Kovach, and M. Millard with changes and enhancements to the GRIN database system used extensively at NCRPIS.

Documentation:
The Races of Maize project had significant alterations and enhancements made during 2004 which has brought the project's closure within reach for FY 2005.

The NCRPIS intranet website was maintained and upgraded as needed with posting of committee meeting minutes, and repair/revision of static and dynamic page links.

Plans for FY 2005:
Continue to replace NCRPIS workstations on an as needed basis (targeting a 3-5 year lifespan for daily use workstations).
Upgrade the NCRPIS Microsoft Exchange email server from 5.5 to Exchange 2003.
Upgrade the anti-virus software used to protect the servers and workstations at NCRPIS.

Develop, test and deploy a two phase solution to bulk processing and uploading of image data from NCRPIS to the GRIN system in Beltsville. The first phase is to develop a PhotoShop plug-in (or Java script) to automate the entry of image document meta-data from laser-scanned barcodes attached to samples that are being scanned on the flat-bed scanner. The second phase is to develop, test and deploy an application that will process (in bulk) whole directories of images. The processing in this second phase application will include inserting data into the GRIN database that is pulled directly from the individual image's meta-data, and then the application should upload the images to the GRIN server in Beltsville. The first phase is targeted for first quarter of 2005 and the second phase is targeted for second quarter of 2005.

Upgrade the door access/security system for the NCRPIS buildings located at the farm. These upgrades are directed at improving the reliability of the system and may involve relocating the main server used for controlling security system.

Develop, test and deploy applications to be installed and used on the Compaq iPaq PocketPCs. These applications will be designed to assist curators in collecting and analyzing field data. The target date for completion of the project is end of second quarter of 2005.

c. <u>Seed Research and Computer Application Development (D. Kovach and M. Erickson)</u>

Seed Research:
During 2004, David Kovach contacted researchers in New York who are developing methods to control microbial growth in fabrics and paper products. Germination paper was sent to Dr. Engel, Professor of Chemistry and Biochemistry, Queens College, NY for treatment. Experiments were conducted using the treated paper to test how well it controls fungal and bacterial growth during germination tests. Initial results demonstrated excellent control of the microorganisms, but very poor seed germination. Follow-up experiments with less heavily treated paper to allow better seed germination did not control the microbial growth. Other methods will be investigated.

In 2004, several experiments were conducted on breaking dormancy in wild *Helianthus*, *Cuphea*, and *Linum*. Tests conducted late in 2004 with higher concentrations of gibberellic acid and lower temperature regimens than are normally used at NCRPIS were promising. Follow-up experiments are planned to verify this treatment's effectiveness in promoting germination in several genera.

D. Kovach and M. Erickson attended the I.S.U. Seed Technology Conference held in February of 2004.

Computer Application Development:
During 2004, D. Kovach made significant changes to several of the Station's internal forms used to help generate annual statistics for this report. These changes now allow us to generate information on the number of accessions actually being sent out from the station to requestors and the number of accessions that are being used at the station for regenerations, germinations, observations, pathological tests, and backing up to NCGRP. This information was requested by Dr. Gardner and other staff members.

Mr. Kovach learned more about using JDeveloper to create Client-side and Web-enabled forms, by attending the 2004 Oracle Developer Tools User Group (ODTUG) Conference. He worked with the JDeveloper 10g software and made progress in developing a client-side form and several web-based forms. The client-side form addressed a special data-loading need to create specialty labels for the GEM project. The web-based forms were for Accession Performance Reports (APR). In addition, Mr. Kovach attended free Oracle Users Group Meeting to keep abreast of latest developments. He also worked with Quinn Sinnott of DBMU and deployed Java Server Page (for the web-enabled APR form).

In order to support the efforts of the Ornamental Plant Germplasm Center (OPGC), D. Kovach adapted and reprogrammed Oracle Forms and Reports for making various labels to work at both NCRPIS and OPGC. He traveled to OPGC in Columbus, OH to install the labeling software and instructed personnel on its use. Alterations were also made to certain Oracle label forms due to field size change in the prod.nc7siteiv table in GRIN.

In 2004, two alternative software vendors for forms development were investigated, IBM's Websphere Studio Application Developed and a trial version of Sun's Java Studio Creator. The Sun Java Studio Creator software showed future promise, but was not as useful as the currently used software, Oracle's JDeveloper.

Internet website related:
During 2004, D. Kovach created web-based APR forms and posted them for curator review. Major changes were requested and implemented. The DataBase Management Unit (DBMU) in Beltsville showed interest in incorporating the NCRPIS APR form on a national level.

Mr. Kovach continued to maintain the station's internet site with updates as needed. Help was provided to NC7 personnel in maintaining the Ames Area Civil Rights Advisory Committee website.

Equipment and facilities related:
In 2004, D. Kovach created or modified Architectural Desktop / AutoCAD drawings to help meet local facility improvement needs. This involved working with the Station Superintendent, Curators, RL, and staff to create facility drawings (front office, germination room, campus greenhouse plans, proposed greenhouse plans, elevated shop office, and GEM Lab renovations), cage drawings (pumpkin, carrot, proposed 7x21), field planting maps, seed order distribution maps, and a personnel photo poster. Modifications were made to facility plans, station networking plans, and door security drawings, as requested.

This past year, a large format printer was obtained to create AutoCAD drawings and large maps. World and U.S. maps were printed for Seed Storage to display geographic patterns of order distribution. This printer will also be used for creating scientific and public information posters.

In 2004, two new workstations were installed for the Seed Storage room. D. Kovach maintained Zebra printers and helped spec and purchase two new Zebra printers for the Maize and GEM projects. The Zebra printer drivers were installed on the network server, and instructions were documented to enable other personnel to do this in the future. Approximately 11,000 specialty labels were located and ordered for the Muenchrath-Gardner maize project, and standard strip labels were printed for the GEM project field day. A new print head installed to replace a defective part.

Supervision:
This past year, Maria Erickson, Agricultural Biological Science Technician, continued to oversee a crew of four part-time students for help in conducting germination tests. For one month, the germination crew was assigned to other projects at PI. M. Erickson was encouraged to take advantage of available educational opportunities, and completed a graduate-level seed physiology course at ISU.

Germination Testing:

During 2004, M. Erickson and her crew continued to fill seed germination orders, conduct germination tests on approximately 3,600 accessions, and help curators germinate seeds for their regeneration efforts. This is a decrease from last year's approximately 4,100 accessions, due to temporary redirection to other projects.

The germination's crew high level of training and increased proficiency allowed M. Erickson to investigate new methods for improved germination of dormant seeds. She conducted tetrazolium tests on 24 accessions in 2004; five accessions were tested in 2003. Tetrazolium tests are used to help determine the seed viability of questionable accessions.

Germination chambers were managed to accommodate the specific needs of each curator's seed regeneration, as well as meeting the needs of the station's ongoing requirements for periodic viability monitoring.

D. Kovach and M. Erickson participated in the design of a new viability testing lab. An exhaust hood was required to reduce exposure of personnel to fungal spores, facilitate chemical handling, and improve personnel safety.

During this past year, a fiber-optic-ring lighting system was ordered and installed for the dissecting scope in the germination room. An imaging camera for the dissecting scope was also ordered and received. This will be used for capturing the results of tetrazolium staining tests and for imaging small seeds that are not easily recorded with a flat-bed scanner.

Plans for 2005:
Plans for staff training in 2005 include Mr. Kovach attending a conference this summer on application development tools, which will be applied to creating forms and reports using the latest version of application development software. In addition, Mr. Kovach plans to attend the W-1168 Seed Biology Working Group meetings in Columbus, OH.

M. Erickson plans to pursue seed analyst certification through the Association of Official Seed Analysts, through the Iowa State University Seed Science Center which coordinates training and participation in this certification.

Seed research priorities will be determined for the coming year in consultation with M. Widrlechner and the curatorial staff. This coming year includes plans for the continued development of specialized forms and reports to meet station needs and providing computer-aided drawings for facility improvements.

L. Lockhart, Farm Superintendent, has notified staff personnel that the renovations for the new Germination Testing room will be completed in the early part of 2005. This should provide more efficient and healthier working conditions for viability testing personnel.

Refinement of the APR form is planned to capture as much information on accession use as possible. After refinements are made, the form will then be presented to the NPGS for possible adaptation and use at the national level.

d. Information Management: Germplasm Program Assistant (R. Stebbins)
Germplasm Collections

Acquisition:
The North Central Regional Plant Introduction Station (NCRPIS) acquired 450 new accessions in 2004. Of these new accessions, 179 were received from within the National Plant Germplasm System (NPGS). The majority came from collection trips conducted by NCRPIS personnel; among them were 42 accessions of medicinals and 27 accessions of wild *Helianthus*.

The remaining 271 accessions, received from outside the NPGS, included 91 accessions of medicinals and 62 accessions of *Eruca* collected in Italy by Jules Janick of Purdue University. As new accessions are recorded in the Germplasm Resources Information Network (GRIN), an effort is made to include as much passport information as possible. Typical passport information would include a source history, cooperator records, collection-site description, pedigree, secondary identifiers, and any other pertinent information provided by the donor.

Maintenance:
Assistance with curatorial management was provided by processing requests for taxonomic re-identifications and nominations of accessions to the inactive file. In total, 208 accessions received taxonomic re-identifications. Among these were 141 accessions of *Amaranthus*. Also, 29 accessions were nominated for inactivation, including 26 accessions of ornamentals.

Additionally, 74 accessions were assigned PI numbers. Included in this group were 23 accessions of *Amaranthus* and 14 accessions of ornamentals.

Projects:
One of the first steps in obtaining a PI number for an accession is to proof the passport information for accuracy and completeness. Proofing passport information is an ongoing project that is secondary to logging in new material. Proofing involves locating paper and electronic files of accession information, corresponding with collectors and donors, and researching Internet sites, maps and GIS databases.

One of my projects involved working with Mark Widrlechner to prepare 22 accessions of ornamentals and mints for PI number assignment. Any errors in GRIN were corrected, and reports were printed for a final check before requesting PI numbers. In addition, I have continued to enter old passport information from logbooks for early Ames-numbered accessions. During the course of this project, I have encountered duplicate accessions and missing GRIN records, which have been corrected once identified.

I gathered information for the Station's report to the Regional Technical Advisory Committee regarding the distribution of germplasm to cooperators within the 12 North Central Regional states.

I aided in the development and implementation of the Non-Research Response Letter. This letter is sent along with small amounts of seed to private individuals who request germplasm for use in their home gardens on a one-time basis. The goal of the letter is to inform requestors of our mission and the variable nature of our accessions while directing them toward commercial sources.

In August, I staffed an ARS booth in the Agriculture Building of the Iowa State Fair where we interacted with the public and ARS personnel from other units. It was a great opportunity to educate the public about our mission.

Conclusions:
Compared to 2003, new accessions received at NCRPIS were down by three in 2004. In maintenance areas, re-identifications were up by 185%, nominations to the inactive file were up by 300%, PI number assignments were down by 83%, and duplications were up by 100% compared to their 2003 levels.

All figures for acquisitions and maintenance were below the nine-year average.

e. Order processing (R. Stebbins and C. Nass)
During 2004, there were 1,153 orders entered into GRIN. These orders led to the distribution of 26,221 items (primarily seed packets, but also vegetative samples) both internally and externally (Table 3). Of the external distributions, 12,442 items (69%) were distributed within the United States, and 5,541 (31%) were sent to foreign requestors. Additionally, 8,238 items were distributed within the NCRPIS, for such uses as regeneration, evaluation, and germination and pathological testing.

The number of orders entered into GRIN in 2004 was 22% greater than that of 2003; also, the number of items distributed was up by 9,074 or 53%. The number of requests received electronically this year was 800, an increase of 28% over 2003.

Cris Nass distributed 409 Initial Accession Performance Report forms in 2004. By the end of the year, 286 (70%) had been returned. The Summary Accession Performance Reports and Final Reports that were mailed out in 2004 totaled 296. Of these, 161 (54%) have been returned. The return rate on the Initial Accession Performance Report forms was slightly lower than that for 2003.

Significant changes are planned for the Accession Performance Reporting process. Electronic versions of the reporting forms are being developed, as described in Section X, and should soon become available on-line. Information collected will be stored in a searchable database. Mailing the paper version of the forms will be discontinued (except for those cooperators without Internet access). These changes should not only save time and resources but also increase the accessibility of the information collected.

f. Seed Storage (L. Burke, L. Pfiffner)
Two full-time, permanent federal employees (Lisa Burke and Lisa Pfiffner), and one part-time, temporary State employee (Mary Block, 20 hours/week thru Sept of 2004) staffed the seed storage department in 2004.

In 2004, we stored 1725 lots, including both newly received lots and those regenerated at Ames or at remote sites. During storage, 264 lots were bulked to create 124 new lots, and 71 original samples were split to create distribution lots due to adequate seed numbers received. Inventory records for 5,555 lots were reviewed to ensure accuracy of seed amounts, and new labels were printed for lots with outdated labels. We prepared 610 original lots for long-term freezer storage.

Seed orders prepared in 2004 included those for distribution, observation, germination, transfer and backup. Seed storage personnel filled 909 orders. This statistic is now tracked with the use of an ORDFILLED action in the order action field of GRIN. There were 631 lots (615 accessions) sent to the National Center for Genetic Resources Preservation (NCGRP) for backup, including both accessions new to NCGRP and

supplemental lots for previously supplied accessions. We distributed 19993 packets to meet distribution and observation requests. Of these, 14452 were distributed domestically and 5541 outside the US. We transferred 38 inventory lots to other NPGS sites. Beginning with the 2004 maize regeneration storage, we now initiate pathology-testing orders for Stewart's Wilt testing.

In 2004, 208 accessions received taxonomic re-identification. All affected seed samples were re-labeled by seed storage personnel. In addition, seed samples of 20 inactivated accessions were removed from the active collection and placed in inactive storage. New labels were made and cold-storage locations and GRIN records were adjusted to reflect changes resulting from the assignment of 74 PI numbers (213 lots).

Major projects for 2004 included the continuation of the prepacking program for NCRPIS crops (440 lots in 2004 and 2559 overall); continued work training NCRPIS and Ornamental Plant Germplasm Center employees on the new web-based GRIN database and assisting the Database Management Unit (DBMU) with additional testing and improvement of GRIN processes; imaging a large collection of maize accessions deposited at NCRPIS by Major Goodman (this project will continue into 2005 due to the volume of accessions – 1874+); development of an imaging protocol for imaging original seed samples; and participation on the Disposal Committee and two hiring committees and service as resource persons for new curators and the maize project.

Training for 2004 included Blood Borne Pathogen re-certification (Lisa Burke); Conflict Management Training (Lisa Pfiffner); Respirator Recertification (Lisa Pfiffner); Seed Treatment Recertification (Lisa Pfiffner) and IT Security Awareness training (Lisa Burke and Lisa Pfiffner).

VII. Curatorial and Scientific Team Reports

a. Controlled insect pollination program (S. Hanlin)

Progress:
Cage pollination: Pollinators were supplied to 607 cages for controlled pollination of 838 accessions. Honey bees were used to pollinate 759 accessions in the field and 5 accessions in the greenhouse. *Osmia* spp. was used to pollinate 81 accessions of *Brassica* sp., 24 accessions of *Crambe* sp., 12 accessions of *Lepidium* sp., 11 accessions of *Erysimum* sp., 9 accessions of *Thiaspi* sp., 9 accessions of *Linium* sp., 4 accessions of *Allyssum* sp. and 3 accessions of *Bicutella* sp.. *Bombus* colonies were used in 5 accessions of ornamentals. Alfalfa leafcutter bees were used to pollinate 39 accessions in the field and 25 accessions in the greenhouse consisting of *Cucumis* sp., *Brassica* sp., *Alyssum* sp., *Linum* sp., *Amaranthus obovatum*, *Angelica* sp., *Carum. Carvi*, *Caragana* sp., *Staphylea* sp., *Bicutella* sp..

The accessions which were pollinated by flies this year are reported by S. McClurg under the "Fly Pollination" heading in the entomology section of this report.

Beekeeping: Honey bees were over-wintered in the indoor wintering facility with a survival rate of 95% for the parent colonies and 37% for the nucleus colonies. The survival rate for the nucleus hives was slightly higher than last years 31% and for the hives moderately higher than last years 85%. This winter, we placed 122 two and three-story parent colonies, 172 double-story nucleus colonies and 23 single story nucleus colonies into the over-wintering facility. This winter, we left 8 three-story parent colonies in the field, placing them into groups of four and wrapping each group with tar paper. All queens to be used for queen rearing will be selected in the spring of 2005 from resilient parent colonies.

In spring 2004, 100 "buckfast" queens were purchased. The queens were placed into two frame nucs to produce "early" nucleus hives which were used for spring pollination, the unused nucleus hives were allowed to build up and supers were placed on top so they could be used throughout the summer for nucleus production. Our queen rearing continued to improve throughout the summer with an average of 80 queens per week being produced. This number is greater than the past years 65 cells produced per week. To decrease injury and mortality to the queen cells, a new Styrofoam cell carrier was designed which holds the cells upright and prevents damage from occurring to the cells.

To prevent swarming in our queen rearing colonies, frames of honey were removed on a weekly basis and replaced with foundation or empty combs throughout the summer. We also removed any swarm queen cells with bees and brood to produce nucleus hives to be used for pollination.

In late July, 35 strong two-story nucleus hives were placed into full size equipment and were over-wintered as parent colonies of bees. By the end of the summer, we had an additional 43 nucleus hives which did not get used for cage pollination. These hives were made into doubled story nucleus hives and over-wintered; they hopefully will be strong nucs in the spring and possible made into parent colonies.

Four swarms were collected and made into colonies. These colonies were included in our nucleus hive production once they became established, and were over-wintered in the fall.

Because of low mite counts in the spring and fall, no miticide was used this year for the control of *Varroa* mites. Mite populations were determined using three separate methods of sampling. We used the "powder sugar roll" in which 1 tablespoon of powdered sugar is placed into a jar with 100 bees that are randomly sampled from the hive as our main sampling technique. A second sampling method used this year involved the uncapping of approximately 25 drone cells per hive, removal of the larvae and examination of the larvae and cell for mites. We also sampled 63 colonies using sticky boards and Checkmite® and Apistan ® mite strips in order to observe a 24 hour mite drop.

All parent colonies and nucleus hives to be over-wintered were fed a total of four feedings of fumidal-B syrup during the fall. This treatment is for prevention of dysentery in the bees while in the over-wintering room.

For wax moth control during the winter of 2004, we used environmental control methods by opening up the outside doors on colder days and allowing the room to drop in temperature and to freeze the moth larvae. During the summer months, we treated stacks of supers containing empty frames with paradichlorobenzene (para-moth®) crystals on a bimonthly basis to fumigate for moth larvae.

Our present syrup feeding system of two 1000 gallon polypropylene tanks (one inside the shop and one outside), a 30 gallon "mixing" tank and a dish washer was used with good success. Minor problems of "crystallization" of syrup occurred in the bottom of the inside tank in the spring and summer of 2004 which was caused crystal formation of the year and a half old syrup. To prevent it from continuing to occur, the syrup weas circulated twice daily. Once the majority of the undiluted syrup had been removed from the tank, the sugared syrup could be resuspended by adding hot water and pumping it into the mixing tank.

Bombus: Four "research" colonies of *Bombus impatiens* were ordered from a commercial supplier. The bumble bee colonies were used for controlled pollination of 5 field cages. The colonies were checked in the fall to determine if they were strong enough to be over-wintered, however, in all cases they found to be weak or no longer alive.

Megachile rotundata: Twenty five cages both in the field and greenhouse were pollinated with alfalfa leafcutting bees which were collected from the cell incubation test. Twenty domiciles of alfalfa leafcutter bees were used for a cooperative research project with R. Palmer in his study of "attractiveness of male sterile lines of soybeans to pollinators".

Osmia cornifrons/O. lignaria: *Osmia* spp. were used to pollinate all *Brassicaceae* seed increase plots.

Approximately 846 bees were used to fill 105 straws in 2004. Because of the dry summer of 2003, we had to purchase the majority of the bees we used in 2004. We collected approximately 1213 straws or 4582 bees last year. This is a major increase from the spring of 2003 possible because of a wetter spring and precise timing of bee emergence

to blooms opening on the plants. We used a new supplier in 2004, however, it was found that the tubes were not mark for the "emergence end" and delivery problems occurred.

Pollinator Protocols:
With assistance from S. McClurg, standard pollinator protocols were summarized in a chart format and presented to curatorial staff in spring, 2004. We also suggested use of a standard "pollinator request" form. These actions filled several needs: to make new curatorial staff aware of what pollinators are utilized and the procedures for placing into and removing from cages as determined by the special needs of each insect, to make pollinator requests more uniform from all curatorial staff so that projects could be supplied insect pollinators equitably and to increase curatorial and farm staff understanding of insect behavior and how to minimize impact the insect pollinators when actions such as pesticide application are required. Our goal in sharing this information was to allow curatorial and farm staff to make better informed pollinator requests to ensure the successful use of the insect pollinators in germplasm increases.

Research:

Cooperative (S. Hanlin, S. McClurg)

Alfalfa leafcutters – We have tried alfalfa leafcutter bees (*Megachile rotundata*) as an alternate pollinator as they will work a wide variety of plants, are non-stinging and require little attention once introduced to cages or field plots. Traditionally these bees are used in summer field pollinations and are incubated in the late spring about 30 days before crop bloom is anticipated. We found that the alfalfa leafcutters successfully pollinated *Cucumis* accessions in NCRPIS winter greenhouse cages in 2003, but we had unreliable bee emergence times from nesting cells due to the incubation conditions used. We wished to determine how quickly bees would emerge in the winter from cells formed the previous summer, and to improve incubation protocols to ensure that bees would be available when needed for both winter and summer use.

An incubation study to determine the best temperature and relative humidity required for emergence of alfalfa leafcutter bees from nesting cells was conducted January through May, 2004. Four different rearing areas were used, each with a different temperature regime. Small groups of cells (ca 130/jar) were incubated in pint glass jars with vented lids and the day noted that most bees appeared in the jars. The most successful rearing area was 26.5 C 30% RH with cells started in mid January, February, March, and April resulting in bees in 39 days, 35 days, 35 days and 30 days respectively. After this portion of the study was completed, we received advice from several sources that 30 C is the ideal temperature for incubating alfalfa leafcutter cells so that bees emerge in 28 to 30 days; we were still unsure how early in the calendar year bees would emerge from a new harvest of cells. We set up a rearing room at ca 28 to 30 C for incubating bees for summer field use which was fairly successful; because of the variability of temperature in this rearing room, we purchased two incubation chambers (one for 4 C storage and one for 30 C incubation) for alfalfa leafcutter bee use in fall, 2004.

In April, 2004, we visited the USDA-ARS Bee Biology and Systematics Lab in Logan, UT. The primary purpose of our visit was to discuss our current controlled pollination system and the insects utilized, and to seek their input on alternate pollinators that would be successful in our cage system. The staff at Logan recommended protocols for successful incubation of alfalfa leafcutter bees and suggested trying these bees on a variety of the germplasm maintained at NCRPIS. As a result of this visit to Logan, we proceeded with alfalfa leafcutter bee incubation, handling and pollination trials at NCRPIS during the spring and summer of 2004.

Handling techniques we developed for alfalfa leafcutter cells included assembling a 34 cm long x 25.5 cm wide x 10 cm deep wood bee emergence box for incubated cells which was attached via 1.5 cm diameter plastic tubing to a clear plastic 26 cm diameter collection dish with modified lid; bees move from the wood box to the dish where they rest on 2.5 cm long cotton wicks soaked in 5% sucrose solution until collected in late morning or early afternoon for transfer to cages. We determined the best pre-incubation /incubation schedule of work to avoid having a lot of bees emerge from cells

on weekends. We found that parasitic wasps infesting alfalfa leafcutter bee cells will exit screened jar lids and are most easily controlled using a black light and water trap in the incubation chamber.

In order to determine if alfalfa leafcutter bees can be successfully used as a general pollinator at NCRPIS, a study was conducted comparing honeybees and leafcutters in field cages, summer, 2004 in cooperation with K. Reitsma, L. Clark, L. Marek, B. Bingaman, and I. Larsen. Twenty-two cages with twelve accessions were included in the test originally; seed was harvested from a total of seventeen cages including three species of *Brassica* and one *Erysimum*, two species of *Cucumis melo*, one *Cucumis sativus*, and two *Cucurbita pepo* species. Bees were placed in the field cages from 7 June through 27 July, 2004; we tried to keep ca ten to fifteen live bees per cage. We were unable to provide alfalfa leafcutter bees to the field cages after July, 2004 as the supply of leafcutter cells purchased in March, 2004 was exhausted and we were unable to obtain additional cells due to import permit difficulties.

Analysis of seed data from ten *Cucumis* and *Cucurbita* cages showed no significant difference between treatments (honeybee and alfalfa leafcutter) or entries (five accessions) for the following variables: number of fruit harvested, total seed weight, and average hundred seed weight. While there were no significant differences between entries for the variable of total seed, there were significant differences between treatments; cages with honeybees had larger quantities of total seed than cages with alfalfa leafcutters. This was probably due in part to the unavailability of alfalfa leafcutter bees at the end of the field season. Germination data will be collected after the *Cucumis* seed matures in order to determine if there is any difference in quality of seed produced by the two bee species. *Brassica* seed data collection is in progress.

We made some valuable observations of alfalfa leafcutter bee activity in these summer field cages as well. We noted that leafcutter pollination is very dependent on the weather and the physical characteristics of the flowers. The leafcutter bee activity doesn't begin until temperatures are warm, ca 25 C (ca 9 to 10 AM); *Cucurbita* plants with flowers that open early in the day and close before noon will not be successfully pollinated by this bee. If there are adequate flowers in the cage and the temperature is warm, bees remain active past 3 PM. There was no bee activity observed in the field cages on cool cloudy rainy days, so pollination may be lost when the leafcutters bees are used exclusively in field cages during periods of bad weather. Leafcutter activity in greenhouse cages is not affected by weather conditions due to the use of grow lights and controlled (usually warm) temperatures. The leafcutters do best on small to medium-size flowers; due to the bee's small size, it is difficult for them to exit flowers that are deep or have wide diameters such as *Cucurbita pepo*. Also because individual large *C. pepo* flowers contain so much nectar and pollen, one leafcutter bee will not cross pollinate additional flowers as they are "full" after visiting a single large flower and return to nesting cells. It was apparent that we need to develop an appropriate domicile for use in field cages as the leafcutter bees attempted to provision nest cells in the holes in cage frame clamps. It was also noted that leafcutter bees like to rest on the warm metal cage frames; the bees could be easily killed if farm workers lean on the cage screening or frames.

Personnel at the Logan, UT bee lab had suggested that it would be appropriate to include nesting materials (both plants and domiciles) in the field and greenhouse cages, in order to keep the alfalfa leafcutter bees "interested" and busy pollinating. We did not have adequate time to prepare additional nesting plants to include in summer, 2004 field cages, but tried two designs of domiciles. A 5 cm diameter PVC pipe 28 cm long, normally used as a domicile for *Osmia* bees, suspended from a metal rod via eyebolts and filled with white paper straws 7.25 mm diameter 15.25 cm long was used initially; alfalfa leafcutters ignored these domiciles. We then constructed a smaller version of the wooden leafcutter field domiciles originally constructed by former bee technician C. Abel. The new leafcutter domiciles are 17 cm wide x 17.75 cm tall; the sides are sloped from 24 cm at the top to 17 cm at the bottom to provide shelter from inclement weather. We used seven 15.25 cm x 9.5 cm sections of 1 cm deep styrofoam predrilled with 6mm holes every 3 mm. These domiciles were secured with 3-foot tall metal cage labels and placed in the NW corner of field cages directed to the south. By

the time domiciles were placed in the cages in late July, 2004 there were few healthy leafcutter bees available to determine the success of the design.

In fall, 2004, we secured from local fields and suppliers some plants thought to be especially desirable to the alfalfa leafcutter bees as sources for leaf discs to cut for use in nesting cells. We planned to use these plants in greenhouse nesting studies in winter 2004-2005; plants included were: both commercial and wild roses, common mallow, alfalfa, and buckwheat.

Pimpinella – In cooperation with K. Reitsma and L. Clark, a greenhouse study to determine the following: the most effective number of fly pupae, the species of fly (houseflies only, blue bottle flies only, or two fly species combined), and the frequency of fly introduction (once per week vs. twice per week) was conducted winter through spring 2004. Two species of flies were introduced to twelve cages of *Pimpinella* through 22 March, 2004. Entomology crew began cleaning test seed in May 2004; seed processing is still in progress as of December, 2004.

Pollination Improvement

In the month of February, a HOBO® portable weather station was place in the over-winter room and in several selected hives to determine the relative humidity and if the humidity was to low. It was found that the room was lower than 50%, but in the top of the hives it was approximately 90%. This would indicate that humidity is not an factor in bee loss in the over-wintering room.

Because of the limited space in the over-wintering room and the increased number of colonies and nucleus hives being over-wintered, several parent colonies were left outside to compare survival rates. In December, two groups of 4 strong three-story parent colonies were placed side by side and back together and wrapped with black tar paper with access only through the bottom. In the spring the outside over-wintered colonies will be compared to the three story colonies which were over-wintered inside based on general strength of colonies and survival percentages. It is thought that the heavier three stories can be left outside in protected areas and wrapped together and survive with good success rather than needing pack in and out of the over-winter room.

To prevent some of the problems we have had in the past using melted bees wax to adhere wood/bee's wax grafting cups to queen grafting frames, we tested several types of plastic queen cups. The plastic cups snapped into the bar either completely or by a small "nipple" extension and required no wax to hold them in. Based on queen production results, of the plastic cups were comparable to the bee's wax cups, however, the "completely" attached cups were more difficult to remove and several cells were ruined trying to remove them from the bar. In the future we will be switching over to the plastic cups with a small extension on them and away from the more time consuming wax cells.

Cooperation :(S. Hanlin)

A cooperative study was carried out in July and August with Dr. Reid Palmer and his graduate student Evelyn Ortiz-Perez of the USDA, ARS. The objective of the study was to continue to observe the attractiveness of soybean flowers to alfalfa leafcutter bees and to try and determine the nectar makeup in the accessions most attractive to pollinators. Ten leaf-cutter domiciles were placed on all four sides of two one acre plots with entrances facing south. Dr. Palmer and his assistants made all plot data observations and nectar makeup analysis. The NCRPIS pollination staff supplied all insects needed in the project and the expertise for determining needed domicile numbers. The pollination entomologist supplied Dr. Palmer and Evelyn with information and contacts about a "colored dish sampling technique" which was used at both their Texas and Idaho experimental sites for collecting native hymenoptera pollinators.

Dale Zaugg, a beekeeper from Emmetsburg, IA contacted the pollination entomologist about Osmia bees and their use as pollinators of fruit trees. Mr. Zaugg was sent a copy of the NCRPIS standard operating procedure for Osmia bees, the plans for designing both the increase PVC pipe domicile and the smaller pollination domicile and a list of suppliers of bees and equipment.

The pollination entomologist was contacted by Jaryd Ostrem, a research assistant at Pioneer Seed Corporation, on the procedures which are used at NCRPIS for the rearing of blue bottle flies. Jaryd received copies of both our fly rearing procedure and the procedure for facilitating mating and egg production in the adult flies. Jaryd had visited with the entomology staff when they were presenting their poster at the Entomological Society of America meeting.

The pollination entomologist was contacted by C. Waits of the USDA in Georgia about the use of honey bees in a greenhouse setting. Mr. Waits was interested in NCRPIS' greenhouse cage set up and strength, and how honey bees were introduced into the cage. Last year Mr. Waits had contacted the entomology staff about recommended pollinators to use for *Ipomoea* sp. in greenhouses. At that time the pollination entomologist recommended either Bombus or solitary bees, however, Mr. Waits had little success during the summer of 2003 with these pollinators.

Presentations:
A presentation to approximately 200 sixth graders at the Squirrel Hollow Nature Center "outdoor classroom" in Jefferson IA was planned by S. Hanlin. The hands on presentation is based on general honey bee facts, the equipment used in beekeeping and a short introduction to the other pollinators used at NCRPIS. Weather forced a cancellation of this program; an invitation was extended to participate in 2005.

On August 18, Susan Stieve and several technicians from the Ornamental Plant Germplasm Center at Ohio State University toured the entomology building. During this tour, several questions were brought up about problems which have been observed with greenhouse and field pollinators in Ohio and possible solutions were suggested by the entomology staff. The Ohio group also had questions and comments about the emergence and use of alfalfa leafcutter bees as pollinators at their facility and at NCRPIS. In September, S McClurg and S. Hanlin were asked to identify several beetles which were found in several seed samples. The specimens were found to be common stored pest insects which are treated by fumigation of seeds or products.

On July 17, S. Hanlin spoke to approximately 55 local beekeepers at the Iowa Honey Producers field day at Ames. The focus of the presentation was on non-*Apis* pollinators used at the NCRPIS, including the history and general information of each insect, purchasing sources, rearing techniques, and what specific crops they are used on and why. N. Behren, student biological science aid for pollination, also spoke at this meeting on the production of "creamed honey" which he has experienced producing with his family for several generations.

On July 26, S. Hanlin spoke at the Iowa Family and Consumer Conference in Ames. The focus of the presentation was on honey bees and their products based on a nutritional value. Several participants were interested in the use of pollinators at NCRPIS and there were several inquiries about several of the accessions grown at NCRPIS and their current use in the U.S. market such as amaranth and Echinacea.

On June 5, S. Hanlin conducted a queen rearing class at the Indian Creek Nature Center in Cedar Rapids IA. The course was attended by 20 individuals whose main focus was to actually produce queens which would either be used by the individuals or by the center. The attendees watched Dr. Marla Spivak's video on queen rearing which is the method used at the station and then had the opportunity for hands on experience in grafting queens. Because of the age of the larva being grafted and the hive set up, queen production was poor. S. Hanlin has been invited next summer to assist in additional training and improved rearing of queens. For the course, 11 new grafting frames were built which hold 4 bars of six cells instead of 2 bars of thirteen cells.

2005 Research plans:
Last spring, in order to fulfill a lack of early nucleus hive demands prior to queen rearing beginning, we purchased 100 queens and made two frame nucleus hives with a two frames of brood and adhering bees. These worked adequately, however most nucs were not as strong as needed for quality pollination. To improve the quality of these early nucs, this coming spring we are purchasing 50 three pound packages (approximately 3000 bees per package) and 50 "Buckfast" queens to be delivered in late March. We will split the packages into 2 nucleus hives and add the package queen to one and a

purchased queen to the other. This will give us 100 nucs to put into cages early in the spring. The split package nucs should be stronger than the two frame nucs which were made last year and thus give better pollination of plants.

We plan to conduct several alfalfa leafcutter (*Megachile rotundata*) greenhouse studies in the winter of 2004-2005. We will be determining if leafcutters will pollinate *Daucus*, *Pastinaca* and *Helianthus annuus* (wild sunflower). Another aspect of our studies is whether addition of nesting materials increases the effectiveness of leafcutter pollination in small cages of *Daucus*, *Helianthus*, and *Cucumis* germplasm. We will include several plants thought to be preferred for use by the leafcutters in their nesting cells consisting of wild roses, commercially grown roses, mallow and alfalfa. As well as testing several different domicile materials and designs such as a smaller domiciles (3 3/4" X 6 ¾" X 3") to hold the Styrofoam nesting sheets and several commercial nesting blocks (Binderboard ®, Beaverboard ®).

We wish to determine if alfalfa leafcutter bee cells can be reliably and successfully incubated for use in wintertime greenhouse cages ca. four months after cells are harvested from field increase locations, which is five months earlier than bees are normally incubated for typical field use. Using the emergence protocol for summer emergence of leafcutter adults, we will determine if the time for emergence of adults is the same (28 days) in the winter or if there is an extended emergence time. We also wish to determine if there are any other consequences in incubating these bee cells earlier than normal, such as reduced emergence or lower quality bees.

In the summer of 2004, use of alfalfa leafcutter bees was compared to honey bees in cages of *Cucumis*, *Cucurbita*, *Brassica*, and *Erysimum*, but we did not have the opportunity to compare the pollinators in cages of sunflowers. In 2005, the comparison study will be done in sunflower cages. The bees will also be tested in different accessions of some of the crops used in the summer of 2004. In addition to testing pollination success of leaf-cutters, we hope to continue the greenhouse tests of preferred nesting materials (both plants and domiciles) in field cages.

We plan to continue cooperating with Dr. Reid Palmer and his graduate student in determining the attraction of *Megachile rotundata* to the male sterile lines of soybeans which he is researching. We also hope to derive benefit from observation and collections of native pollinators observed in Texas and in Idaho by Dr. Palmer and his graduate students. The transport and placement of pollinators will be done by NCRPIS entomology personnel; all field observations and research will be made by Dr. Palmer's personnel. The identification of collected pollinator samples using the "colored dish sampling technique" in Texas and Idaho will be done by Evelyn Ortiz-Perez with assistance of the NCRPIS entomology personnel.

In the past, when cages of Brassica containing Osmia bees were sprayed, the domiciles were removed and the adult bees were lost or killed. When pollinators were again requested, a new domicile was placed in the cage to continue pollination. This created a need for additional domiciles and bees which may or may not get used, depending on the severity of pest problems occurring in a spring. To possible reduce the number of Osmia bees needed for pollination this summer, a method comparable to the honey bee switching/removal will be tested. When a cage needs the bees removed for insecticide treatment, the domicile will be removed after dark and placed at a new location at NCRPIS for at least 24 hours. When the curator requests bees put back in, the domicile will be retrieved from the field and then be placed back in the cage after dark.

Publications/Posters

On March 30, S. Hanlin and the S. McClurg presented a poster on "Laboratory Rearing Techniques for Blue Bottle Flies" at the North Central Branch of the Entomological Society of America in Kansas City, MO.

Summary of Pollinator Use over the Last Ten Years

Total cages per year											
Crop	**Pollinator**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Horticulture	Honey bee					39	102	74	43	33	57
	ALC										2
	Osmia	2	1	2			36			1	
	Bombus	5			1			5	11	10	4
Sunflower	Honey bee					55	131	129	107	103	129
	Osmia		1								
	Bombus									2	
Flax	Honey bee							15			
Cuphea	Honey bee	1				5		3	4	9	8
Vegetable											
Cucumis	Honey bee					136	164	120	77	172	181
	ALC										12
	Bombus								4		
Cucurbita	Honey bee					3	6		10	16	24
	Flies									7	
Daucus	Honey bee					22	45	61	36	50	62
	Flies					9	37	14	62	55	62
Brassica	Honey bee	14	14			40	43	76	76	36	154
	Osmia	3	126	137	85	82	114	194	71	63	129
	ALC										12
	Bombus							4			
	Flies								47		
Lepidium	Honey bee						3				11
	ALC										1
	Osmia						2				9
Linum	Honey bee						4		82	37	24
	ALC										15
	Osmia						1				14
Umbels	Honey bee			1		4	135	129	74	79	63
	Osmia			1						1	
	ALC										1
	Flies						44		3		12
Amaranthus	Bombus			2							
	ALC										1
	Honey bee					1					1
Melilotus	Honey bee										43
Total	Honey bee	785	616	580	565	305	633	607	509	535	757
	Osmia	5	128	140	85	82	153	194	71	65	152
	Bombus	8		1	3			9	15	12	4
	Flies					9	81	14	112	62	74
	ALC										44

b. Entomology (S. McClurg)

Progress:

Field

Maize – A replicated test of previously untested maize accessions (two hundred-ninety inbred accessions and one hundred-eighteen population accessions) were evaluated for leaf-feeding resistance to first-generation European corn borer in the field in Ames in 2004 for curator M. Millard. Eight accessions (three inbreds and five populations) were rated as resistant in two replications.

Sunflower – Eleven accessions of the core collection of one hundred-twelve cultivated sunflowers remained untested for sunflower moth resistance in Ames field tests as of January, 2004. Not all of these accessions were listed as available for distribution as of April, 2004; the sunflower curatorial staff enabled the field testing of all eleven of these core accessions summer, 2004.

In addition ten accessions from two clusters (groups three and four) were included in the test plot to verify if these core clusters do show more susceptibility to sunflower moth larval feeding as indicated in past tests. Eleven accessions from cluster six were included in the test plot to verify if this core cluster shows more resistance to sunflower moth larval feeding as indicated in past tests.

Unfortunately a number of treated heads in this test plot were severely damaged by crows (*Corvus brachyrynchos*), immediately prior to harvest in October, 2004. It is uncertain if adequate data was obtained for most accessions due to this pest problem. It may be necessary to retest the same accessions to obtain the data desired to complete core collection information on sunflower moth resistance.

Data collection was completed summer, 2004 on forty-four accessions of cultivated sunflower from two of the three core collection clusters that appeared to have more resistance to sunflower moth larval feeding (groups one and seven); these accessions were tested in the field summer, 2003. Data analysis is in progress.

Sunflower moth - We maintained a laboratory colony of sunflower moths for use in the field resistance evaluation of cultivated sunflowers at Ames.

Laboratory seed investigations:

Coriander – We continued work on the seed chalcid (*Systole* sp.) infesting coriander maintained by D. Brenner with the goal of determining if there were non-destructive methods to measure percent infestation of seed accurately. Analysis of radiographs of coriander fruit x-rayed with a cabinet system is in progress; both radiographs and enlarged digital images from scanned radiographs are being assessed. The results will be compared to dissected samples for accuracy.

Fly pollination:

We continued to use houseflies (*Musca domestica*) and blue bottle flies (*Calliphora* sp.) as pollinators in field and greenhouse regeneration cages containing primarily umbel type plants.

We reared colonies of both houseflies and blue bottle flies from January through May, 2004 at which time the two fly colonies were discontinued. Use of only purchased fly pupae was initiated in June, 2004.

We arranged for scheduled shipments of blue bottle fly pupae from Forked Tree Ranch, ID during the summer and again in late winter, 2004. We continue to make needed changes in ordering and storage protocols to ensure successful use of these purchased pupae.

When the decision to use only purchased fly pupae was made, it was suggested that we use only blue bottle flies as they are inexpensive; in addition blue bottle flies are considered to be very effective pollinators in some situations. Horticulture staff

found the blue bottle flies were ineffective pollinators when used in the greenhouse during the summer due to high heat and humidity present. We purchased housefly pupae from J. Coats (ISU, Ames), beginning late July, 2004 to supplement summer horticulture greenhouse cages. Because blue bottle flies appeared to be less active in *Daucus* field cages during hot humid summer weather, we also ordered housefly pupae for winter, 2004 greenhouse cages.

Field

Daucus and *Pastinaca* - Purchased blue bottle fly pupae were placed once weekly into summer, 2004 vegetable project field regeneration cages; five hundred sixty-five cartons of flies were placed in sixty-three field cages containing six different *Daucus* species (in forty-eight cages) and two species of *Pastinaca* (in fifteen cages) from 11 June to 7 September, 2004.

The blue bottle flies appeared to be very effective pollinators of *Pastinaca*; they also worked well in cool wet weather in early summer, 2004. Umbel cages without honeybees in addition to flies had apparently reduced pollinator activity in hot humid weather later in the summer.

Greenhouse

Winter/Spring deliveries:
A total of eleven hundred and nine cartons of NCRPIS-reared flies of both species together were placed once or twice weekly in greenhouse cages from 2 January through 28 May, 2004. Fifty-seven cartons were used for 11 accessions of miscellaneous umbels (5 species total) including *Torilis, Eryngium, Cicuta*, and *Angelica* curated by D. Brenner. One hundred ninety-one cartons were used for twelve test cages of 2 accessions of *Pimpinella* in a pollinator research test. Eight hundred fifty-eight cartons were used for 32 accessions of *Daucus* sp. Three cartons were used for one accession of *Spireae*.

Summer deliveries:
A total of eighty-eight cartons of blue bottle flies and seventy-eight cartons of houseflies (grand total of one hundred sixty-six cartons of both flies) were used for three plant species in two greenhouses. Plants receiving fly pollinators were: one accession of *Ampelopsis*, thirteen accessions of *Hyoscyamus*, and one accession of *Daucus* from 16 July through 13 September, 2004.

Fall/winter deliveries:
A total of fifty-six cartons of both houseflies and blue bottle flies had been taken to greenhouse cages from 17 November through 29 December, 2004. Forty-three cartons were for eight accessions (from three different species) of *Daucus* and thirteen cartons were for 3 accessions of *Hyoscyamus*.

For summer through winter, 2004 greenhouse fly deliveries, each species of fly was placed in the cages once weekly; species introduction was staggered to ensure ongoing pollinator presence in the cages. Campus cage work was performed by Horticulture personnel; entomology personnel delivered flies to farm greenhouses and field cages.

It was noted in December, 2004 that the blue bottle flies work flowers actively in greenhouse cages when grow lights are not positioned directly over the cage; grow lights cause flies to cluster at the tops of cages.

Controlled pollination research:
Please refer to the controlled pollination section of this report for cooperative work performed with S. Hanlin and appropriate curatorial staff on the following projects:

Pimpinella – Determine the most effective number of pupae, species of fly, and frequency of introduction of fly pupae per small mesh greenhouse cage, spring 2004; work continued from winter, 2003.

Alfalfa leafcutter – Incubation of cells spring, 2004 trials; 2004 summer field use in cages of C*ucumis* and miscellaneous oilseeds; nesting studies (both plants and domiciles) as well as *Daucus* pollination trials in the greenhouse winter, 2004.

Publications and Posters:

Laboratory Rearing Technique for Blue Bottle Flies (*Calliphora* sp.), S. J. Hanlin and S. G. McClurg, poster presented at the North Central Branch Entomological Society of America annual meeting, Kansas City, MO, 30 March, 2004

Plans for 2005:
We will continue host-plant resistance evaluations in the field, laboratory, and greenhouse with the collaboration of NCRPIS curators and appropriate cooperating scientists from other ARS units. These evaluations will include reaction to first-generation European corn borer in maize and sunflower moth in cultivated sunflower. We plan to complete evaluation of all core collection cultivated sunflowers.

We will continue support activities for the NCRPIS insect pollinator program, assisting in the incubation and placement of bees and flies, as well as providing cooperation in pollinator studies proposed by S. Hanlin and NCRPIS curators. Learning more about the alfalfa leafcutter bee is a priority.

We will continue to work with seed infestation projects such as seed chalcid in coriander as appropriate. S. McClurg plans to assist D. Brenner and D. Kovach in writing a publication on coriander processing protocols developed in 2002 – 2003 to ensure distribution of seed with non-viable chalcid (*Systole* sp.) wasps.

S. McClurg will continue to offer support to all NCRPIS and GEM project personnel when insect pest identification/information is needed, and to continue to process, archive and make data publicly available from past host plant resistance evaluations. She will also work on indexing past Entomology project slides and photos to make them accessible to other NCRPIS staff.

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

Research Notes:

Maize (Zea mays):
Three hundred and seventy (370) maize accessions were evaluated for Stewart's wilt (*Pantoea stewartii*) resistance. Good resistance was observed in many accessions and results were summarized for inclusion in GRIN.

Sunflower:
Charles Block released two wild *Helianthus annuus* populations with multiple disease resistance to Alternaria leaf blight, Septoria leaf blight and powdery mildew. The populations, SAM-1 and SAM-2, were added to the sunflower germplasm collection.

Sixty-nine wild sunflowers accessions were evaluated in a field trial for Septoria leaf blight resistance to correlate geographic origin with resistance.

Amaranthus (various species):
About 60 amaranth accessions were tested in the greenhouse for stem canker resistance, caused by *Pythium aphanidermatum*. The objective is to assess the resistance of grain type accessions and various wild species.

We cooperated in a field trial with D. Brenner to evaluate *A. tricolo*r selections for *Phomopsis amaranthicola* resistance. Slight differences were noted among the entries, but no high levels of resistance were found.

Cucurbits:
Bacterial fruit blotch (BFB) (caused by *Acidovorax avenae* subsp. *citrulli*) seed transmission was detected from 22 year-old melon seed. This is the longest known survival of the BFB pathogen.

A survey of 736 beetles (striped cucumber beetles and root worm beetles -northern, western, and southern) found some that were potential vectors of cucurbit viruses. Several beetles tested strongly positive by ELISA for squash mosaic virus and a few were weakly positive for watermelon mosaic virus (WMV-2). All were negative for cucumber mosaic virus and papaya ringspot virus (PRSV-W, formerly WMV-1).

C. Block and K. Reitsma authored a manuscript describing evaluations of 977 cucumber accessions for powdery mildew resistance, caused by *Podosphaera xanthii* (syn. *Sphaerotheca fuliginea*). Seventeen of the 20 most-resistant accessions came from Asian sources, including China (PIs 418962, 418964, 432860, and 432870), India (PIs 197085, 197088, and 605930), Japan (PIs 279465, 288238, 390258, and 390266), Pakistan (PI 330628), the Philippines (PIs 426169 and 426170), and Taiwan (PIs 321006, 321009, and 321011.

Disease observations on seed increase crops:
Field observations for plant diseases were made in the seed increase plots of *Brassica*, cucurbits, sunflower, and maize.

***Brassica* and related *Brassicaceae* genera:**
Brassica plots in field N6 were inspected on 4-June-2002 and again in July. The unusually cool weather delayed flowering, and many accessions were in the field weeks longer than normal. Black rot, a bacterial disease caused by *Xanthomonas campestris* pv. *campestris*, was the main disease problem. The only other disease of note was powdery mildew. Serious diseases such as blackleg, caused by *Leptosphaeria maculans,* and the various *Alternaria* diseases were absent.

Cucumber and melon (*Cucumis sativus* and *C. melo*):
Cercospora leaf spot, caused by *Cercospora citrullina*, caused minor leaf spotting on many accessions. Anthracnose (*Colletotrichum orbiculare*) was noted in two melon cages. Timely fungicide application prevented further development of these diseases.

Bacterial fruit blotch (BFB) was an issue on melons grown from older seed (1987 and earlier). Cages were sprayed with a copper-containing bactericide to minimize disease spread and all harvested seeds were treated with 1% HCl as a disinfectant. BFB was absent from cucumber, pumpkin, and squash accessions.

Cucurbit virus-testing:
Cucurbit seedlings were tested by ELISA for seed-borne squash mosaic virus before transplanting. Results are summarized in the following table.

Species	Number of accessions tested	Accessions with infected plants	Number of plants tested	Number of infected plants	% infected plants
C. sativus	39	0	810	O	0%
C. melo	149	2	4296	5	0.1%
C. pepo	29	3	602	3	0.5%

Sunflower (*Helianthus annuus*):
The main phytosanitary disease for U.S.-grown sunflowers is downy mildew, caused by *Plasmopara halstedii*. Seeds are routinely treated with Allegiance (metalaxyl) fungicide. Despite the seed treatment, we found downy mildew-infected plants in field N7. This was surprising as it was the first time this field was used for a seed increase. All infected plants were eliminated after multiple field visits.

Corn (*Zea mays*):
The maize seed increase plots were inspected during late August for the presence of Stewart's wilt, common rust, common smut, gray leaf spot, and northern leaf blight. Stewart's wilt arrived late in the season, about mid-August. Northern leaf blight and common rust were more abundant than normal.

Laboratory seed health testing:
We conducted lab tests on 377 maize seed lots for *Erwinia stewartii*, 21 accessions for wheat streak mosaic virus, 10 accessions for *Stenocarpella* (*Diplodia*) *maydis* and three accessions for *Helminthosporium* diseases. Seed testing results were entered into our local database and uploaded to GRIN.

Publications

Pataky, J.K., **C.C. Block**, P.M. Michener, L.M. Shepherd, D.C. McGee, and D.G. White. 2004. Ability of an ELISA-based seed health test to detect Erwinia stewartii in maize seed treated with fungicides and insecticides. Plant Dis. 88:633-640.

Block, C.C. and Reitsma, K.R. 2005. Powdery mildew resistance in the U.S. National Plant Germplasm System cucumber collection. HortScience. 40(2):416-420.

Block, C.C. 2004. Development of wild Helianthus annuus populations with multiple disease resistance. C.C. Block. Phytopathology 94:S8. (APS Poster Abstract)

Marek, L.F., Larsen, I., **Block, C.C**., and Gardner, C.A. 2004. The Sunflower Collection at the North Central Regional Plant Introduction Station. Proc.16th Inter. Sunf. Conf. Fargo, ND. pp. 761-765.

Gitaitis, R.D., Walcott, R.R., Sanders, F.H., and **Block, C.C**. 2004. A lognormal distribution of phytopathogenic bacteria in corn, cowpea, tomato and watermelon seeds. Phytopathology 94:S34. (APS Poster Abstract)

Meetings and workshops:
Charles Block:
Attended Sunflower Research Forum, Fargo, N.D. (Jan).
Attended 26th annual Seed Technology conference, Ames, IA. (Feb).
Attended BIGMAP Risk Assessment Symposium for Corn-Produced Pharmaceuticals and Industrials (Apr).

Attended Amer. Phytopath. Soc. Conf., Anaheim, CA. (Aug.). Presented two posters (see publications); seed pathology committee member; maintained website; created seed pathology listserve.
Attended the 16th International Sunflower Conference, Fargo, ND (Sept). Presented poster on sunflower germplasm collection (see publications).
Attended ASTA Corn and Sorghum conference, Chicago, IL (Dec.) & pathologists' meeting.

Other activities:
Charles Block:
Elected as an Associate Editor for Seed Science and Technology (ISTA).

Served as NCRPIS liaison with USDA-APHIS and with the Iowa Department of Agriculture and Land Stewardship for phytosanitary issues and regulations.

2005 project plans:
Maize disease resistance evaluations. We plan to continue long-term evaluations in the maize collection for disease resistance. Wee have focused heavily on Stewart's wilt resistance, but we may add evaluations for northern leaf blight resistance.

Sunflower disease resistance. We will conduct additional disease resistance evaluations in sunflower, focusing primarily on Septoria leaf blight resistance.

Magnetic capture hybridization and real-time multiplex PCR for the detection of seedborne pathogens. We are participating in a study with Ron Walcott (Georgia), Tony Keinath (Clemson), Satish Rai and Lisa Shepherd (ISU Seed Science Center) to explore magnetic bead capture systems (antibody or DNA-coated beads) coupled with real-time PCR for detecting seedborne pathogens. The goal is to develop PCR assays which are suitable for detecting several pathogens simultaneously. *Pantoea stewartii* from corn, and the cucurbit pathogens, *Acidovorax avenae* subsp. *citrulli* and *Didymella bryoniae* will be used in the initial studies.

d. <u>Amaranthus, Celosia, Chenopodium, Coronilla, Dalea, Echinochloa, Galega, Marina, Melilotus, Panicum, Perilla, Setaria, Spinacia and miscellaneous Umbelliferae and Poaceae (D. Brenner)</u>

Acquisition and inactivation (Table 1)
Twenty-two new *Melilotus* accessions were received from a plant exploration project in Tajikistan. The exploration was partially USDA-ARS funded but it was organized by Ken Street at ICARDA.

The new Flora of North America treatment of *Chenopodium* is available on-line, and is very useful. Based on the new treatment we want to acquire four additional subspecies of *C. berlandieri* from within the United States. They are of interest because of their close taxonomic relationship to *C. quinoa*. Eric Jellen at BYU, Provo, Utah is actively collecting and donating wild *Chenopodium*, as part of his cytotaxonomic research.

The new millet accessions are primarily transfers from NCGRP. We transferred sub-samples of long-held accessions that were unique to NCGRP for better curation here.

Maintenance and distribution (Tables 2 and 3)

<u>Amaranthus and Chenopodium:</u>
The 212 accessions ordered for observation were primarily for taxonomic determinations of greenhouse plantings at the NCRPIS. The regenerations were grown in the fall greenhouse.

<u>Echinochloa, Panicum, Setaria, miscellaneous Poaceae:</u>
A *Tridens flavus* accession (Ames 18956) performed well in a field cage. An *Apera intermedia* accession(Ames 23686)performed poorly in our summer field conditions and will be tried in the winter greenhouse where it could be better adapted.

Mary Block, working on the seed storage staff, reviewed millet seed packets stored at the end of the collection. She classified the packets by the needed curator action. The majority of lots need taxonomic re-identification.

<u>Melilotus and other legumes</u>
The twenty-eight *Melilotus* accessions regenerated were all annuals pollinated in field cages. Accessions of two species (*M. italicus*, and *M. siculus*) died under summer field conditions, they are probably winter annuals and will therefore be grown in the greenhouse during the winter. Three accessions that did not flower in the field were transplanted to the greenhouse and will be vernalized for flowering in 2005.

<u>Spinacia</u>:
In 2004-2005 Larry Gautney and Beiquan Mou will grow 14 accessions to regenerate them in positive pressure chambers, in a cooperative effort involving Sakata Seed and the USDA-ARS in Salinas, California.

Three accessions of wild *Spinacia* were increased in the winter greenhouse. However, two of these had population sizes of less than six and were therefore not very successful. Once they germinate the plants are successful at maturing seeds, but germination is a problem. In addition to dormancy problems some of the original seeds may not be viable. An attempt to remove the pericarps following a technique described in Suganuma and Ohno, 1984 (J. Jpan. Soc. Hort. Sci. 53:38-44) did not improve germination of Ames 26359. However, the method might work well with better technique or better original seed lots.

This effort with wild spinach is important because new germplasm is needed to combat evolving pathogens. Since the wild species are under-represented, successful regenerations would make more unique diversity available for breeding disease resistance.

In addition to wild spinach, the genera *Monolepis* and *Suckleya* were assigned as priority crops at the NCRPIS since they are believed to be the closest related to

Spinacia. As yet we have no germplasm of these genera, but we plan to acquire them from wild sources within the United States.

Miscellaneous Umbelliferae:
A new protocol was used to kill seed-infesting chalcid insects (*Systole*) by freezing them in liquid nitrogen vapor. This new method was developed by David Kovach on our staff. Our previous method required waiting two years for the insects to emerge and die before final seed cleaning and distribution could begin. The new method is a big improvement.

This was a successful year for *Carum* regeneration. All ten *Carum carvi* accessions over-wintered well in the field and matured seeds in field cages. This success is in contrast to eratic vernalization from October planting and chill treating. Other genera also over-wintered well in the field including two species of *Eryngium*, and one species each of *Anthriscus*, *Conioselinum*, *Livisticum*, *Chaerophyllum*, and *Sium*.

Two new *Angelica* regeneration methods were successfully used. Three accessions were over-wintered from 2003 in the field and flowered well in 2004. One accession was chill-treated at 4°C in the Soil Tilth growth chamber and then taken directly from the growth chamber to the field on March 23 for successful flowering in field cages. Both these methods avoid the use of large greenhouse pollination cages that are otherwise needed to pollinate *Angelica* plants.

An accession of *Ferula communis* (Ames 23700), matured seeds for the first time. This species is unusual for having summer dormancy. It dies back to the ground in the summer then grows in the fall and flowers in March. They are dramatic 2 M tall plants with bright dandylion-yellow flowers.

The 60 accessions ordered for observation at NC7 are primarily *Coriandrum* ordered by Pedro Lopez and Mark Widrlechner for research at the NCRPIS.

Viability testing:
It was a terrific year for viability testing thanks to Maria Erickson and her group. Fourteen percent or 1,190 accessions of my 8,652 accessions were tested.

Characterization/taxonomy/evaluation (Table 4)
More amaranth observations were entered in GRIN than were taken in 2004. This is good news because it means that the backlog shrank. This is partly because the new GRIN bulk loaders are faster and easier to use than the older version.

Three new millet descriptors were approved at the 2004 Forage and Turf Grass CGC meeting; and ten new spinach descriptors were approved at the 2004 Leafy Vegetable CGC meeting.
I made 165 taxonomic changes in 2004 for my combined crops. With this year's 141 *Amaranthus* re-identifications I have determined about 1,500 *Amaranthus* accessions since I began working here in 1989.

Enhancement and/or utilization:

Amaranthus:
I am continuing to enhance grain amaranths for reduced lodging and reduced shattering. Eighty-one white-seeded grain amaranth lines were segregated in the field in 2003 and tested by field planting in 2004. Twelve of these lines were selected for more study. The most interesting of these (DB 2003038) is non-shattering and matured on September 17, 2004 at 125 cm tall. The twelve lines that were advanced will be tested in larger plots in 2005.

Collaboration was continued with Charlie Block to enhance vegetable *A. tricolor* for disease resistance to *Phomopsis amaranthicola*. We were both surprised to see that well ventilated plants at the edge of the field had substantially slower disease development than mid-row plants inside the field. Therefore good air circulation is a potential partial control method for *P. amaranthicola*.

An attempt to enhance *Panicum miliaceum* germplasm by crossing advanced germplasm (PI 583347) to an exotic accession with small green seeds (PI 269954) resulted in no hybrid plants. This particular cross might have been prevented by the parents having incompatible chromosome complements. We will try again in 2005 with a different pair of parents.

Publications and presentations:

D.M. Brenner. Chenopodiaceae and Amaranthaceae Germplasm. Oral presentation. January 20, 2004. Department of Plant and Animal Sciences, Brigham Young University, Provo, Utah.

D.M. Brenner. Plant Germplasm. Oral presentation to the Introduction to Sustainable Agriculture class. October 29, 2004. Department of Biology, Marshalltown Community College, Marshalltown, Iowa.

I established a new email list serve for Chenopodium communication and continued to administer the existing Amaranthus list serve.

My manuscript entitled "Methods for *Melilotus* Germplasm Regeneration" was accepted for publication in the Plant Genetics Resources Newsletter. Publication is scheduled for early 2005.

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

Tallest Amaranthus:
We grew the world's record tallest amaranth plant using PI 553076, *Amaranthus australis*. It was 4.61 m (15 ft 1 inch) on September 29, 2004. The record was acknowledged on the Guinness World Record www site at the following link. http://www.guinnessworldrecords.com/index.asp?ID=52944. The seeds germinated in April 2004, and grew in a greenhouse until they were transplanted into a field on June 7, 2004.

This kind of amaranth is known to grow especially large. Also it is unusual among amaranths for having hollow stems and separate male and female plants (the champion plant was male). The plants have no problem with breaking or falling and require no staking because the stems are strong, without being woody.

We hope that this new record will encourage new research with amaranths for biomass and forage. Amaranths could be grown on land fertilized with poultry wastes or other high fertility wastes, beating the 2004 record, and perhaps extracting fertility in a useful way. Taller plants of the same species could also be found in the wild where they are native in the southern US and in Mexico.

There is a photo of the champion plant on line at the bottom of this page: http://www.ars-grin.gov/ars/MidWest/Ames/Crops_New/Amaranth.html

There was also a WOI radio interview about this record attempt. The interview is kept on-line at the radio show archives. The amaranth part runs from 34 to 42.40 minutes of Monday September 20, 2004 at this URL: http://129.186.89.193/radio/midday.php?week=1

The record was featured in two newspapers articles:

Dillon, William. Ames plant on way to Guinness Book. The Tribune. Oct. 2, 2004. pg. B1.

Schumacher, Jenifer. Campus amaranthus breaks world record. Iowa State Daily. Nov. 17, 2004. pg 7.

Plans for 2005:
The Spinacia accessions that have traits of both wild and cultivated plants will be re-identified to *Spinacia hybrid* rather than any of the three *Spinacia* species.

I realized that there are substantial taxonomic problems in the millet collections. I plan to develop my expertise in solving these problems. This will require a series of taxonomic comparison grow-outs.

The millet passport data on GRIN is poor and I would like to improve it. For example, the improvement status can often be determined from the passport data, but in most cases has not been entered. Much of the prose published in the PI books is not entered in GRIN, but should be entered. The incompleteness of this basic data makes seed order selections difficult.

Genus	Accessions with improvement status entered
Echinochloa	12 acc (4.4%)
Panicum	34 acc (3.4%)
Setaria	143 acc (14%)

The 2005 field planting will include an observation of white seeded grain amaranths that have all-green coloring. There are several accessions with this combination of traits already in the collection. This combination is potentially useful for consumers that want both green vegetable foliage and grain production from the same plant.

I plan to release two ornamental *Amaranthus hypochondriacus* lines through Iowa State University. They will be named 'Pillar Orange' and 'Pillar Red'. They have dense inflorescences and non-shattering seed cases so they will be sturdier as cut flowers than existing ornamental varieties.

Acknowledgments:

Amber Bartels, Alex Fales, Lindsey Margis, and Andrew Martin, worked with us as part time student help.

Computer resources improved dramatically in 2004. Pete Cyr, David Kovach, and Mark Millard engineered and taught many improvements. Kovach's new inventory report makes it possible for the first time to make efficient use of harvest population size information already in GRIN. Also, the new version of GRIN improved routine updates.

Research (impact) derived directly from our seed orders:
Doust, Andrew N., and Elizabeth A. Kellogg. 2002. Inflorescence diversification in the panicoid "bristle grass" clade (Paniceae, Poaceae): evidence from molecular phylogenies and developmental morphology. American Journal of Botany 89:1203-1222.

Giussani, Liliana M., J. Hugo Cota-Sánchez, Fernando O. Zuloaga, and Elizabeth A. Kellogg. 2001. A molecular phylogeny of the grass subfamily Panicoideae (Poaceae) shows multiple origins of C_4 photosynthesis. American Journal of Botany 88:1993-2012.

Makus, D.J. 2003. Salinity And Nitrogen Levels Can Affect The Agronomic Performance, Leaf Color And Mineral Nutrients Of Vegetable Amaranth. Subtropical Plant Science 55:1-6.

Siles, M.M., W. Ken Russell, David D. Baltensperger, Lenis A. Nelson, Blaine Johnson, L. Dale Van Vleck, S. G. Jensen, and Gary Hein. 2004. Heterosis for Grain Yield and Other Agronomic Traits in Foxtail Millet. Crop Science 44:1960-1965.

Research (impact) indirectly about our germplasm:

Baltensperger, D.D., G.E. Frickel, L.A. Nelson, J.M. Krall, M. Vigil, J. Hain, J. Johnson, C. Stymiest, and J.R. Rickertsen. 2004. Registration of 'Horizon' Proso Millet. Crop Science 2004 44: 688-689.

Baltensperger, D.D., L.A. Nelson, G.E. Frickel, R.F. Heyduck, and T.T. Yu. 2004. Registration of NE-1 Proso Millet Germplasm. Crop Science 44:1493-1494.

Baskin, C.C., T.S. Hawkins, and J.M. Baskin. 2004. Ecological life cycle of Chaerophyllum procumbens variety shortii (Apiaceae), a winter annual of the North American Eastern Deciduous Forest. Journal of the Torrey Botanical Society 131:126-139.

Bertero, H.D., A.J. de-la Vega, G. Correa, S. E. Jacobsen, and A. Mujica. 2004. Genotype and genotype-by-environment interaction effects for grain yield and grain size of quinoa (Chenopodium quinoa Willd.) as revealed by pattern analysis of international multi-environment trials. Field Crops Research. 89:299-318.

Blodgett, J.T., Swart, W.J., Louw, S.v. 2004. Identification of fungi and fungal pathogens associated with *Hypolixus haerens* and decayed and cankered stems of *Amaranthus hybridus*. Plant Disease 88:333-337.

Chiasson, H., Bostanian,N.J., and Vincent,C. 2004. Acaricidal properties of a Chenopodium-based botanical. Journal of Economic Entomology 97:1373-1377.

Chiasson,H., Vincent,C., and Bostanian,N.J. 2004. Insecticidal properties of a Chenopodium-based botanical. Journal of Economic Entomology. 97:1378-1383.

Burton L. Johnson and Tracey L. Henderson. 2002. Water Use Patterns of Grain Amaranth in the Northern Great Plains. Agronomy Journal 94:1437-1443.

Maughan,P.J., Bonifacio, A., Jellen, E.N., Stevens,M.R., Coleman, C.E., Ricks, M., Mason,S.L., Jarvis, D.E., Gardunia, B.W., and Fairbanks, D.J. 2004. A genetic linkage map of quinoa (*Chenopodium quinoa*) based on AFLP, RAPD, and SSR markers. Theoretical and Applied Genetics. 109:1188-1195.

MacDonald, D., K. VanCrey, P. Harrison, P.K. Rangachari, J. Rosenfeld, C. Warren, G. Sorger. 2004. Ascaridole-less infusions of *Chenopodium ambrosioides* contain a nematocide(s) that is(are) not toxic to mammalian smooth muscle. Journal of Ethnopharmacology. 92:215-221.

e. Horticulture (M.P. Widrlechner, J. Carstens)

Germplasm Collections

Acquisition:

During 2004, we received 58 new accessions of ornamentals and mint family plants (Table 1). The largest groups included 16 accessions collected from wild populations in Minnesota, 10 collections from the Ozarks and Carolinas made by our new medicinal-plant curator, Joe-Ann McCoy, and 8 collections from the Republic of Georgia. In addition, we were able to re-obtain samples of 10 accessions that were pending inactivation due to past losses.

Maintenance:

Note: In the summer of 2004, about 240 accessions of *Echinacea* and *Hypericum* were transferred to Joe-Ann McCoy for curation. In addition, about 500 accessions of herbaceous ornamental germplasm representing 23 genera once part of this project were transferred to the Ornamental Plant Germplasm Center (OPGC) in Columbus, Ohio for maintenance in 2002.

Statistics presented in the summary tables at the end of this Annual Report exclude activity in the transferred accessions. However, for comparative purposes, statistics reported in the historical distribution table (below) do include activity related to the transferred accessions conducted prior to their transfer.

Long-term field plantings of trees and shrubs received special attention in 2004, resulting in the removal of many older plantings that were no longer needed after seed regeneration or re-propagation. A new *Ulmus* rootstock field was established to facilitate the re-propagation of declining *Ulmus* clonal accessions. Shrubs were also transplanted to simplify their isolation requirements and/or pollination in field cages.

Availability:
During 2004, approximately 43% of the ornamental collections and 59% of the mint family plants were available for distribution (Table 1), figures nearly identical to those reported in 2003 (43 and 60%).

Back-up:
Approximately 31% of the ornamental collections and 59% of the mint family plants are duplicated at NCGRP (Table 2), figures identical to those reported in 2003.

Regeneration:
Regeneration efforts continued at approximately the same levels established in 2001. A new, three-year cage field was established for shrubs along with cages for 39 accessions of annual herbaceous ornamentals, focusing on *Calendula*, *Glebionis*, and annual Malvaceae. The harvests listed in Table 2 include 49 successful cage increases and 19 woody-ornamental seed increases. There were also 46 accessions of woody plants established from seeds and 4 accessions vegetatively re-propagated.

Viability Testing:
In 2004, 33 ornamental and three mint-family accessions were tested for germination (Table 2). Late in 2004, tests began on the current year's regenerations; statistics for this effort will be reported in 2005.

Distribution:
As summarized below (and in Table 3), requests for accessions of ornamental germplasm remained at a high level during 2004, especially given the transfer of highly-demanded medicinal plants to Joe-Ann McCoy. However, the total number of items distributed did decline substantially. The 361 "order items" included all the distributions for the NC7 Trials (described in the following section), along with 33 plants, 595 cuttings, seven leaf samples for DNA extraction, and 239 seed packets, distributed to fulfill external requests for ornamental plant germplasm. This group encompassed 49 genera; those most in demand were *Alcea* (28 packets), *Spiraea* (26 packets), and *Malva* (17 packets). In addition, 45 seed packets were distributed of mint family germplasm.

Historical Summary of Distribution Activity:

Crop	Year	No. of Orders	No. of Recipients	No. of Items Distributed	No. of Accessions Distributed
Ornamentals[1]	00	84	79	596	282
	01	94	85	671	365
	02	103	89	779	361
	03	108	91	883	320
	04[2]	87	81	361	297
Mint Family	00	3	3	37	35
	01	5	5	42	42
	02	4	4	22	19
	03	9	9	45	39
	04[2]	17	16	45	37

[1] Includes genera transferred to OPGC in 2002 (through 2002) and to the medicinal-plant curator in 2004 (through 2003).
[2] Includes external distributions only.

Characterization/taxonomy:
During 2004, the CGC-approved descriptor list for *Echinacea* was added to the GRIN database, with training and responsibility for the collection and loading of these evaluation data given to Joe-Ann McCoy.

All the herbaceous ornamentals in annual cage field and many of the tree and shrub accessions being regenerated were checked to verify identifications. In all, 11 ornamental accessions were re-identified. During 2004, Jeff Carstens captured 125 images of 29 ornamental accessions for our local database (Table 4). These will be named following our standard protocol and loaded to GRIN once a new mass-loading system for images, currently being developed by Pete Cyr, is operational.

Evaluation:
An extensive collection of evaluation data was received from NC-7 trial-site cooperators and has been loaded into our Access database. Selected data were also

summarized and prepared for loading to our Internet database (described further in the section "Coordination of the NC-7 Regional Ornamental Trials").

Enhancement:
There was no major progress to report with enhancement activities in 2004.

Coordination of the NC-7 Regional Ornamental Trials:
Plant Distribution - In 2004, Mark Widrlechner and Jeff Carstens distributed 197 plants of five accessions to 18 sites for long-term evaluation, with an additional 50 plants of these accessions provided to six public gardens. As part of that process, during May, Mark Widrlechner and Jeff Carstens delivered plants and met with cooperators in Wisconsin, Illinois, and Ohio.

The distribution of two accessions of tree seedlings grown from the 1999 exploration to Ukraine essentially completed efforts to propagate and test this germplasm in the NC-7 Trials. Between 2001 and 2004, 19 Ukrainian accessions were distributed for long-term evaluation in order to identify well-adapted, new landscape plants for the North Central Region and to test scientific hypotheses about relationships among soils, climates, vegetation patterns and woody-plant adaptation.

Computer-generated, "One-, Five-, and Ten-year Performance Report" forms were distributed to trial-site cooperators this summer, and all data returned by cooperators in 2003 were recorded in Access in 2004. Evaluation data received from the trial sites and managed in Access were summarized for posting in Public GRIN in a new format utilizing Accession Actions and were organized for uploading to the website early in 2005. The Access database was modified to streamline the data-entry process.

An extensive collection of reports on the evaluation of NC7 Trial plants was published from the 1960s until about 1980. These reports are not widely available. During 2002, Kyle Cavanaugh scanned these reports and created .pdf files. These reports have been indexed and will also be placed on our website in 2005.

Five updates were emailed or sent to trial cooperators in 2004 to inform them about recent developments in the testing program and to provide them with information about the commemoration of the 50th anniversary of the Trials. A half-day symposium marking this event was held in June 2004, in conjunction with a meeting of the Metropolitan Tree Improvement Alliance sponsored by the Morton Arboretum, Lisle, IL. This event included five talks, a panel discussion, and special recognition of long-term commitments to the Trials by individual and institutional cooperators. The Proceedings of this meeting are being posted at
http://www.ces.ncsu.edu/fletcher/programs/nursery/metria/metria13

Germplasm activities in crops other than those curated:
Until the arrival of Joe-Ann McCoy in April, all requests for *Echinacea* and *Hypericum* germplasm were handled by Mark Widrlechner, resulting in the distribution of 101 seed packets and 46 plants of *Echinacea* and five packets of *Hypericum*.

Mark Widrlechner led an in-house subcommittee charged with the development of guidelines for the disposal of seed and vegetative germplasm samples. These guidelines were approved for internal use in October, 2004 and were communicated to all other NPGS sites for their reference.

Throughout 2004, Mark Widrlechner actively participated in a university-industry-ARS collaboration to guide the development of the Ornamental Plant Germplasm Center (OPGC), in Columbus, OH, and facilitate its integration within the National Plant Germplasm System. He serves as the Agency's representative to administer a Specific Cooperative Agreement (SCA) between ARS and The Ohio State University to fund the OPGC. In 2004, the original SCA was completed and new three-year agreement negotiated and approved.

In 2002, Iowa State University and the University of Iowa were awarded a five-year grant from the National Institutes of Health establishing a Center for Research on Botanical Dietary Supplements to study variation and bioactivity in *Echinacea* and *Hypericum*. Mark Widrlechner has continued his involvement the Center through a

subcontract to ARS, which supports the curation of the Station's *Echinacea* and *Hypericum* germplasm collections and the distribution of that germplasm so it can be evaluated for chemical composition, genetic diversity, and bioactivity. Early in 2004, negotiations were successfully completed to hire Joe-Ann McCoy as medicinal-plant curator. Curatorial efforts on these genera are presented in Section **X**.

During 2004, Mark Widrlechner was involved with a number of other collaborative germplasm activities including:

1. work with Amalio Santacruz-Varela on two papers describing patterns of genetic and morphological variation among New World popcorn germplasm (one published in Crop Science in 2004);

2. a *Coriandrum* germplasm evaluation project being conducted with Pedro Lopez, a doctoral candidate at Iowa State University, who focused on data analysis, vouchering samples, and developing AFLP-marker systems to study patterns of genetic diversity, and with Terry Isbell, National Center for Agricultural Utilization Research, Peoria, IL, who evaluated fatty-acid composition in its seed oils;

3. preparation of a comprehensive literature review on cucurbit germplasm for a chapter in the series "Genetic Resources, Chromosome Engineering, and Crop Improvement," with Aleš Lebeda, Palacký University, Czech Republic, Jack Staub, USDA-ARS, Madison, WI, et al.;

4. a project to evaluate variation in seed dormancy in wild and cultivated populations of *Echinacea purpurea* with Luping Qu of Gaia Herbs, Inc., Brevard, NC, which resulted in the submission of a manuscript reporting the results of this work to HortScience; and

5. the revision of national policies on germplasm acquisition and distribution through service in the Plant Germplasm Operations Committee.

Mark Widrlechner's other research and training activities:

Collaboration continued with Welby Smith of the Minnesota Department of Natural Resources to finalize his treatment of *Rubus* for a new book on the woody plants of Minnesota and was initiated with George Yatskievych of the Missouri Department of Conservation to assist with his treatment of *Rubus* for the new "Flora of Missouri."

Collaborations also continued on the development of models to predict the risk of naturalization of non-native woody plants. In 2004, Mark Widrlechner, Jeff Iles (ISU Horticulture Department), Jan Thompson (ISU Natural Resource Ecology and Management Department), and Phil Dixon (ISU Statistics Department) completed and tested three predictive models that combine the geographic risk-analysis approach with biological attributes and compared them to an existing risk-assessment model. Results were published in the Journal of Environmental Horticulture. The project was strengthened by the establishment of a Specific Cooperative Agreement with Peter Bristol at the Chicago Botanic Garden to validate these models by using data from the Chicago region and begin the process of developing models applicable on a regional basis.

In 2004, Mark Widrlechner was asked by ARS National Program Staff to organize and chair a national Technical Review Committee that provides technical direction and oversight to a new ARS project to update the USDA Plant Hardiness Zone Map by using the best available technologies and to make the next version of the Map accessible via the Internet.

Other Horticultural project-training and staff-development activities:
In 2004, Mark Widrlechner and Jeff Carstens attended training sessions to satisfy continuing education requirements for tractor safety, Worker Protection Standards, IT security, conflict resolution, and state pesticide applicator certification. Jeff also attended training for forklift safety, respirator certification, and a session on "Propagation Basics for Professionals" offered by the International Plant Propagators' Society in Columbia, MO.

Communications Activities:

Manuscript and Proposal Review:
Mark Widrlechner continued his service on the Editorial Review Boards of Genetic Resources and Crop Evolution and the Journal of the American Rhododendron Society. He also reviewed four manuscripts as a member of the Editorial Review Board for the 5th International Symposium on New Floricultural Crops. He served as a peer reviewer for manuscripts submitted to the Journal of the American Society for Horticultural Science, Journal of Heredity, Horticultural Reviews, and Proceedings of the National Academy of Science, and as an internal reviewer for three papers prior to journal submission. He reviewed grant proposals for the American Rhododendron Society, the Eastern Region of the International Plant Propagators' Society, the Landscape Plant Development Center, and the U.S. Civilian R&D Foundation.

Posters, Presentations and Seminars:
Lopez, P.A., and M.P. Widrlechner. 2004. Morphological and chemical variability in coriander germplasm. Presented by Lopez to the Association for the Advancement of Industrial Crops and New Uses Council Annual Meeting, September 19-22, Minneapolis, MN. AAIC Abstracts, p. 30.

Widrlechner, Mark P. 2004. Insights into woody plant adaptation and practical applications. Presented to the 13th METRIA Conference, 18 June, Lisle, IL, and presented in expanded form as a seminar to the ISU Horticulture Department, 6 December.

Widrlechner, Mark P., Janette R. Thompson, Jeffery K. Iles, and Philip M. Dixon. 2004. Models for predicting the risk of naturalization of non-native woody plants in Iowa. Presented by Widrlechner to ISU Plant Health & Protection 498 on 9 April.

Publications which appeared in print in 2004:
Lebeda, A., and M.P. Widrlechner. 2004. Response of wild and weedy Cucurbita L. to pathotypes of Pseudoperonospora cubensis (Berk. & Curt.) Rostov. (cucurbit downy mildew). Advances in Downy Mildew Research 2: 203-210.

Santacruz-Varela, A., M.P. Widrlechner, K.E. Ziegler, R.J. Salvador, M.J. Millard, and P.K. Bretting. 2004. Phylogenetic relationships among North American popcorns and their evolutionary links to Mexican and South American popcorns. Crop Science 44: 1456-1467.

Tay, David, Mark P. Widrlechner, and James L. Corfield. 2004. Establishment of a new genebank for herbaceous ornamental plants. FAO/IPRGI Plant Genetic Resources Newsletter 137: 26-33.

Towill, L.E., and M. Widrlechner. 2004. Cryopreservation of Salix species using sections from winter vegetative scions. CryoLetters 25: 71-80.

Widrlechner, Mark P. 2004. Insights into woody plant adaptation and practical applications. METRIA Proceedings Volume 13, published on the Internet at: http://www.ces.ncsu.edu/fletcher/programs/nursery/metria/metria13/widrlechner/index.html

Widrlechner, Mark P., Janette R. Thompson, Jeffery K. Iles, and Philip M. Dixon. 2004. Models for predicting the risk of naturalization of non-native woody plants in Iowa. Journal of Environmental Horticulture 22: 23-31.

Departmental Activities:
Mark Widrlechner continued as an active member of the Crop Seeds Committee and the Plant Breeding and Genetics Advisory Panel of the Agronomy Department at Iowa State

University. He also served on Greenhouse & Growth Chamber Committee and increased his involvement in the Horticulture Department as it prepares for an external CSREES review in 2005. He continued to serve as Co-major Professor for Pedro Lopez, a Ph.D. candidate in Plant Breeding, and on the Program of Study Committees for two Ph.D. candidates in Plant Breeding and an M.S. candidate in Sustainable Agriculture. He became a member of the Program of Study Committee for a Ph.D. candidate in Horticulture. He assisted Laura Merrick (ISU Natural Resource Ecology and Management Department) in teaching a 0.5-credit module of Agronomy 565D, Ethics in Professional Practice, dealing with plant genetic resources.

Conclusions and Plans for 2005:

Curation

Curation efforts in 2004 focused on mentoring Jeff Carstens in germplasm regeneration and in planning for increasing our levels of activity in that area. Major renovations were made to existing long-term field plantings of trees and shrubs, removing plantings no longer needed and creating more efficient field designs. The transfer of *Echinacea* and *Hypericum* to Joe-Ann McCoy also involved mentoring to help ensure a smooth transition with increased levels of attention directed toward these highly-demanded genera.

Looking ahead, patterns of recent demand and unmet requests are being used to set priorities to address regeneration backlogs by establishing cage fields for Malvaceae and *Potentilla*, among the herbaceous ornamentals, and for *Spiraea*, *Physocarpus*, and *Diervilla,* among the shrubs. For the tree genera, *Alnus* and *Betula*, efforts will focus on the development of controlled-pollination systems for seed production. And given the serious threat caused by the introduction of Emerald Ash Borer to the North Central Region, additional attention will be given to the regeneration of *Fraxinus* germplasm.

To help capture valuable information about our accessions, we plan to develop a descriptor list for horticultural and biochemical characteristics of *Calendula*, a crop with ornamental, medicinal, and industrial uses.

Research

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

Research efforts for the coming year will focus on:

1. validating recently developed risk-assessment models for the invasiveness of non-native woody plants in the Midwest with support from the SCA recently initiated with the Chicago Botanic Garden (attempts will also be made to secure additional external support for this project);

2. coordinating technical advice and relaying appropriate research information in support of efforts by Robert Webster, USDA-ARS, Beltsville, MD, to revise the USDA Plant Hardiness Zone Map;

3. completing and submitting for publication a study that uses long-term germplasm viability records and distribution histories to estimate target quantities for seed regeneration;

4. developing practical protocols with Leigh Towill, NCGRP, Fort Collins, CO for routine cryogenic storage and plant recovery of *Salix* clones;

5. completing collaborative manuscripts on cucurbit genetic resources, a germplasm user survey, and the biochemical analysis of *Echinacea* collections; and

6. providing guidance to Pedro Lopez as he completes his studies on patterns of genetic and phenotypic diversity in *Coriandrum*.

Staff Development

Plans for staff development for 2005 will focus on training for Jeff Carstens and for the new medicinal-plant curator, funded in part by the Center for Research on Botanical Dietary Supplements. Training experiences for Jeff are likely to include attendance at the Eastern Region Annual Meeting of the International Plant Propagators' Society, the Iowa Shade Tree Short Course, visits to local nurseries, and safety training. Mark Widrlechner is registered to participate in the ARS Congressional Briefing Conference in Washington, DC.

f. Maize Curation (M. Millard, G. Crim, M. Weishaar

Equipment:
Three 17" by 11" large bed scanners were acquired for imaging in 2004. The Microtek 9800XL scanners are used to image maize ears, maize ear cross-sections, and kernels. One of these scanners was installed in seed storage where they will image original seed samples by the seed storage staff. The Goodman race collection represents over 1800 original seed samples that will be imaged in this way.

Personnel:
The maize curation project returned to 2002 staffing levels during 2004. The vacant permanent federal maize technician position was filled by Ms. Mindy Weishaar in August, 2004, replacing term technician Ms. Lisa Pfiffner, who moved to seed storage at the station in January, 2004. Ms. Weishaar has an MS in plant breeding from Iowa State University working on alfalfa, and has previous maize experience working with a private company. The maize curation project permanent staff consists of M. Millard, ISU Curator II; G. Crim, ISU Field Tech II; and M. Weishaar, a GS-6 Federal Biological Science Lab Technician making up the core maize team. Federal student employees that average 5 full-time equivalents on a yearly basis handle the remainder of the core maize curation work.

A permanent federal IT specialist position was created for the NCRPIS to oversee all computer related issues. Pete Cyr joined the staff in this position in March. This is significant to maize curatorial project because M. Millard was acting in this capacity for the station since mid-2003. Two new curators were hired for the NCRPIS in 2004. Dr. Laura Marek was assigned to the oilseeds including sunflowers and brassicas. Dr. Joanne McCoy was hired as the medicinals curator working mainly on *Echinacea* and *Hypericum.* Their initial training in the use of the GRIN (Germplasm Resources Information Network) has been completed with the help of M. Millard as GRIN liaison, along with other NCRPIS staff.

Research Progress:
The following paper was published in 2004: A. Santacruz-Varela, M. P. Widrlechner, K. E. Ziegler, R. J. Salvador, M. J. Millard, and P. K. Bretting. Phylogenetic Relationships among North American Popcorns and Their Evolutionary Links to Mexican and South American Popcorns. Crop Sci. 2004. 44: 1456-1467. This paper resulted from a Ph.D. thesis project started by Dr. Amalio Sanacruz-Varela at Iowa State University and the NCRPIS in 1998.

Two thesis projects on maize genetic resources are currently being undertaken at NCRPIS. Ms. Lisa Burke is comparing data acquisition by manual means and through the maize curatorial project's standard maize images on races native to the United States. Ms. Lindsay Werth is studying the landraces of maize native to the U.S. Southwest with the aim at describing the races found there. Dr. Debra Muenchrath is the major professor for both studies, and Candice Gardner serves as Ms. Werth's co-advisor.

Work continued on the Races of Maize CDs. Copyrights for most works were successfully obtained through the efforts of Wilfredo Salhuana, Henry Shands, and Candice Gardner. This process took longer than expected, delaying the planned early 2004 release. During this process we received the rights to image the Spanish version of the Races of Maize, but this document had not been received before by the station. We have recently obtained a copy from Wilfredo Salhuana, and Major Goodman is acquiring a second, hopefully pristine copy. The NCRPIS staff will use a combination of these two copies to image this document. The CD's will then be officially released. The reception by

most authors of this project has been very positive. It has been discovered that there are Spanish versions of many of these monographs that are even rarer and in poorer condition then the English versions. Therefore the NCRPIS has begun planning for a later revised edition of this compendium which would include more of these monographs.

Dr. Ed Buckler agreed to do quality assurance using SSR markers to verify the genetic quality of 89 accessions. These accessions are inbred lines in the Goodman diversity set that had been previously increased by the NCRPIS. We are trying to determine whether the SSR profiles of previously regenerated samples compare favorably with Dr. Major Goodman's samples in order to save resources that would be utilized by regenerating these again from Goodman sample seed.

Acquisition:
There were 35 new accessions incorporated into the collection in 2004 as seen in Table 1. These included one landrace collection from Mexico identified as Onaveno; five sweetcorn populations from Dr. Bill Tracy, University of Wisconsin; two Arizona landrace collections from the USDA breeding collection at Tifton, Georgia; four historical sugary enhanced lines from the University of Illinois; twelve inbred lines with expired PVP certificates; six Crop Science registered inbred lines; and an apomictic line from Dr. Bryan Kindiger, USDA-ARS, Grazing Lands Research Laboratory, El Reno, Oklahoma.

The NCRPIS obtained the Goodman Racial Collection of Maize consisting of about 1800 accessions in June, 2004. Dr. Candice Gardner and Dr. Mike Blanco transported the well packed items from Raleigh, North Carolina after GEM meetings to ensure their safety. These accessions were maintained in the freezer by Dr. Major Goodman during the last three decades. They were used in his laboratory research, shared with other scientists, and were the focus of many research papers. Dr. Goodman provided a complete computerized inventory with the accessions to speed their incorporation into the NCRPIS maize collection. The collection has not yet been completely incorporated and therefore the number of new accessions has not been reflected in this year's collection statistics reported in Table 1. The plan of action is as follows:

1. The material will be inventoried and compared with Dr. Goodman's computerized list. An image of each lot of seed will be obtained using a flatbed scanner. Because the material has been in the freezer for so long, handling will be much more limited than is the standard practice on logging in new seed. Images are important because they will serve as vouchers for the material and limit the need for direct access to the seed. This process was begun in October as the 2004 harvest season slowed. To date, 120 man-hours have been spent to complete 20% of this task.
2. Dr. Goodman accessioned material based on its source in addition to the material's collection id, and with good reason. The accessions were derived from the country of origin genebanks, CIMMYT, USDA collections, and other researchers who obtained seed in various ways. Due to the possibility of historical errors in identification or similar ids put on different collections by different organizations or possible regeneration errors, combining materials in a way that they cannot be separated is prohibited. All lots of seed will remain separate within the NCRPIS collection and will receive a separate lot identifier and description of ultimate origin.
3. Ids and images of materials will be compared with accessions already in the collection. Where these match currently held accessions, Goodman's lots will be identified under the current USDA accession id, but held as a separate lot.
4. New USDA accession ids will be given to accessions new to the collection.
5. An attempt will be made to procure additional seed from the original institutions where current supplies are limited. Most of Dr. Goodman's samples are in the 500 kernel range and Dr. Goodman indicates that his regenerations were from a limited sample size. A sample from a larger original sample size is preferred to maintain the integrity of the original genetic profile of the collection. In most cases, Dr. Goodman's sample may serve as a voucher.
6. Prioritization of regenerations will occur. Accessions from rare races

with low seed supplies will be regenerated first, either from seed from the institution of origin or from Dr. Goodman's sample if that seed is unavailable.

7. Realizing the regenerations goal of 100 ears sample size will be dependent on accession performance and seed availability. An initial smaller increase will be attempted on accessions where performance is uncertain. This initial small increase will provide insurance that the accession is not lost, allow acquisition of performance data, and allow faster access by the public to the materials. This smaller increase will be combined with a larger increase performed later to increase sample size.
8. Race identifications from Goodman's data will be entered into GRIN. These accessions will be designated as core accessions. Data previously obtained by Dr. Goodman on these collections, especially molecular data, will also be added to GRIN, if absent.
9. Parts of the Goodman Racial Collection of Maize may be in any of the stages above. This will allow for some regeneration to begin ASAP. The Mexican collections are ready for step 2. Guatemalan collections will soon follow. If the curator receives information on parts of the collection being of special interest, those accessions will be moved up in priority.

Regeneration:
There were 317 maize increase attempted in the field in 2004 in Ames compared to 438 accession regenerations attempted in Ames in 2003 and 296 in 2002. Last years increase attempts were inflated due to a large number of increases from small starter seed supplies. This year's Ames nursery size was reduced slightly due to staff changes. 211 of these were inbred lines including 143 lines from Goodman's variable inbred line set. The planting was divided into two widely spaced planting dates to spread pollinations over a long period for efficient crew usage. The first nursery, planted on April 15th, included early inbreds along with populations and suffered a frost. Leaves were singed on scattered plants, but did not affect final stand or yield. The main season planting had excellent conditions after some early season flooding. There were fears that a cool August would delay maturity causing frost damage on accessions pollinated during the later half of August. There was a slightly earlier frost that damaged the leaves on many accessions, but most of the late crop matured ears on resources in green husks, cobs, shanks, and stalks. A killing freeze arrived in the second week in November (later than average) and most of nursery matured adequately.

One annual teosinte was regenerated to 150,000 seeds in the greenhouse in Ames during the winter of 2003-2004 in an experiment to demonstrate the usefulness of the growth regulator Bonzi® (active ingredient paclobutrazol) in regenerating teosinte. The goal was to determine the correct application method for maximum seed production in the smallest area. If no adverse affects are documented in resulting progeny growouts, this growth regulator will be used in the future on all teosinte increases.

Seed from 2 accessions of *Zea perennis* were harvested from four accessions grown in the Ames greenhouse during 2004. These accessions can be maintained clonally indefinitely. As seed is harvested, the clones are discarded.

Seed from one *Tripsacum dactyloides* eastern gamagrass was harvested from an apomictic population growing in isolation.

Three sets of 50 accessions were sent to the Golden Harvest facility near Ponce, Puerto Rico for increase. Two of these have been received in 2004 in good condition. While a hurricane did cause excessive rain during half of the harvest of one nursery, seed quality did not appear to have been affected. The rains did delay the planting of a third nursery while the irrigation system was repaired.

Forty-two accessions were sent to St. Croix for increase in 2004 and increase seed has been received.

Four tropical maize inbreds with very low seed quantities were sent to Hebron Smith, D&H Farms at Guthrie, Kentucky in 2004 for increase in his greenhouses.

Sixty-seven accessions were sent to the Illinois Crop Improvement Association (ICIA) site near Ponce, Puerto Rico. These were tropical adapted inbreds from the Goodman inbred collection. They will be pollinated by NCRPIS maize curatorial staff in 2005.

Maintenance:
Table 1 indicates that accession availability slightly increased to 65% though the number of accessions increased by 35 accessions. This indicates that the 438 accessions made available indicated in table 2 just covered the number of new accessions obtained plus the number of accessions made unavailable due to depleted supply or reduced viability. This indicates that though regenerations continue to increase, the NCRPIS must increase the number of regenerations even more in future years to maintain availability. These numbers do not include the Goodman Maize Race collections of 1,800+ accessions as these have not yet been completely incorporated into the collection statistics. This will mean that the percent of the collection available will go down significantly next year. At the current acquisition rate, the collection is projected to reach 20,000 accessions just after 2005.

In 2004, 970 accessions were tested for viability compared to 899 accessions or 5% of the collection in 2003. This represents testing of 8% of the total number of accessions available, which is more representative of maintenance viability testing because you cannot test seed that you do not have. Most unavailable accessions do not have seed for testing. Maize testing is expected to increase in 2005 to at least 10% of available accessions. Viability testing detected 7 accessions (.7% of those tested) that were less than 50% viable compared to 33 accessions (3.7% of those tested) in 2003 and 49 (1.2%) in 2002.

Distribution:
Maize seed packet distribution was up significantly in 2004 over 2003 (116%). The expired PVP inbred lines continue to be a popular distribution. There were 43 of these accessions distributed representing .2% of the collection. Of the total packets distributed, 649 packets (13.1%) were from these 43 accessions. They were distributed to 39 (16.1%) of the 241 individuals ordering seed. Another area of growth in seed orders is to unaffiliated individuals who are interested in seed not readily available in the trade for personal use. One time distributions are made on these orders and we request that they save their own seed and revert to using seed from commercial sources whenever possible, as our resources cannot sustain regeneration and distribution demand for personal use.

Crop	Calendar Year	No. of Orders	No. of Recipients	No. of Items Distributed	No. of Accessions Distributed
Maize relatives	2000	9	9	20	7
	2001	7	7	13	7
	2002	5	5	16	7
	2003	7	7	22	8
	2004	8	8	11	6
Average		**7**	**7**	**16**	**7**

Maize	2000	214	176	2585	1809
	2001	270	198	2637	1606
	2002	399	279	4714	2511
	2003	226	178	2298	1475
	2004	335	241	4973	2617
Average		**289**	**214**	**3441**	**2004**

Characterization:
There were 7,480 data points relating to 14 ear descriptors on 335 accessions loaded into GRIN in 2003. This compares with 13,062 data points on 980 accessions in 2003 and 8,834 data points on 450 accessions in 2002. The reduced ear description reflects the vacant maize tech position from January until August of 2004.

We obtained 3035 images of 806 accessions compared to 4,512 images of 1602 accessions in 2003 and 6,451 images of 3,337 accessions in 2002. There is at least one digital image on 14,244 accessions or 78% of the maize collection.

Evaluation:

The maize disease resistance-screening program continued in 2004.

Five hundred accessions were sent to Dr. S. Moore at Louisiana State University for for aflatoxin production and Aspergillus ear rot resistance trials. These were planted for topcrossing to Mo17. In 2005 he will observe the topcross material in a nursery in Louisiana that consistently shows high *Aspergillus flavus* ear infections for resistance.

Dr. W. Dolezal with Pioneer Hi-Bred International, Inc. planted 250 accessions in Johnston, Iowa in 2004. Northern leaf blight resistance was observed under artificially infested field conditions with a very high incidence of the disease. He also rated herbicide Calisto damage (active ingredient mesotrione). He hosted a tour of the nursery at Pioneer for the NCRPIS maize curator, NCRPIS GEM coordinator, and NCRPIS plant pathologist.

Dr. C. Block of the NCRPIS evaluated 375 accessions for Stewart's wilt resistance. The majority of this nursery consisted of inbred lines.

Mr. Ken Zeigler retired in 2004 and therefore popping expansion evaluation ceased in 2004.

Ms. S. McClurg of the NCRPIS entomology group screened 410 accessions for first generation European corn borer resistance.

Communication:
Several demonstration orders for maize and its relatives went out to cooperators in 2004, including Dr. Pat Schnable's group at Iowa State. A graduate student project on the farm to evaluate a large set of Southwestern U.S. landraces, along with the regeneration plots, offered a large set of diverse materials toured during the growing season. No special demonstration plots were planted to conserve permanent staff time which was smaller than usual due to personnel changes and less available support.

Many groups who tour the farm observe the maize imaging project as part of their learning experience. This has been a popular demonstration over the past few years with visitors, and has increased awareness of image availability in GRIN.

2005 Project Plans

Acquisition:
In 2005 the Goodman racial collection will fully incorporated into the NCRPIS maize collection in the manner previously stated in this report. The NCRPIS maize project will continue to procure the core accessions (not already incorporated) designated by CIMMYT and published in CD format from the LAMP project. The NCRPIS will try to further identify and fill gaps in maize racial populations, and to acquire more of the Caribbean accessions from CIMMYT in 2005.

There will by continued exchanges of accessions between NCGRP, CIMMYT, and NCRPIS. NCRPIS would like to obtain at least one accession from each of the type collections for each race described in the Races of Maize bulletins. CIMMYT is the best source for obtaining these accessions. Additionally we need to procure more of the LAMP core, CIMMYT core, and Caribbean accessions. We must obtain more guidance on International exchange issues in 2005.

Regeneration:

Funding will support tropical maize regenerations of 150 to 200 accessions per year by private sector nursery providers to NCRPIS specifications.

Regenerations in Ames will be maintained at 250-300 accessions annually. Dr. Widrlechner, in association with other NCRPIS staff, has documented that viability of maize accessions consistently lasts 30-35 years under our current conditions of cold storage of 5° C and 20% relative humidity. Since half the collection of 18,000 accessions is temperate adapted, calculations indicate that 300 regenerations/year are required to maintain the collection, depending on demand. Any additional accessions regenerated would contribute to eliminating the backlog of some 7,000 accessions.

Quarantine regenerations on St. Croix will continue at the 30-50 accession level during 2005.

Maintenance:
The last of the Goodman tropical increases from Mexico will be backed up in 2005 at NCGRP, and 500 kernel samples will be distributed to CIMMYT. Additionally, we will send several hundred accessions to CIMMYT from other LAMP countries, which the NCRPIS holds, but CIMMYT does not.

We will send several hundred accessions of maize to CIMMYT which represent U.S. landraces. This will enhance CIMMYT's ability to serve as an international center for maize germplasm. It also demonstrates U.S. policy of freely sharing unencumbered farmer varieties. Seed is abundant for most of these landraces since increasing them at the 100-ear population size generates large seed quantities.

The NCRPIS, NCGRP, CIMMYT, and Dr. Wilfredo Salhuana will work on a continuing project to develop and cross reference a consolidated list of the holdings of the various L.A. countries' maize germplasm collections, the CIMMYT collection, and U.S. collections in order to identify materials that may be at imminent risk of loss.

Viability tests will be increased in 2004 to maintain the maize testing schedule to provide timely data for regeneration priorities.

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

The project will continue planting observation plots to obtain maturity data. Additionally, older data from field book sources will be gleaned for inclusion into GRIN. Maturity data is one of the most important pieces of data determining selection of accessions which meet researchers' objectives and allows them to plan their work.

Loading of existing molecular marker information and frequencies on collections held at the NCRPIS will continue. After finishing the N.C. State isozyme data, we will add SSR data obtained here at the NCRPIS.

I will attempt to augment the collection of images for 2,000 accessions on GRIN with images of an additional 10,000 accessions in fiscal 2005.

Other Items:
The Races of Maize CDs should be ready for public release in 2005.

The NCRPIS will be hiring a full time permanent federal curator to increase the man-hours dedicated to maize curatorial duties.

g. <u>Medicinals (J. McCoy)</u>

Germplasm Collections:

The medicinals project was in transition during 2004 as Joe-Ann McCoy was hired in April to serve as curator, funded in part by the NIH Center for Research on Botanical Dietary Supplements. Collections currently curated by the Medicinal project include *Echinacea* and *Hypericum* (NC7 Medicinals).

Acquisition:
During 2004, we received and/or collected 138 new accessions of medicinal species representing 44% of the current collection (Table 1). The curator negotiated with a research donor and received live plants from 19 populations of *Actaea racemosa*

throughout its native range and planted them in field cages for survival testing. Additional live plants of *Sanguinaria canadensis, Chamaelirium luteum, Actaea racemosa*, and *Hydrastis canadensis* were acquired from the curator's past research projects and are currently being tested for adaptation to our field conditions. After field testing, these plants may be accessioned and added to the Medicinals project.

Collection trips:
In collaboration with the MWPCC (Midwest Plant Collecting Collaborative), a collection trip was conducted October 18 – 31, 2004. This collection trip to the Ozark Plateau covered portions of northern Arkansas and southern Missouri and resulted in 156 collections. Participants included Scott Woodbury and James Trager from the Shaw Nature Reserve, Kunso Kim from the Morton Arboretum, and Boyce Tankersley from the Chicago Botanic Garden. A short collection trip to NC, SC, and TN was coordinated by Joe-Ann McCoy October 5-8, 2004 in collaboration with USFWS botanist, Gary Kauffman, and Clemson University Herbarium Curator, Patrick McMillan. Twenty-four species were collected on that trip. These collections are being incorporated into our holdings where appropriate and are also being shared with other NPGS sites based on their maintenance priorities.

Availability and Backup:
Thirty-eight percent of the NC7 medicinal accessions are currently available (Table 1). Twenty-three accessions have been harvested and 29 made available since April, 2004. Twenty-nine accessions have been backed up in 2004, with a total of 139 accessions now backed up in Fort Collins (Table 2), representing 45% of the total collection.

Regeneration and Maintenance:
Seeds from 23 accessions of *Echinacea* and *Hypericum*, which were regenerated in field cages, were harvested, processed and stored (Table 2). Regeneration efforts focused on new *Hypericum* accessions for a field planting in 2005. Vegetative samples of these new accessions were also made available to ISU / NIH researchers for both chemical and genetic analyses. In addition, during the summer of 2004, 12 cages of newly acquired *Hypericum* accessions were planted.

Distribution:
Two hundred and twenty one items were distributed in 2004; of these, 71% were domestic while 29% were foreign distributions (Table 3).

Along with seed distribution, 222 leaf samples from 37 *Hypericum* accessions grown under greenhouse conditions were distributed for molecular-marker analyses to Dr. Jonathan Wendel's lab and to Dr. Eve Wurtele's lab for associated HPLC analysis. Both projects are associated with an NIH Center for Research on Dietary Supplements grant project.

Characterization and Taxonomy:
Descriptor data for 43 morphological features were collected from 23 field accessions of *Echinacea* last summer, following the CGC descriptor list protocol as developed by Mark Widrlechner. Observations for 27 accessions of *Echinacea* have been mass loaded into GRIN (Table 4). All available *Echinacea* data collected from 2000-2004 have been entered in a single spreadsheet for mass loading into the GRIN database. All data have been refined and standardized and will be loaded in February 2005, once permission is granted to change current CGC descriptors in order to increase precision.

Hypericum descriptors are currently being developed for trial use during the summer of 2005 and approval by the New Crops CGC.

Sixty-three digital field photographs have been taken, representing 10 accessions including aster yellows symptoms. These images will be loaded with data in 2005 utilizing standardized file naming protocols. All 2005 blooming accessions will be photographed.

With the assistance of Mark Widrlechner and Robert Stebbins, six 6 PI numbers were assigned to *Echinacea* and *Hypericum* accessions. With the assistance of Mark Widrlechner 14 taxonomic re-identifications were initiated (2 for *Hypericum* and 12 for *Echinacea*).

Pathogen Observations:
Field plantings were monitored weekly during the growing season, for *Colletotrichum* and aster yellows disease symptoms. With guidance from staff pathologist Charles Block, a *Colletotrichum gloeosporioides* screening protocol for *Hypericum* seed accessions was developed. Thirty-six accessions have currently been tested (Table 3_NC7). All germination and pathogen data collected have been entered in the GRIN database.

Joe-Ann McCoy's other research and training activities:
Attended the annual New Crops CGC meeting, 9/19/2004 in Minneapolis where *Hypericum* was added to the list of genera under the CGC's purview. At this meeting, CGC approval for the development of a descriptor list for *Hypericum* was received, and three experts have been identified to serve as advisors.

Regularly attended monthly meetings for NIH cooperators associated with the Center for Research on Botanical Dietary Supplements. In reference to the NIH project, have: 1.)worked with two Ph.D. students to supply plant material for two projects; 2.) identified and provided commercial *Hypericum* seed to cooperators for field testing and HPLC analysis; 3.) provide relevant journal articles and conference proceedings associated with the project.

Posters / Publication:

McCoy, J., Camper, N., and Davis, J. 2004. Rhizome Propagation of *Actaea racemosa* (black cohosh) and Analysis of Associated Triterpene Glycosides, in Proceedings of the 2004 International Conference on Natural Products Research (ICNPR). July 31-August 4, 2004. Phoenix, Arizona, P:585.

McCoy, J. 2004. Noteworthy Collections. *Actaea racemosa* var. *dissecta*. Castanea 69(4) p. 329.

Invited Talks:

1.) Development of Propagation Protocols for *Actaea racemosa* and analysis of Associated Triterpene Glycosides. ISU Horticulture Seminar series. 11/8/2004.

2.) Seed and Rhizome Propagation of *Actaea racemosa.* Shaw Nature Reserve; Missouri Botanical Garden. 10/18/2004

3.) Disease and Pest Management of Medicinal Crops. Third Medicinal and Aromatic Plant Symposium. Mountain State University & USDA-ARS. Beaver, West Virginia. 9/25/2004.

Annual Meetings:
Have attended annual meetings for 1.) New Crops CGC (AAIC); 2.) The Third Medicinal and Aromatic Plant Symposium (USDA-ARS / MSU); and 3.) The International Congress on Natural Products Research (ICNPR).

Manuscript Review:
In 2005 two peer reviewed manuscripts were reviewed prior to submission.

2005 Project Plans:
Further acquisition of *Echinacea* and *Hypericum* cultivars to increase the Medicinal collection will be a primary goal for 2005. A collection trip to the Republic of Georgia is under discussion with plans to write an exploration proposal in 2005. A southeast US collection trip will be planned for Fall, 2005 for *Hypericum* accessions. Plans to attend an In Situ Subcommittee meeting at the PGOC meeting in Pullman, WA have been finalized. This meeting will establish protocols for in situ collection and conservation methods which will be utilized for protected areas.

All *Echinacea* descriptor data will be mass loaded into GRIN in 2005.

The curator has been invited to give two talks at the North Carolina Natural Products Association Medicinal Plant Conference in March, 2005.

A presentation will be developed to introduce and describe the NCRPIS medicinal collection to medicinal plant researchers and growers.

A collaboration is being established with Dr. Tom Ranney, North Carolina State University, Fletcher, NC, to determine ploidy levels via flow cytometry for the *Echinacea* collection and plans are underway to write an evaluation grant proposal to fund the research in 2005.

A Pesticide Applicator License will be obtained in 2005.

Monthly meetings with post doc researchers and graduate students associated with the NIH Center for Research on Botanical Dietary Supplements will be attended.

h. Oil Seeds (L. Marek, I. Larsen, B. Bingaman)

I started my tenure as the Oilseeds Curator at NCRPIS on February 23, 2004. I am responsible for curating the *Helianthus*, *Brassicaceae*, *Linum*, *Cuphea*, miscellaneous *Asteraceae* and *Euphorbia* collections held at NCRPIS. I would like to take this opportunity to formally thank everyone at NCRPIS for all the help I have received during my first year as curator.

ACQUISITIONS
In 2004, we received 118 new oil seed accessions.

***Helianthus*:** Thirteen *Helianthus californicus* accessions were received from a 2003 collection trip to California by Dr. Thomas Gulya and Dr. Gerald Seiler, USDA Sunflower Research Group, Fargo. Twenty-seven accessions representing six species were received from a 2003 trip in the southeastern US also taken by Dr. Thomas Gulya and Dr. Gerald Seiler. Processing of 14 additional accessions from the SE US trip is pending USFWS approval to distribute endangered species seed. Three *H. niveus* ssp. *tephrodes* accessions were collected in California in 2004 by BLM co-operator Mr. Chris Knauf. Nineteen accessions representing four species from two 2004 collecting trips to southern California taken by Dr. Thomas Gulya and/or Dr. Laura Marek are being processed. The new sunflower accessions include ten species which have previously not been available for distribution. An increased interest by the sunflower research community in wild *Helianthus* germplasm has resulted in the CGC approved goal of

acquiring accessions representative of the geographic distribution of all 66 Helianthus taxa.

***Brassicaceae*:** 62 *Eruca* species (primarily *Eruca sativa*) were received from a 2004 collection trip to the Mediterranean by Dr. Jules Janick, Purdue University. One *Alyssum murale* accession capable of Ni hyper-accumulation was received from Dr. Rufus Cheney, USDA, Beltsville. We expect to obtain additional germplasm useful for phytoremediation from Dr. Cheney in 2005.

***Linum*:** Nine accessions of *Linum usitatissimum* were received from an ICARDA/NPGS collection trip taken into Tajikistan. One *L. lewisii* accession was received from the NRCS Plant Materials Center in Aberdeen, Idaho through Shawn Belt, NRCS Beltsville as a selected ecotype germplasm release for restoration of disturbed sites in the central intermountain west.

***Cuphea*:** One accession of *Cuphea viscosissima* was collected in Missouri by Dr. Joe-Ann McCoy during a 2004 MWPCC trip.

MAINTENANCE

General statistics about availability and management of the collections are presented in Tables 1 and 2 in appendix "X".

***Helianthus*:** The cultivated *Helianthus annuus* accessions are roughly 90% available. When CSR restricted accessions are removed from the calculations, cultivated *Helianthus* accessions are 95% available. We are managing our increases to maintain that level of availability and to ensure that the core collection accessions are always available. Cultivated *Helianthus annuus* accessions requiring long seasons or short days to flower are increased in the greenhouse as space allows (three to four accessions per season; four in the winter of 2004-2005). Research co-operators currently have strong interest in wild *Helianthus* germplasm as potential sources of disease resistance, herbicide tolerance and other valuable traits. As a result, we have dramatically increased our efforts to make wild annual and perennial accessions available at the same level as the cultivated accessions. We caged and harvested seed from 23 wild annual *Helianthus* accessions and 102 wild perennial accessions in 2004. Eighty of the wild perennial accessions were established in the field in 2003 and caged for the first time in 2004. Forty-seven perennial accessions were established in the field in 2004 and 15 of these were caged for seed production in 2004. The 47 new accessions represent 46% of the wild perennials that were attempted in 2004.

We are working with the NPGS Parlier site (Dr. Maria Jenderek, curator) as a location for increase of accessions requiring a longer growing season than is available in Ames as well as for at least a portion of our cold sensitive wild *Helianthus* accessions. Not all cold sensitive accessions can be successfully grown in Parlier because the location averages 30 occurrences of temperatures at 26 F or below annually. In 2004, Dr. Jenderek harvested seed for 12 *Helianthus* accessions. These increases are not reflected in the statistics for the current annual report because seed and data were not received in Ames until 2005. New accessions were not established at Parlier in 2004. Because of the difficulties associated with germinating wild *Helianthus* species, beginning in 2005 and for future increases at Parlier, we will germinate accessions at NCRPIS and send seedlings to Dr. Jenderek by mid to late March. The Parlier location now has 40 sunflower cages (purchased by NCRPIS) and can handle up to 40 accessions per year.

***Brassicaceae*:** Brassicaceae accessions are 75% available. We continue to work towards having at least 90% of these accessions available and the number of accessions increased in 2004 represented a significant increase over the previous year. An unusually wet and cool spring in 2004 resulted in the loss due to flooding of two *Brassica rapa* accessions. Eighteen *Erysimum* accessions (eight different species) did not flower in the field. We removed plants of these accessions from the field to the greenhouse before freezing temperatures in fall 2004. Six of the accessions began flowering during the winter season. We will either cage these plants in the greenhouse if space is available or re-introduce these plants to the field when conditions permit.

***Linum*:** No new *Linum* accessions were established in the field in 2004. Seed was harvested from 16 wild *Linum* accessions over-wintered from 2003. The cultivated accessions are 99% available. We are working towards having more than 90% of the wild *Linum* accessions available. Available wild *Linum* accessions increased by 9% during 2004 and we will be attempting to increase 65% of the unavailable accessions in 2005.

***Cuphea*:** Seeds are available for 88% of the accessions of seven species (*C. calophylla, C. carthegenensis, C. lanceolata, C. lutea, C. tolucana, C. viscosissima, C. wrightii*) being used by members of the National *Cuphea* Consortium for the development of domesticated lines of Cuphea for agronomic production of mid-chain fatty acids. Seeds were harvested from nine of the ten accessions established in the field in 2004. 54% of the Cuphea accessions of species of primary interest for horticultural/floricultural uses are available. Due to steady interest in this area, we will work to make a larger percentage of these accessions available.

DISTRIBUTIONS
General statistics about distributions of the collections are presented in Table 3 in appendix "X".

***Helianthus*:** The overall trend in *Helianthus* distributions has been a decline in requests for cultivated *H. annuus* germplasm an increase in demand for wild germplasm. The full potential of this interest is not reflected in general statistics because only 37% of the non-*Helianthus annuus* wild accessions are available for distribution. We distributed *Helianthus* accessions in 2004 to cooperators at the USDA Sunflower Research Group in Fargo for evaluation of resistance to sunflower moth, banded sunflower moth, stem weevil, red sunflower seed weevil, resistance to multiple races of rust, *Phomposis* stem canker, downey mildew, and resistance to the *Sclerotinia* disease complex. Accessions were also sent to co-operators to study salt tolerance and herbicide tolerance. Other accessions were requested to investigate sunflower domestication, regulation of flowering time, polyploid evolution, and research into the development of hybrid perennial sunflowers. In addition, NRPIS supplied germplasm to be used as the source of EST libraries for the *Helianthus* portion of the National Science Foundation funded *Compositae* Genome sequencing project.

***Brassicaceae*:** The surge in distributions of Brassicaceae accessions in 2004 was in part due to the distribution of the entire collection to Dr. Philip Griffiths at Cornell University for a black stem rot evaluation. Because the comprehensive nature of the screen was important, we included all possible accessions in the distribution not just accessions listed as available in GRIN. In addition, Dr. F. Seyis, Mayis University in Turkey, requested all available *Brassica* germplasm for breeding work. Portions of the Brassicaceae accessions were distributed for screening for resistance to *Sclerotinia sclerotiorum* as well as for screening for nematode resistance and weed research into insect host preferences. We distributed accessions for research in oil content, biofuel and biolubricant development, and to a breeding program developing spring canola for northern Mexico. We continue to regularly distribute accessions for phytoremediation research.

***Linum*:** We distributed *Linum* accessions to several programs for evaluation of oil content as well as to a research program working to develop perennial flax suitable for use in a grazing mix. We sent *Linum usitatissimum* accessions to Israel for the development of fiber flax.

***Cuphea*:** Cuphea accessions were distributed for breeding programs, for the evaluation of oil content and for insect feeding experiments. Accessions were also distributed for evaluation for use in the floriculture trade.

RESEARCH ACTIVITIES
General statistics about observations and images recorded for the collections are presented in Table 4 in appendix "X".

***Helianthus*:**
Germination experiments: We are facing a number of issues as we focus on making a larger portion of the wild germplasm available. Eighty percent of the original seed from non-*Helianthus annuus* wild annual accessions has been stored for 19 years or

longer. Increases have not been attempted for most wild perennial accessions and 65% of the original seed has been stored for 19 years or longer. In 2004, we observed low germination success of wild perennial seed stored more than 15 years. We experimented with protocols to increase germination. For some accessions, germination was increased by a 24 hour washing in cool, running tap water and/or by clipping the non-embryo end of the seed. Imbibition with gibberellic acid (1.0 mM) increased germination but had a negative effect on seedling transplant survival. We continue to experiment to find optimal germination conditions for the different species.
Molecular profiling: I have started preliminary work to establish molecular profiles of the *H. niveus* species group. I collected DNA samples on Whatman FTA cards during collecting trips so that intra- and inter-population variation can be sampled and examined. Once protocols are established, the molecular profiles of the *H. tuberosus* collection can be examined to determine the genetic integrity of accessions that have been maintained long term in a perennial nursery.

Brassicaceae:
Germplasm for phytoremedition: A field population of the Ni accumulating *Alyssum murale* accession donated by Dr. Rufus Cheney was established and we began experimentation with Ni fertilization. The species is perennial and we are attempting to overwinter it.
Brassica napus genetic study: We grew 40 accessions of *Brassica napus* to provide seed for a genetic study by graduate student Von Mark Cruz. These 40 plots were successfully direct seeded, the first time we had used this technique for *Brassicaceae* accessions. These plots required special attention to ensure the genetic integrity of the seed because the *B. napus* plants became much too large for the cages traditionally used for *Brassicaceae* increases. Ten accessions did not flower and were left in the field to overwinter. Because survival of the overwintered populations is not assured, these accessions will also be started for re-growing in 2005 incorporating a longer vernalization period with older seedlings having greater leaf mass then the plants started for 2004.

***Cuphea*:**
Germination experiments: *Cuphea* seeds can be difficult to germinate. The standard germination protocol previously in use at NCRPIS involved excision of the seed coat after imbibition of the seeds. During 2004 we experimented with protocols to simplify and improve germination including not excising the seed coat after imbibition, using a heat treatment prior to imbibition to melt crystallized fatty acids in the seeds (based on collaborative research with NCGRP), and using gibberellic acid as the imbibing solution. We were very successful in obtaining germination under experimental conditions; however, some conditions that promoted germination were detrimental to seedling survival. Eighty percent of accessions we attempted to increase in 2004 germinated, although only 40% of these were successfully established in the field. Thirty percent of the successfully germinated accessions had not germinated in previous attempts. All of the failed accessions had failed to germinate in previous attempts (which had included excision of seed coats). We are continuing our experiments to find optimal germination conditions for the different Cuphea species. We have discontinued the use of seed coat excision as a standard protocol for *Cuphea* seed germination.

Collection trips:
I participated in two collection trips for wild *Helianthus* germplasm in 2004. In September, I met Dr. Thomas Gulya, Plant Pathologist, USDA Sunflower Research Group, Fargo in southern California. We spent 6 days collecting wild *Helianthus* germplasm from east of San Diego to as far north as the Sacramento River Delta, covering over 1000 miles. We collected accessions of *H. exilis* (1 recollect), *H. gracilentis* (3 new accessions), *H. californicus* (4 recollects, 4 new), and *H. bolanderii* (1 new accession). In December I spent two days in the Imperial Sand Dunes (BLM) east of El Centro, California collecting *H. niveus* ssp. *tephrodes* (3 recollects, 3 new accessions) with BLM Program Manager Mr. Christopher Knauf.

Only one *Helianthus* taxon, *Helianthus niveus* ssp. *niveus*, does not have populations in the United States. This taxon is endemic to the Baja California peninsula. A future goal is to have this taxon and populations of other *Helianthus* taxa that range south into Mexico represented in the NPGS. In an effort to begin building local contacts for future collecting trips, in December I attended the VII Baja Botanical Symposium at the

Universidad Autonoma de Baja California in Ensenada, Mexico. After the meeting, I traveled with students from UABC to observe a large population of *H. niveus* ssp. *niveus* on the Pacific sand dunes southwest of Vincente Guerrero.

PROFESSIONAL ACTIVITIES
Publications and Presentations:
Heilanthus: I prepared a poster entitled "The Sunflower Collection at the North Central Regional Plant Introduction Station" with co-authors Irvine Larsen, Charles Block and Candice Gardner for display at the 2004 International Sunflower Conference held in Fargo, ND in September. I also submitted a paper with the same title and authors for publication in the 2004 International Sunflower Conference Proceedings. In December I presented an invited seminar entitled "*Helianthus* in Mexico: a reserve of genetic diversity", with co-authors Thomas Gulya and Gerald Seiler at the VII Baja Botanical Symposium, at the Universidad Autonoma de Baja California in Ensenada, Mexico.
Brassicaceae: I presented the annual *Brassicaceae* Germplasm Status Report to the Brassica CGC committee on July 20th at the ASHS Meeting in Austin, TX.
Cuphea: I presented an overview of the Cuphea collection and introduced germination issues of interest at the Cuphea Winter Technical Meeting in Bloomington, MN, March 9 - 10. I presented the results from 2004 germination experiments at the Cuphea Summer Field Days in Morris, MN, August 27. A crop status report was prepared for the New Crops CGC meeting in Minneapolis, MN in September which included data relevant to various miscellaneous *Asteraceae* species and the *Euphorbia* collection in addtion to *Cuphea*.

Service Activities:
NCRPIS: I am a member of the Safety Committee and participated in meetings at the station in the fall of 2004 as we worked out issues dealing with increased security required for our location by the Department of Homeland Security.
Agronomy Departmental activities: I continue to coordinate the monthly Agronomy Department Professional and Scientific staff meetings. For the 2004 - 2005 academic year, the group incorporated informal monthly presentations by P&S staff from the different research/teaching/service groups within the department describing their area activities. NCRPIS P&S staff were responsible for the November 2004 presentation.
PGOC: I attended the CGC Chairs/PGOC annual meetings in Beltsville, MD in June as an introduction to NPGS issues at the national level. I am a member of the recently re-activated *In situ* Conservation Subcommittee within the PGOC which will meet formally at the June 2005 PGOC annual meeting in Pullman, WA.

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

Collections curated by the Vegetable Project include *Cichorium* (NC7-chicory), *Cucumis sativus* (NC7-cucumis.cucs), *Cucumis melo* (NC7-cucumis.melo), *Cucumis* species (NC7-cucumis.wilds), *Cucurbita pepo* (NC7-cucurbita), *Cucumella aspera and Oreosyce africana* (NC7-cucurbits.misc), *Daucus* (NC7-daucus), *Ocimum* (NC7-ocimum), and *Pastinaca* (NC7-parsnips). Statistics for accession numbers and availability for each site crop are found in Table 1.

Acquisition:
Forty new accessions were received and are listed by site-crop in Table 1. Four *Cucumis melo* and 1 Cucumis sp. Greek landrace accessions were received from via California. One *Cucumis melo* and 22 *Daucus* were collected from Uzbekistan by P. Simon, University of Wisconsin. Seven old *Daucus carota* varieties from the National Center for Genetic Resources Preservation (NCGRP) in Ft. Collins, CO were incorporated into the NCRPIS collection after regeneration by cooperators. Two old varieties of *Cucumis melo* were requested from NCGRP for incorporation into the NCRPIS collection as they are often used in disease evaluations. One *Cucumis melo*, and 2 *Cucurbita pepo* were also received from NCGRP as expired PVPs.

Maintenance:

Table 2 contains 2004 data for regenerations attempted and accessions harvested.

Cucurbit regenerations focused primarily on accessions having low seed quantities on distribution lots. Many of the *Cucumis melo* accessions were regenerated from seed lots received from the SRPIS in Griffin, GA which may have been infected with bacterial fruit blotch (*Acidovorax avenae*). This year, the disease was again very prevalent in our cage increases, so all *C. melo* seeds harvested from field cages were treated with 1% hydrochloric acid during the extraction process to clean the bacteria from the surface of the seeds. Squash Mosaic Virus was also present in the Cucurbita regeneration plantings again this summer but plant infection was delayed until late in the growing season due to the use of the new 5' x 15' x 40' Cucurbita field cages. The resulting increase seed lots will be evaluated for the presence of SqMV. The Plant Pathologist is looking into the possibility that the virus may not have been transmitted to these seeds because plant infection was delayed until late in the growing season. (For additional information on current NCRPIS research activities on bacterial fruit blotch and squash mosaic virus, please refer to the Plant Pathology section of this annual report.)

Daucus regeneration efforts have been primarily directed towards making newly acquired accessions available. In addition to the regenerations in Ames, we received seed increases from R. Maxwell, Seminis Vegetable Seeds, Idaho (1 accession), and R. Freeman, Nunhems (formerly Sunseeds), Oregon (11 accessions). Accessions regenerated by Maxwell and Freeman were "at risk" old cultivars with low viability at NCGRP. These accessions will receive PI numbers and be incorporated into the NCRPIS collection.

As accessions are regenerated, seed samples are sent to NCGRP for back-up. Seven of the nine vegetable collections have 76% or more of their accessions backed up at NCGRP (Table 2).

In 2004, 541 germination tests (Table 2) were performed, and included seed increases from the 2003 regenerations and 5-year germination testing of Cucumis sativus accessions.

Distribution:

Packet and accession distributions for the vegetable collections are summarized in Table 3. In 2004, 2978 packets (items) were distributed. Distribution history for the last five years can be found in the following table.

Crop	Calendar Year	No. of Orders	No. of Recipients	No. of Items Distributed	No. of Accessions Distributed
Cichorium	2000	5	5	52	52
	2001	6	6	288	175
	2002	8	8	261	134
	2003	8	7	192	144
	2004	5	4	45	43
Cucumis	2000	58	44	1021	819
	2001	59	49	1229	933
	2002	58	46	2658	1773
	2003	46	36	1901	1391
	2004	73	64	1393	1105
Cucurbita	2000	19	18	457	363
	2001	22	20	288	156
	2002	20	17	165	132
	2003	11	11	170	150
	2004	38	35	702	490
Cucurbits - Mics.	2000	0	0	0	0
	2001	2	2	2	1
	2002	0	0	0	0
	2003	1	1	1	1
	2004	1	1	2	2
Daucus	2000	11	11	169	167
	2001	13	12	235	211
	2002	11	11	75	67
	2003	13	12	426	294
	2004	21	21	596	378
Ocimum	2000	7	7	245	75
	2001	4	4	96	79
	2002	7	7	18	16
	2003	8	8	52	42
	2004	22	22	235	84
Pastinaca	2000	0	0	0	0
	2001	0	0	0	0
	2002	2	2	9	8
	2003	1	1	1	1
	2004	3	3	5	4
Total		563	495	12989	9290

Characterization and Taxonomy:

Digital images, along with basic notes for taxonomic identification and accession characterization, are recorded during regeneration (Table 4). Data for approximately 17 descriptors, primarily fruit descriptors, are recorded at harvest for *Cucumis* and *Cucurbita* accessions. Plant habit, flowering dates, and life-cycle notes are recorded for *Daucus* and *Pastinaca*. Images will be made available on GRIN once the NCRPIS Imaging Committee approves guidelines for naming and loading images to the database.

With the assistance of Dr. Mark Widrlechner (Horticulturist), taxonomic identities are reviewed and confirmed as each accession is regenerated. The 2004 re-identifications included: 1 *Cichorium endivia* to *C. intybus*; 1 *Daucus carota* to *D. littoralis*; 15 *Daucus sp.* to 1 *D. involucratus*, 4 *D. guttatus*, and 10 *D. carota*.

Evaluation/Utilization:
Dr. Charles Block (Pathologist) continued to screen all *Cucurbita* and *Cucumis* seedlings grown for regeneration for the presence of squash mosaic virus with an ELISA protocol before seedlings can be transplanted to the field. He also visually inspected all cucurbit field plantings for disease during the 2004 growing season. Seed-borne diseases are of specific interest, with bacterial fruit blotch in *Cucumis melo* being of greatest concern since phytosanitary issues have prevented the distribution of *Cucumis* germplasm to some countries.

We are still awaiting oil analysis and DNA fingerprinting data for the NPGS *Ocimum* collection from Dr. Katerina Svoboda and her student Senga Oxenham, at The Scottish Agricultural College Auchincruive, Ayr, Scotland, UK. Dr. Widrlechner and I are collaborating on a publication with Svoboda and Oxenham regarding the evaluation work.

Future Plans:
Regenerations: We will continue to increase *Cucumis* and *Cucurbit* accessions where distribution quantities and percent germination have fallen below critical values as set on GRIN. Fifty-one accessions of *Daucus* were started in the greenhouse in October 2004 for the summer 2005 field cages (24 new accessions, and 26 old PI accessions having low germination or low seed quantity). Regeneration of hard to handle and wild *Cucumis* species will continue in the greenhouse as time, space, and labor allocation permits.

Germinations: Viability tests will be performed on the 2004 cucurbit regeneration seed lots in April 2005 and on the 2004 *Daucus* regeneration seed lots in June. Five-year germination tests to monitor viability of the distribution lots were completed on *Cucumis sativus* and *Daucus* in 2004. Five-year germination testing will be performed on *Cucurbita* in 2005. It is interesting to note that we are currently distributing *Cucumis* and *Cucurbita* seed from regeneration lots now more than 40 years old. These seed lots have been stored in the NCRPIS cold storage facilities where the temperature and humidity have generally been held at 4° C and between 25 and 40% RH.

Characterization: A 2-year observation planting of all available *Cichorium* accessions will be direct seeded in the spring of 2005 so that the collection may be characterized and accession taxonomy verified. Resulting data will be loaded into GRIN. We will also continue to record characterization data as regenerations occur on other vegetable accessions.

Evaluation: The Pollinator Program and the Vegetable Program will continue to collaborate on pollinator tests. One test involves evaluating whether alfalfa leaf cutter bees may be a useful pollinator for vegetable crops maintained at the NCRPIS in field and greenhouse regenerations. Collaboration continues on developing a year-round cage and pollinator program for regenerating *Cucumis* and *Cucurbita* in the greenhouse. For more information on these tests, please refer to the Entomology section of the annual report.

Another possible evaluation project for the future will be to compare the OP melon seed lots transferred to Ames with seed samples backed up at NCGRP by the SRPIS. Many of the older seed lots were backed up prior to 1970 and may have been regenerated by open pollination less often than the seed samples sent to Ames. Unfortunately, many of these backup samples are low quality and low quantity and will have to be regenerated before we can do the comparisons.

Publications:

The following article has been accepted for publication in 2005:
Block, C. C. and K. R. Reitsma. Powdery Mildew Resistance in the U.S. National Plant Germplasm System Cucumber Collection. HortScience 40(2) 416-420. 2005.

j. Research Leader Activities: by C. Gardner

Primary duties include the coordination of the ARS and NC7 components of the North Central Regional Plant Introduction Station, including the Plant Introduction Research and GEM CRIS Projects.

Current research activities include:
1) Development of best pollination practices document to preclude contamination during regeneration.
2) Oversight of Plant Breeding Ph.D. student Von Mark Cruz' Brassica genetics studies
2) Co-advises Sustainable Agriculture Student Lindsay Werth's Southwestern Maize racial characterization project
3) Research interests in the development of use of alfalfa leafcutter bees for NCRPIS crop regenerations
3) Serves on ASA's Biosecurity Committee
4) Serves as secretary of the AAIC, American Association of Industrial Crops
5) Coordinating collection of site needs for ARS's NPGS greenhouse initiative
6) Co-chair for the 9th International Plant – Pollinator Relations Symposium in Ames, IA in 2006.

Year 2004 **Table 1** **# NCRPIS Accessions (Acc), # Acquired, # Available**

CURATOR	GENUS CROP	Number Accs	Number Accs Acquired	Percent Acquired	Number Available	Percent Available	Percent Avail Last Year
Brenner	NC7-amaranth	3329	1	0	3097	93	92
	NC7-celosia	54	0	0	23	43	35
	NC7-echinochloa	271	2	1	194	72	71
	NC7-grasses	119	2	2	14	12	12
	NC7-legumes	227	0	0	109	48	45
	NC7-melilotus	952	22	2	675	71	74
	NC7-panicum	982	5	1	872	89	89
	NC7-perilla	22	0	0	22	100	100
	NC7-quinoa	234	2	1	192	82	82
	NC7-setaria	1006	8	1	895	89	90
	NC7-spinach	401	0	0	370	92	93
	NC7-umbels	1055	19	2	453	43	40
	Total:	8652	61	1	6916	80	80
Marek	NC7-asters	323	0	0	92	28	29
	NC7-brassica	1993	1	0	1658	83	84
	NC7-crucifers	1197	63	5	733	61	63
	NC7-crucifers.pvp	1	0	0	0	0	0
	NC7-cuphea	650	1	0	477	73	75
	NC7-euphorbia	219	0	0	47	21	20
	NC7-flax	2818	9	0	2798	99	100
	NC7-flax.wilds	165	1	1	64	39	30
	NC7-sun.cults	1681	0	0	1507	90	87
	NC7-sun.wilds	24	0	0	12	50	56
	NC7-sun.wilds.ann	1449	8	1	1119	77	0
	NC7-sun.wilds.per	749	35	5	150	20	0
	Total:	11269	118	1	8657	77	77
McCoy	NC7-medicinals	311	138	44	117	38	Na
	Total:	311	138	44	117	38	Na
Millard	NC7-corn.kin	34	0	0	7	21	21
	NC7-maize	18293	35	0	11910	65	64
	Total:	18327	35	0	11917	65	64
Reitsma	NC7-chicory	250	0	0	196	78	82
	NC7-cucumis.cucs	1350	1	0	1281	95	93
	NC7-cucumis.melo	3104	8	0	2325	75	72
	NC7-cucumis.wilds	329	0	0	127	39	38
	NC7-cucurbita	993	2	0	813	82	81
	NC7-cucurbits.misc	2	0	0	2	100	100
	NC7-daucus	1086	29	3	739	68	69
	NC7-ocimum	96	0	0	85	89	88
	NC7-parsnips	71	0	0	36	51	50
	Total:	7281	40	1	5604	77	75
Widrlechner	NC7-mints	128	5	4	76	59	60
	NC7-ornamentals	1957	53	3	834	43	43
	Total:	2085	58	3	910	44	44
NCRPIS Total:		**47925**	**450**	**1**	**34121**	**71**	**71**

na = not available. This sitecrop is new for 2004.

Year 2004 **Table 2** **# NCRPIS Accessions (Accs) Germinated, # Regenerated, # Made Available, # Backed Up**

CURATOR	GENUS_CROP	Number Accessions (Accs)	Number Accs Germed	Percent Accs Germed	Number Attempted Regen	Number Harvested Regen	Number Perm Perennial	Number Perennial Harvested (Vegetative)	Number Accs Made Available	Number Accs Growing	Number Accs Backed Up for YR	Total # Accs Backed Up	Percent Accs Backed Up
Brenner	NC7-amaranth	3329	71	2	151	96	0	0	83	0	49	3131	94
	NC7-celosia	54	4	7	0	5	0	0	4	0	3	23	43
	NC7-echinochloa	271	2	1	8	2	0	0	2	0	2	219	81
	NC7-grasses	119	0	0	3	2	0	0	0	0	0	38	32
	NC7-legumes	227	4	2	1	0	0	0	8	0	3	168	74
	NC7-melilotus	952	9	1	33	28	0	0	9	0	16	760	80
	NC7-panicum	982	1	0	7	3	0	0	7	0	4	895	91
	NC7-perilla	22	0	0	0	0	0	0	0	0	0	22	100
	NC7-quinoa	234	3	1	22	6	0	0	1	0	1	201	86
	NC7-setaria	1006	481	48	5	0	0	0	4	0	1	944	94
	NC7-spinach	401	0	0	3	3	0	0	0	0	0	374	93
	NC7-umbels	1055	85	8	82	79	0	0	55	21	48	491	47
	Total:	8652	660	8	315	224	0	0	173	21	127	7266	84
Marek	NC7-asters	323	0	0	0	1	0	0	1	0	1	73	23
	NC7-brassica	1993	10	1	103	81	0	0	22	8	15	1923	96
	NC7-crucifers	1197	19	2	107	73	0	0	19	16	21	815	68
	NC7-crucifers.pvp	1	1	100	0	0	0	0	0	0	0	1	100
	NC7-cuphea	650	0	0	0	1	0	0	8	10	2	563	87
	NC7-euphorbia	219	0	0	0	1	0	0	0	6	0	53	24
	NC7-flax	2818	423	15	0	0	0	0	42	0	9	2816	100
	NC7-flax.wilds	165	25	15	0	16	1	0	26	0	17	56	34
	NC7-sun.cults	1681	90	5	0	49	0	0	74	0	40	1585	94
	NC7-sun.wilds	24	3	13	0	0	0	0	0	0	0	13	54
	NC7-sun.wilds.ann	1449	187	13	0	23	0	0	101	0	93	1134	78
	NC7-sun.wilds.per	749	25	3	0	2	0	0	23	0	17	234	31
	Total:	11269	783	7	210	247	1	0	316	40	215	9266	82
McCoy	NC7-medicinals	311	41	13	3	23	0	0	29	0	29	139	45
	Total:	311	41	13	3	23	0	0	29	0	29	139	45
Millard	NC7-corn.kin	34	1	3	0	1	0	0	0	1	0	8	24
	NC7-maize	18293	970	5	564	468	4	0	438	6	46	13506	74
	Total:	18327	971	5	564	469	4	0	438	7	46	13514	74
Reitsma	NC7-chicory	250	0	0	0	0	0	0	0	0	0	199	80
	NC7-cucumis.cucs	1350	277	21	52	34	0	0	30	0	26	1265	94
	NC7-cucumis.melo	3104	142	5	156	151	0	0	137	0	92	2444	79
	NC7-cucumis.wilds	329	1	0	0	16	0	0	1	0	1	136	41
	NC7-cucurbita	993	18	2	38	25	0	0	17	0	12	769	77
	NC7-cucurbits.misc	2	0	0	0	0	0	0	0	0	0	2	100
	NC7-daucus	1086	103	9	105	91	0	0	12	0	30	822	76
	NC7-ocimum	96	0	0	0	0	0	0	0	0	0	87	91
	NC7-parsnips	71	0	0	0	15	0	0	0	0	0	32	45
	Total:	7281	541	7	351	332	0	0	197	0	161	5756	79
Widrlechner	NC7-mints	128	3	2	0	1	0	0	4	0	4	76	59
	NC7-ornamentals	1957	33	2	168	67	125	0	40	83	33	603	31
	Total:	2085	36	2	168	68	125	0	44	83	37	679	33
NCRPIS Total:		**47925**	**3032**	**6**	**1611**	**1363**	**130**	**0**	**1197**	**151**	**615**	**36620**	**76**

Year 2004 **Table 3** **# NCRPIS Accessions (Accs) Distributed Domestically and to Foreign Countries**

			External Domestic Distributions				Foreign Distributions				External Domestic & Foreign Distributions				# Distinct
CURATOR	**GENUS CROP**	**# Accs**	**# Accs**	**# Orders**	**# Recipients**	**# Items**	**# Accs**	**# Orders**	**# Recipients**	**# Items**	**# Accs**	**# Orders**	**# Recipients**	**# Items**	**Accs for NC7 Orders**
Brenner	NC7-amaranth	3329	308	27	26	373	77	12	11	99	352	39	37	472	692
	NC7-celosia	54	4	4	4	5	0	0	0	0	4	4	4	5	5
	NC7-echinochloa	271	27	6	6	32	1	1	1	1	28	7	7	33	3
	NC7-grasses	119	0	0	0	0	0	0	0	0	0	0	0	0	3
	NC7-legumes	227	5	1	1	5	70	2	2	78	75	3	3	83	7
	NC7-melilotus	952	53	7	5	59	9	2	2	9	58	9	7	68	73
	NC7-panicum	982	877	7	6	909	11	2	2	11	877	9	8	920	6
	NC7-perilla	22	5	1	1	5	9	2	2	16	14	3	3	21	0
	NC7-quinoa	234	54	14	13	87	10	5	5	11	58	19	18	98	26
	NC7-setaria	1006	31	9	9	39	93	3	3	93	117	12	12	132	490
	NC7-spinach	401	71	15	14	80	0	0	0	0	71	15	14	80	144
	NC7-umbels	1055	59	23	23	77	154	10	9	276	193	33	32	353	266
	Total:	8652	1494	114	108	1671	434	39	37	594	1847	153	145	2265	1715
Marek	NC7-asters	323	6	3	3	6	1	1	1	1	6	4	4	7	1
	NC7-brassica	1993	1735	36	32	2559	1661	22	19	1789	1735	58	51	4348	69
	NC7-crucifers	1197	792	20	17	1058	290	11	10	345	793	31	27	1403	23
	NC7-crucifers.pvp	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	NC7-cuphea	650	180	13	9	227	2	1	1	2	180	14	10	229	34
	NC7-euphorbia	219	2	1	1	3	0	0	0	0	2	1	1	3	0
	NC7-flax	2818	83	10	9	83	126	6	6	128	201	16	15	211	107
	NC7-flax.wilds	165	32	5	5	68	1	1	1	1	32	6	6	69	25
	NC7-sun.cults	1681	125	27	20	189	110	11	11	121	210	38	31	310	260
	NC7-sun.wilds	2222	277	33	25	400	138	11	10	149	386	44	35	549	843
	Total:	11269	3232	148	121	4593	2329	64	59	2536	3545	212	180	7129	1362
McCoy	NC7-medicinals	311	88	24	22	157	51	7	7	64	112	31	29	221	77
	Total:	311	88	24	22	157	51	7	7	64	112	31	29	221	77
Millard	NC7-corn.kin	34	6	7	7	10	1	1	1	1	6	8	8	11	0
	NC7-maize	18293	2181	299	209	4038	805	36	32	935	2617	335	241	4973	2289
	Total:	18327	2187	306	216	4048	806	37	33	936	2623	343	249	4984	2289
Reitsma	NC7-chicory	250	43	5	4	45	0	0	0	0	43	5	4	45	201
	NC7-cucumis.cucs	1350	262	24	22	319	92	13	10	115	324	37	32	434	309
	NC7-cucumis.melo	3104	105	29	29	122	662	17	13	775	728	46	42	897	261
	NC7-cucumis.wilds	329	30	3	3	32	30	4	4	30	53	7	7	62	1
	NC7-cucurbita	993	441	31	28	546	151	7	7	156	490	38	35	702	51
	NC7-cucurbits.misc	2	2	1	1	2	0	0	0	0	2	1	1	2	0
	NC7-daucus	1086	325	16	16	419	154	5	5	177	378	21	21	596	226
	NC7-ocimum	96	84	22	22	235	0	0	0	0	84	22	22	235	0
	NC7-parsnips	71	4	3	3	5	0	0	0	0	4	3	3	5	0
	Total:	7281	1296	134	128	1725	1089	46	39	1253	2106	180	167	2978	1049
Widrlechner	NC7-mints	128	28	17	16	45	0	0	0	0	28	17	16	45	37
	NC7-ornamentals	1957	110	76	70	203	135	11	11	158	220	87	81	361	297
	Total:	2085	138	93	86	248	135	11	11	158	248	104	97	406	334
NCRPIS Total:		**47925**	**8435**	**644**	**470**	**12442**	**4844**	**165**	**141**	**5541**	**10481**	**809**	**611**	**17983**	**6826**

Table 4 **# NCRPIS Accessions (Accs) Obs in GRIN, # Images in GRIN**

CURATOR	GENUS CROP	Number Accs	Number Acc Obs Trials	Number Acc Obs in Curator Notes	Number Obs in GRIN for Year	Number Acc Obs in GRIN for Year	Number Acc Obs in GRIN Last Year	Number Acc Obs in GRIN (all yrs)	Number Acc Imaged	Number Acc Images in GRIN for Year	Number Acc Images in GRIN (all years)
Brenner	NC7-amaranth	3329	212	165	1746	466	135	3300	158	0	218
	NC7-celosia	54	0	3	0	0	0	3	4	0	3
	NC7-echinochloa	271	1	4	103	10	259	259	5	0	0
	NC7-grasses	119	0	1	0	0	0	1	3	0	0
	NC7-legumes	227	0	0	0	0	0	84	0	0	0
	NC7-melilotus	952	0	29	0	0	0	912	23	0	0
	NC7-panicum	982	2	3	0	0	976	977	6	0	0
	NC7-perilla	22	0	0	0	0	0	0	0	0	1
	NC7-quinoa	234	1	14	0	0	0	229	17	0	1
	NC7-setaria	1006	1	2	0	0	993	993	1	0	0
	NC7-spinach	401	2	3	5817	338	1	401	4	0	0
	NC7-umbels	1055	60	70	0	0	0	18	75	0	0
	Total:	8652	279	294	7666	814	2364	7177	296	0	223
Marek	NC7-asters	323	0		0	0	0	4	0	0	0
	NC7-brassica	1993	3		346	82	65	1629	117	0	234
	NC7-crucifers	1197	1		336	85	124	496	99	0	223
	NC7-crucifers.pvp	1	0		0	0	1	1	1	0	0
	NC7-cuphea	650	1		0	0	0	326	0	0	0
	NC7-euphorbia	219	0		0	0	0	0	0	0	0
	NC7-flax	2818	1		4	3	175	2804	0	0	0
	NC7-flax.wilds	165	0		147	18	66	72	11	0	0
	NC7-sun.cults	1681	133		1890	103	318	1616	44	0	0
	NC7-sun.wilds	24	0		0	0	0	15	0	0	0
	NC7-sun.wilds.ann	1449	75		0	0	181	1255	23	0	0
	NC7-sun.wilds.per	749	3		0	0	26	503	3	0	0
	Total:	11269	217	0	2723	291	956	8721	298	0	457
McCoy	NC7-medicinals	311	0		0	0	0	27	1	0	0
	Total:	311	0	0	0	0	0	27	1	0	0
Millard	NC7-corn.kin	34	0		0	0	0	0	1	0	0
	NC7-maize	18293	1035		8223	876	1761	15259	804	1	2437
	Total:	18327	1035	0	8223	876	1761	15259	805	1	2437
Reitsma	NC7-chicory	250	201		0	0	0	249	0	0	0
	NC7-cucumis.cucs	1350	0	340	0	0	0	1345	31	0	0
	NC7-cucumis.melo	3104	4	1812	0	0	0	3088	143	0	0
	NC7-cucumis.wilds	329	0	224	0	0	0	293	0	0	0
	NC7-cucurbita	993	2	192	0	0	0	981	16	3	3
	NC7-cucurbits.misc	2	0		0	0	0	1	0	0	0
	NC7-daucus	1086	0	162	0	0	0	1031	68	0	0
	NC7-ocimum	96	0		0	0	0	0	0	0	0
	NC7-parsnips	71	0	15	0	0	0	0	12	0	0
	Total:	7281	207	2745	0	0	0	6988	270	3	3
Widrlechner	NC7-mints	128	0		0	0	0	0	0	0	0
	NC7-ornamentals	1957	0		0	0	1	32	29	0	0
	Total:	2085	0	0	0	0	1	32	29	0	0
NCRPIS Total:		**47925**	**1738**	**3039**	**18612**	**1981**	**5082**	**38204**	**1699**	**4**	**3120**

Year 2004 **Table 5** **Five-Year Summaries of NCRPIS Accession Orders**

CURATOR	GENUS CROP	TIME PERIOD	Number Orders	Number Recipients	Number Items Distributed	Number Accessions Distributed
Brenner	NC7-amaranth	01/01/2000 - 12/31/2000	41	35	846	445
		01/01/2001 - 12/31/2001	47	36	908	596
		01/01/2002 - 12/31/2002	35	31	301	160
		01/01/2003 - 12/31/2003	43	42	921	516
		01/01/2004 - 12/31/2004	39	37	472	352
	Total:		205	181	3448	2069
	NC7-celosia	01/01/2000 - 12/31/2000	5	5	8	6
		01/01/2001 - 12/31/2001	2	2	12	11
		01/01/2002 - 12/31/2002	6	6	8	6
		01/01/2003 - 12/31/2003	3	3	17	14
		01/01/2004 - 12/31/2004	4	4	5	4
	Total:		20	20	50	41
	NC7-echinochloa	01/01/2000 - 12/31/2000	5	4	166	149
		01/01/2001 - 12/31/2001	4	4	36	33
		01/01/2002 - 12/31/2002	4	4	5	5
		01/01/2003 - 12/31/2003	5	5	26	26
		01/01/2004 - 12/31/2004	7	7	33	28
	Total:		25	24	266	241
	NC7-grasses	01/01/2000 - 12/31/2000	0	0	0	0
		01/01/2001 - 12/31/2001	3	3	7	6
		01/01/2002 - 12/31/2002	1	1	1	1
		01/01/2003 - 12/31/2003	1	1	1	1
		01/01/2004 - 12/31/2004	0	0	0	0
	Total:		5	5	9	8
	NC7-legumes	01/01/2000 - 12/31/2000	4	4	12	11
		01/01/2001 - 12/31/2001	3	3	6	6
		01/01/2002 - 12/31/2002	7	5	69	50
		01/01/2003 - 12/31/2003	5	5	31	26
		01/01/2004 - 12/31/2004	3	3	83	75
	Total:		22	20	201	168
	NC7-melilotus	01/01/2000 - 12/31/2000	16	12	712	554
		01/01/2001 - 12/31/2001	11	10	53	49
		01/01/2002 - 12/31/2002	5	5	43	42
		01/01/2003 - 12/31/2003	11	10	210	197
		01/01/2004 - 12/31/2004	9	7	68	58
	Total:		52	44	1086	900
	NC7-panicum	01/01/2000 - 12/31/2000	9	8	58	49
		01/01/2001 - 12/31/2001	8	8	662	650
		01/01/2002 - 12/31/2002	2	2	9	9
		01/01/2003 - 12/31/2003	7	6	719	661
		01/01/2004 - 12/31/2004	9	8	920	877
	Total:		35	32	2368	2246
	NC7-perilla	01/01/2000 - 12/31/2000	6	6	41	21
		01/01/2001 - 12/31/2001	7	7	41	22
		01/01/2002 - 12/31/2002	4	4	26	22
		01/01/2003 - 12/31/2003	7	7	56	22
		01/01/2004 - 12/31/2004	3	3	21	14
	Total:		27	27	185	101
	NC7-quinoa	01/01/2000 - 12/31/2000	20	18	340	149
		01/01/2001 - 12/31/2001	18	15	239	173
		01/01/2002 - 12/31/2002	23	22	333	161

		01/01/2003 - 12/31/2003	22	20	275	195
		01/01/2004 - 12/31/2004	19	18	98	58
	Total:		102	93	1285	736
	NC7-setaria	01/01/2000 - 12/31/2000	13	12	795	757
		01/01/2001 - 12/31/2001	6	6	20	19
		01/01/2002 - 12/31/2002	9	8	48	43
		01/01/2003 - 12/31/2003	7	7	55	50
		01/01/2004 - 12/31/2004	12	12	132	117
	Total:		47	45	1050	986
	NC7-spinach	01/01/2000 - 12/31/2000	6	6	669	348
		01/01/2001 - 12/31/2001	12	11	1736	354
		01/01/2002 - 12/31/2002	12	11	767	362
		01/01/2003 - 12/31/2003	14	12	321	260
		01/01/2004 - 12/31/2004	15	14	80	71
	Total:		59	54	3573	1395
	NC7-umbels	01/01/2000 - 12/31/2000	11	11	143	124
		01/01/2001 - 12/31/2001	13	12	98	93
		01/01/2002 - 12/31/2002	21	17	294	208
		01/01/2003 - 12/31/2003	17	15	248	150
		01/01/2004 - 12/31/2004	33	32	353	193
	Total:		95	87	1136	768
	Brenner Total:		694	632	14657	9659
Marek	NC7-asters	01/01/2000 - 12/31/2000	8	8	87	40
		01/01/2001 - 12/31/2001	4	4	8	7
		01/01/2002 - 12/31/2002	7	5	14	11
		01/01/2003 - 12/31/2003	7	7	25	21
		01/01/2004 - 12/31/2004	4	4	7	6
	Total:		30	28	141	85
	NC7-brassica	01/01/2000 - 12/31/2000	67	55	1200	855
		01/01/2001 - 12/31/2001	34	31	459	408
		01/01/2002 - 12/31/2002	51	47	527	361
		01/01/2003 - 12/31/2003	57	49	1562	795
		01/01/2004 - 12/31/2004	58	51	4348	1735
	Total:		267	233	8096	4154
	NC7-crucifers	01/01/2000 - 12/31/2000	16	15	72	66
		01/01/2001 - 12/31/2001	20	17	634	265
		01/01/2002 - 12/31/2002	24	23	241	212
		01/01/2003 - 12/31/2003	15	15	89	79
		01/01/2004 - 12/31/2004	31	27	1403	793
	Total:		106	97	2439	1415
	NC7-crucifers.pvp	01/01/2000 - 12/31/2000	0	0	0	0
		01/01/2001 - 12/31/2001	0	0	0	0
		01/01/2002 - 12/31/2002	0	0	0	0
		01/01/2003 - 12/31/2003	0	0	0	0
		01/01/2004 - 12/31/2004	0	0	0	0
	Total:		0	0	0	0
	NC7-cuphea	01/01/2000 - 12/31/2000	9	7	114	81
		01/01/2001 - 12/31/2001	16	12	712	481
		01/01/2002 - 12/31/2002	10	8	247	216
		01/01/2003 - 12/31/2003	19	12	389	244
		01/01/2004 - 12/31/2004	14	10	229	180
	Total:		68	49	1691	1202
	NC7-euphorbia	01/01/2000 - 12/31/2000	3	3	37	37
		01/01/2001 - 12/31/2001	1	1	1	1
		01/01/2002 - 12/31/2002	4	4	8	6
		01/01/2003 - 12/31/2003	2	2	9	7

		01/01/2004 - 12/31/2004	1	1	3	2
	Total:		11	11	58	53
	NC7-flax	01/01/2000 - 12/31/2000	8	8	120	118
		01/01/2001 - 12/31/2001	13	13	267	223
		01/01/2002 - 12/31/2002	8	8	73	63
		01/01/2003 - 12/31/2003	6	6	96	95
		01/01/2004 - 12/31/2004	16	15	211	201
	Total:		51	50	767	700
	NC7-flax.wilds	01/01/2000 - 12/31/2000	0	0	0	0
		01/01/2001 - 12/31/2001	2	2	22	19
		01/01/2002 - 12/31/2002	2	2	18	12
		01/01/2003 - 12/31/2003	3	3	20	19
		01/01/2004 - 12/31/2004	6	6	69	32
	Total:		13	13	129	82
	NC7-sun.cults	01/01/2000 - 12/31/2000	25	25	826	717
		01/01/2001 - 12/31/2001	41	30	1434	759
		01/01/2002 - 12/31/2002	44	36	562	422
		01/01/2003 - 12/31/2003	43	34	543	405
		01/01/2004 - 12/31/2004	38	31	310	210
	Total:		191	156	3675	2513
	NC7-sun.wilds	01/01/2000 - 12/31/2000	18	13	682	535
		01/01/2001 - 12/31/2001	32	27	1259	858
		01/01/2002 - 12/31/2002	32	20	890	652
		01/01/2003 - 12/31/2003	34	22	473	355
		01/01/2004 - 12/31/2004	44	35	549	386
	Total:		160	117	3853	2786
	Marek Total:		897	754	20849	12990
McCoy	NC7-medicinals	01/01/2000 - 12/31/2000	12	12	34	7
		01/01/2001 - 12/31/2001	18	18	356	88
		01/01/2002 - 12/31/2002	22	17	207	96
		01/01/2003 - 12/31/2003	35	27	387	122
		01/01/2004 - 12/31/2004	31	29	221	112
	McCoy Total:		118	103	1205	425
Millard	NC7-corn.kin	01/01/2000 - 12/31/2000	9	9	20	7
		01/01/2001 - 12/31/2001	7	7	13	7
		01/01/2002 - 12/31/2002	5	5	16	7
		01/01/2003 - 12/31/2003	7	7	22	8
		01/01/2004 - 12/31/2004	8	8	11	6
	Total:		36	36	82	35
	NC7-maize	01/01/2000 - 12/31/2000	214	176	2585	1809
		01/01/2001 - 12/31/2001	270	198	2637	1606
		01/01/2002 - 12/31/2002	399	279	4714	2511
		01/01/2003 - 12/31/2003	226	178	2298	1475
		01/01/2004 - 12/31/2004	335	241	4973	2617
	Total:		1444	1072	17207	10018
	Millard Total:		1480	1108	17289	10053
Reitsma	NC7-chicory	01/01/2000 - 12/31/2000	5	5	52	52
		01/01/2001 - 12/31/2001	6	6	288	175
		01/01/2002 - 12/31/2002	8	8	261	134
		01/01/2003 - 12/31/2003	8	7	192	144
		01/01/2004 - 12/31/2004	5	4	45	43
	Total:		32	30	838	548
	NC7-cucumis	01/01/2000 - 12/31/2000	58	44	1021	819
		01/01/2001 - 12/31/2001	59	49	1229	933

		01/01/2002 - 12/31/2002	58	46	2658	1773
		01/01/2003 - 12/31/2003	46	36	1901	1391
		01/01/2004 - 12/31/2004	73	64	1393	1105
	Total:		294	239	8202	6021
	NC7-cucurbita	01/01/2000 - 12/31/2000	19	18	457	363
		01/01/2001 - 12/31/2001	22	20	288	156
		01/01/2002 - 12/31/2002	20	17	165	132
		01/01/2003 - 12/31/2003	11	11	170	150
		01/01/2004 - 12/31/2004	38	35	702	490
	Total:		110	101	1782	1291
	NC7-cucurbits.misc	01/01/2000 - 12/31/2000	0	0	0	0
		01/01/2001 - 12/31/2001	2	2	2	1
		01/01/2002 - 12/31/2002	0	0	0	0
		01/01/2003 - 12/31/2003	1	1	1	1
		01/01/2004 - 12/31/2004	1	1	2	2
	Total:		4	4	5	4
	NC7-daucus	01/01/2000 - 12/31/2000	11	11	169	167
		01/01/2001 - 12/31/2001	13	12	235	211
		01/01/2002 - 12/31/2002	11	11	75	67
		01/01/2003 - 12/31/2003	13	12	426	294
		01/01/2004 - 12/31/2004	21	21	596	378
	Total:		69	67	1501	1117
	NC7-ocimum	01/01/2000 - 12/31/2000	7	7	245	75
		01/01/2001 - 12/31/2001	4	4	96	79
		01/01/2002 - 12/31/2002	7	7	18	16
		01/01/2003 - 12/31/2003	8	8	52	42
		01/01/2004 - 12/31/2004	22	22	235	84
	Total:		48	48	646	296
	NC7-parsnips	01/01/2000 - 12/31/2000	0	0	0	0
		01/01/2001 - 12/31/2001	0	0	0	0
		01/01/2002 - 12/31/2002	2	2	9	8
		01/01/2003 - 12/31/2003	1	1	1	1
		01/01/2004 - 12/31/2004	3	3	5	4
	Total:		6	6	15	13
	Reitsma Total:		563	495	12989	9290
Widrlechner	NC7-mints	01/01/2000 - 12/31/2000	3	3	37	35
		01/01/2001 - 12/31/2001	5	5	75	42
		01/01/2002 - 12/31/2002	4	4	22	19
		01/01/2003 - 12/31/2003	8	8	44	38
		01/01/2004 - 12/31/2004	17	16	45	28
	Total:		37	36	223	162
	NC7-ornamentals	01/01/2000 - 12/31/2000	39	37	263	204
		01/01/2001 - 12/31/2001	46	42	205	132
		01/01/2002 - 12/31/2002	56	50	350	259
		01/01/2003 - 12/31/2003	81	72	496	198
		01/01/2004 - 12/31/2004	87	81	361	220
	Total:		309	282	1675	1013
	Widrlechner Total:		346	318	1898	1175
NCRPIS Total:			**4098**	**3410**	**68887**	**43592**