NCRPIS Annual Report - 2002
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NORTH CENTRAL REGIONAL PLANT INTRODUCTION STATION
NC-7 ANNUAL REPORT, JANUARY 1 - DECEMBER 31, 2002

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	*C. Rife	10. Ohio	*D. Francis, Chmn.
5.	Michigan	*A. Iezzoni	11. S. Dakota	*A. Boe
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	*J. Rissler
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

1. USDA-ARS Staff	
a. Research Leader/Coordinator	C.A.C. Gardner
Supervisory Program Support Assistant	L. Wilson-Voss
Office Automation Assistant	S. Winter
Office Automation Clerk	C. Nass
Biological Science Lab Technician	L. Pfiffner
Agricultural Research Technician	S. McClurg
Entomologist	S. Hanlin
Plant Biologist (GEM)	S. Duvick
b. Horticulturist	M. Widrlechner
Agricultural Research Technician	Vacant
Agronomist	D. Kovach
Biological Science Lab Technician	M. Erickson
Biological Science Lab Technician	L. Burke
Biological Science Lab Technician	M. Arnold
Biological Science Lab Technician	M. Block
Germplasm Program Assistant	R. Stebbins
d. Plant Pathologist	C. Block
Agricultural Research Technician	J. Van Roekel
e. Geneticist (GEM)	M. Blanco
IT Specialist (Data Manager)	M. Shen
Biological Science Lab Technician	B. Alt
f. Geneticist	M. Brothers
Biological Science Technician	I. Larsen
2. Iowa State University Staff	
a. Research Station Superintendent II	L. Lockhart
Farm Equipment Operator III	L. Crim
Field-Lab Technician II	J. Scheuermann
Field-Lab Technician II	B. Buzzell
Clerk III	L. Minor
b. Curator II (Maize)	M. Millard
Field-Lab Technician II	G. Crim
d. Curator II (*Brassica*, Grasses)	R. Luhman
Field-Lab Technician II	Vacant

e.	Curator II (Vegetables)	K. Reitsma
	Field Lab Technician II	C. Clark
f.	Curator II (Amaranth)	D. Brenner
	Field-Lab Technician II	Vacant

III. PROGRESS OF WORK (C.A.C. Gardner)

As we focus on our mission to acquire, regenerate, characterize, evaluate, and distribute germplasm and associated information in today's world, threatened by environmental degradation, genetic erosion, and random acts of destruction, it is clear that development, preservation and use of valuable germplasm collections is increasingly important. The NCRPIS has been identified as a mission-critical research unit, and will implement appropriate security measures to ensure the safety of our staff, germplasm, intellectual and physical resources. In addition to our normal variety of service and research-related activities, the NCRPIS experienced two audits in 2002. The Office of the Inspector General (OIG) conducted an audit of inventory controls, and a team of security specialists contracted by USDA assessed and made recommendations to address potential threats related to facilities, collection holdings, Information Technology (IT, and general staff security.

Completion of hiring of additional GEM Project and viability testing staff to support the Curators enabled us to better support their missions.

Personnel changes:

New hires: Brian Alt, (GEM Project) Agr. Sci. Research Technician, GS 7. Mary Block, (Seed Storage) Temporary Biol. Sci Lab Technician, GS 4. Maria Erickson, (Germination Testing) Term GS 4, Biological Science Technician, GS 4. Nuo (Mack) Shen, (GEM Project) IT Specialist (Data Manager), GS 11. Jaryd Sunstrom, Student Computer Clerk, GS 4. Brent Werner, LA Biol. Science Technician, GS 5.

Promotions: Lisa Burk, Biol. Sci. Lab Technician, from GS 8 to GS 9. Irv Larsen, Agri. Research Technician, from GS 7 to GS 8. Stacey Winter, Office Automation Assistant, from GS 4 to GS 5.

Departures: Paul Ovrom, Agr. Sci. Research Technician, GS9. Kyle Cavanaugh, Computer Clerk and student intern, GS4. Nick Golder, IT student intern.

All former RSA student employees (45) were converted to federal student positions; new student employees are hired as federal student employees (STEP).

Construction:

Phase II of the facility renovation was completed; this included remodeling of areas for office spaces for technicians, the maize curator and the GEM staff. The archival documents and digital imaging lab are fully utilized. Final details of the fire suppression system were accomplished. In 2003-2004, an Access Security System for the entire NCRPIS complex will be installed.

Equipment:

Acquisitions included a high density filing system for the document archives room, a Percival germinator for added viability testing capacity, office furniture for newly remodeled staff office areas, a new tractor, vehicles, and an array of Information Technology (IT)-related equipment to support security and capacity of data management operations.

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 later in the document.)

Acquisition:

In 2002, we acquired 635 new accessions, which increased NC-7's net collection holdings to 47,618 (after accounting for inactivations), representing over 300 genera and 1,800 species. The acquisitions included 329 maize accessions; the remainder included *Daucus, Cucurbita*, *Cucumis*, *Brassica*, Cruciferae, cultivated *Helianthus*, *Amaranthus,* new ornamentals acquired through an NPGS-sponsored exploration in China, and miscellaneous umbels. Some of the germplasm was acquired as a result of collection trips by vegetable geneticist Phil Simon in Poland, Alan Whittemore's exploration to the Russian Far East, collaborators funded through a Plant Exploration grant in Turkmenistan, and from Indices Seminum.

Regeneration and Maintenance:

Regeneration efforts were conducted in Ames, IA, Parlier, CA, Davis, CA (Sakata Seeds), Puerto Rico and Hawaii (ICIA, Syngenta and Pioneer Hi-Bred), Idaho (Seminis Vegetable Seeds), Oregon (Sunseeds) and the Netherlands (Bejo Zaden B.V.). Increases were attempted of 1396 accessions using hand- or insect pollinator- controlled pollination techniques; 1383 of these regenerations were harvested. The 2002 growing environment was highly variable, with extensive wet chilly or hot and dry periods. Viability testing is still in progress for some seed lots prior to storage.

Pollinators were used in 667 cages for controlled pollination of 573 accessions, primarily using honeybees and *Osmia* bees, but also utilizing *Bombus*, alfalfa leafcutter bees and two fly species.

Management of foliar leaf diseases was an issue for several crops. The use of Gaucho insecticide seed treatment to manage Stewart's bacterial wilt is proving very effective, greatly enhancing our ability to produce seed which meets phytosanitary certification standards for export. Across crops, seed harvest amounts were generally good. Taxonomic re-identification was accomplished for 98 accessions in 2002. Over 6,420 accessions, or 14% of our holdings, were tested for viability in 2002, approximately twice the number of accessions tested in 2001. This is a positive reflection on the ability of our new germination testing technician and the process put in place with the curators.

Seed Storage personnel completed a handbook to document seed-storage processes, which will be incorporated into our Operations Manual. In 2002, 2252 seed lots were stored, and inventories of 4,730 lots were reviewed. Backup of 1,444 lots at the National Center for Germplasm Resources Preservation (NCGRP) was accomplished. NCRPIS collections are currently 70% available (68% in 2001) and 75% of the accessions are backed up at the NCGRP (74% in 2001).

Distribution:

Over 10,400 NC-7 accessions were distributed in 2002, representing 880 orders. (In 2001, 11,621 accession distributions resulted from 738 orders.) Interest in *Echinacea* and teosinte remains high, as reflected by germplasm requests, and also in the *Brassica* accessions involved in phytoremediation investigations. In general, requests are increasingly targeted more specifically for certain accessions or accessions having specific characteristics or traits.

Evaluation and Characterization:

Over 43,450 observations made on a wide array of descriptors for 12,055 accessions were loaded into the GRIN database in 2002. (This contrasts with 45,600 observations on 7,488 accessions loaded in 2001.) Over 4,500 digital images were recorded in 2002; only 725 of these have been loaded to GRIN.

Protocols have been developed by our internal imaging committee to facilitate management of the image capture and management process by non-curatorial personnel. An image management system is under development which will be

implemented in 2003-2004, facilitating batch loading of digital image information to GRIN. Software development is being supported partially by the NPS.

Evaluation of sunflower for resistance to sunflower moth, and maize for European corn borer were conducted by Sharon McClurg.

All *Cucurbita* and *Cucumis* seedlings were screened for squash mosaic virus infection using ELISA techniques prior to field transplantation; infected seedlings were eliminated.

The maize curator, Mark Millard, provided stover samples of to a DOE investigator for energy production assays. If analyses are productive, this collaboration is expected to continue. Evaluation data will be posted to the GRIN database when available.

Information management and computers:

Hardware and software purchasing included new desk top and hand-held computers and various network upgrades. Oracle forms and reports were developed or modified to assist in analyzing order history, retrieval of information regarding seed viability status and viability testing status. Station personnel continue to work with the DBMU group in Beltsville by assisting in the development and Beta-testing of 'new GRIN', or PC-GRIN.

Testing germplasm's germination, viability, and health:

The third year of a maize disease evaluation project for multiple leaf disease, stalk and ear rot disease resistance was completed, with private and public pathologists. Information from year 2001 evaluations is available in GRIN.

A joint project with Charlie Block (plant pathologist), Mary Brothers (sunflower curator), Tom Gulya, (USDA pathologist at Fargo, ND) and Robert Webster (National Germplasm Resources Lab) uses GIS and spatial statistical software to predict geographic locations where disease resistant sunflowers might be found based on two years of *Septoria* evaluation data were used for the model.

A study to determine whether the presence of chemical seed treatments affect the sensitivity of the Stewart's wilt ELISA test was completed; none of the seed treatment negatively affected the assay.

Insect management:

Investigations designed to understand the biology and control of chalcid insect infestation of coriander continued. A study to survey and characterize floral visits by native insect pollinators in Ames continued for a second year; research on alternative native pollinator insect choices is one of our high priority needs. Research on possible pollinators and improved cage systems for use in greenhouse regenerations of *Cucumis metuliferus* continued for a second year, focused on comparing the pollinating efficacy of honeybees, Bombus, Osmia, alfalfa leaf-cutter bees and flies. Detailed hourly observations were recorded; the results provided valuable learning; methods will be modified and the study will be completed in 2003. A three year study was completed comparing effectiveness of three pollinator insect species on sunflower species.

Outreach and Scholarship:

About 460 visitors toured the NCRPIS in 2001; 28 unique tours were organized.

Staff members continue to participate in teaching students, civic and other organizations about germplasm conservation and management, and the work done at NCRPIS.

Our staff authored or co-authored many journal articles and made presentations at

five scientific society meetings. Publication covered the diverse areas of interest of our researchers, ranging from taxonomy of native and invasive plants, climatic adaptation of plants, molecular and biochemical characterization, host plant resistance, and plant pathology epidemiology and germplasm management issues.

NCRPIS staff traveled extensively to present lectures, attend and facilitate workshops, serve on advisory committees and review panels or establish contacts with foreign germplasm researchers. The amaranth curator serves as President of the Amaranth Institute.

Our Pathologist served on a technical panel to review seed health testing methods for spinach and celery, as Chair of the Sunflower Disease Panel of the National Seed Health System, and as our liaison for phytosanitary issues with USDA-APHIS and the IA Dept. of Agriculture and Land Stewardship. Our Horticulturist serves as Chair of the Written Preliminary Exam Committee for ISU's Plant Breeding and Genetics Advisory Panel, and on the Editorial Review Board of the international journal, Genetic Resources and Crop Evolution, as the advisor of a Ph.D. student from Mexico, and a member of several POS committees. Our Research Leader serves as the advisor of a Ph.D. student from the Philippines.

V. SUPPORT TEAM REPORTS

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

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/or farm 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 24.0 FTE's. We coordinated and completed facility construction and upgrades.

Labor:

During 2002, 97 applications for hourly employment were received and reviewed. There were 41 interviews, resulting in 28 hourly employees hired. Currently there are 43 (18.0 FTE) part-time hourly employees working at the NCRPIS. In October and November all hourly student employees were converted to the federal payroll system.

NCRPIS Farm Crew:

Larry Lockhart (Station Superintendent II) has been on staff since 1985.

Lloyd Crim (Equipment Operator III) has been on staff since March 1998 and is primarily responsible for facility and field maintenance.

Jerry Scheuermann (Field Lab/Tech) has been on staff since December 1991 and is primarily responsible for general farm equipment and vehicle maintenance. Jerry retired in January 2003. His talents, skills and friendly demeanor will be missed.

Brian Buzzell (Field Lab Tech II) joined the staff in May 2002. He has assumed the responsibilities formerly covered by Jerry Scheuermann. Brian has been a welcome addition to the farm crew.

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) Completed remodeling of former dryer rooms to office, archive and lab space.
2) Re-constructed entryway to GEM Seed Cooler to minimize condensation problems.
3) Started Phase II of headquarters remodeling project. GEM Techs office and work space are 95% complete. Renovation of two other offices is now underway.
4) Constructed a wooden stairway to the overhead storage area in new machine shed.
5) Obtained a 1999 Dodge Intrepid from the area office and repaired damaged engine. This added a badly needed vehicle to the fleet for day-to-day errands and trips.
6) Installed temperature and intrusion alarms on walk-in freezer and GEM Seed Cooler.
7) Installation of sewer line from headhouse/greenhouse to bring sewer disposal up to current code.
8) Replaced 60 year old water line branch that feeds the cave and manager’s residence.
9) Installation of shelving in GEM Seed Cooler
10) Constructed cage trench back-filling machine

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) Four vehicles
2) A JD Gator utility vehicle for general farm use
4) A germinator to add capacity
5) A JD 6420 Tractor
6) Office furniture for remodeled areas
7) Times two high density filing system for archive room
8) Sheet metal shear
9) Table saw

Tours:

This past year, we organized and conducted 28 tours. There were 462 visitors to the NCRPIS during 2002.

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:

Next year promises to be a busy year with several maintenance and construction projects already in progress:

1) Completion Phase II Headquarters Remodelling project
2) Initiation of Phase III (Server security) Remodeling
3) Initiate Tiger team security recommendations
4) Plan and design farm irrigation system with possible installation in 2004.

b. <u>Controlled Insect Pollination Program (S. Hanlin)</u>

Progress:

<u>Cage pollination</u>: Pollinators were supplied to 667 cages for controlled pollination of 573 accessions. Honey bees were used to pollinate 456 accessions in the field and 8 accessions in the greenhouse. *Osmia* spp. were used to pollinate 54 accessions of Brassicaceae and 1 accession in the greenhouse of *Melilotus* sp.. *Bombus* colonies were used in 12 accessions of ornamentals and 4 accessions of Cucumis sp. in the greenhouse. A combination of blue bottle flies and house flies were used in 35 accessions of *Crambe* and *Camelina*, 62 accessions of *Daucus* and 3 accessions of Umbels. In the greenhouse, house flies and blue bottle flies were placed into 24 cages of *Daucus* and a single cage of *Torilis*.

<u>Beekeeping</u>: Honey bees were over-wintered in the indoor wintering facility with a survival rate of 65% for the parent colonies and 69% for the nucleus colonies. The survival rate for the nucleus hives was much higher than last years 16% and for the hives moderately higher than last years 61%. This winter, we placed 40 two-story parent colonies, 25 three story parent colonies, 131 double-story nucleus colonies and 10 single story nucleus colonies into the over-wintering facility. All queens to be used for queen rearing will be selected in the spring of 2003 from resilient parent colonies.

In spring 2002, 50 two-pound packages of bees were purchased. These bees were used to increase the parent colony numbers which were lost during the winter of 2001.

Our queen rearing continued to improve throughout the summer with an average of 65 queens per week being produced. This number is approximately double the 32 cells per week produced last year. To prevent swarming in our queen rearing colonies, we removed frames of honey on a biweekly basis and replaced them with foundation or empty combs throughout the summer.

By the end of the summer we had an additional 81 nucleus hives which did not get used for cage pollination. These hives were made into doubled story nucs and over-wintered; they hopefully will be strong nucs in the spring and possible made into parent colonies.

The mitacide "checkmite@ or coumaphos was used for a second year for the control of *Varroa* mites. We treated all colonies and nucleus hives in the fall based on mite sampling from which an average mite count of 30 mites per 100 bees was determined. The sampling techniques used consisted of 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. A second sampling method used this year involved the uncapping of approximately 25 drone cells per hive, removal and examination of the larvae and cell for mites. We also sampled half of the hives (35 colonies) using sticky boards and 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 2002, we used environmental control methods by opening up the outside doors on colder days and allowing the room to drop in temperature, freezing 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.

To allow us to closely monitor feed container content and make moving the bees into the over-wintering room an easier transition, all of the colonies and nucleus hives were transported to the station approximately a month prior to their movement inside.

Bombus: Six "research" colonies of *B. impatiens* were ordered from a commercial supplier. The bumble bee colonies were used for controlled pollination of 12 field cages and 4 greenhouse cages. The colonies were checked in the fall to determine if they were strong enough to survive over-wintered, however, in all cases they were found to be weak or dead.

Two drone colonies of *B. impatiens* were purchased to test as greenhouse pollinators. The occupants of the original domicile were divided between several cages of *Daucus*; however we found that removing the individuals from the domicile promoted high mortality and a decline in pollination. Additional drone colonies will be purchased and tested in the impending greenhouse pollination study, in which the hives will be used as purchased and not be divided.

Megachile rotundata: No alfalfa leaf-cutting bees were used this year to regenerate plant germplasm accessions. However, fifty domiciles of alfalfa leaf-cutter bees were used for a cooperative research project with Dr. Reid Palmer. We also used 9 domiciles of alfalfa leaf-cutter bees in the sunflower pollination comparison study as a replacement for one of the species of sunflower leaf cutter bee which we have used in the past. Two domiciles of ALC were also used in a cage with the greenhouse pollination study which was carried out this past summer.

Osmia cornifrons/O. lignaria: *Osmia* spp. were used to pollinate all *Brassicaceae* seed increase plots and a single greenhouse cage of *Melilotus* sp.

Approximately 5760 bees were used to fill 720 straws in 2002. The spring was warm and wet, so that we did get an increase of bees with approximately 603 straws or 2867 bees being collected. Additional bees will be purchased in 2003; however fewer bees will need to be bought than in the past.

Musca domestica: House fly rearing continues in the entomology growth chamber. Three cages of house flies are presently maintained as production colonies to supply flies for pollination. On one occasion this summer, we had to obtain an additional 250 pupae from ISU to resupply our production colonies. An improvement

to the rearing of house flies which was created by B. Werner was a new watering dish for weekend watering. A specimen container was used with a wick in the top which allowed more water to be accessible and less evaporation to occur. This same watering system was used with the blue bottle flies also. The house flies were used in combination with blue bottle flies and/or honey bees for the pollination in the field and in greenhouse cages of *Daucus, Crambe*, *Camelina* and umbels.

Cochliomyia macellaria: Two cages of blue bottle flies were maintained from January to December of 2002 in the entomology growth chamber. On four occasions during the year, extra supplies of blue bottle fly pupae were purchased from a supplier in Idaho. Because of the assistance that we received from an entomology intern B. Werner, we had a very successful rearing program this year and had to purchase fewer pupae than last year. Some of the inventions which were created by B. Werner to improve the production of flies were a "fly house" in which plexiglas was formed into a roofed covering and painted black. This invention improved the laying of the flies and an increase in egg production was observed. To prevent larvae from crawling from diet and pupating underneath the diet dishes or on the walls of the bucket, a "larval ring" was constructed and placed around the diet dishes inside the buckets. A new larval diet ingredient was tested; "black blow fly diet" was used in place of blood meal in several experimental trials. The new diet was found to be "too watery"; however development of the immature flies was found to be comparable with the original diet. The flies were used in combination with the house flies and/or honey bees in field cages of *Daucus, Crambe, Camelina* and Umbels. These flies were also used in isolates and greenhouse cages for the pollination of *Daucus* and *Torilis*.

Research:

For a third year, a comparison study was conducted using honeybees, a species of sunflower leaf-cutter bee (*Megachile pugnata)* and alfalfa leaf-cutter bees (*M. rotundata*). The alfalfa leaf-cutter bees were used in replacement for the Washington sunflower leaf-cutter bee (*M.* apicalis) which we have used for the past two years but were unable to obtain this year. The three pollinator species were randomly placed into small cages containing either a cultivated species of sunflower or one of two types of wild species. Several *Oenothera* plants were placed in the cages containing *M. pugnata* to assist in the formation of the egg cases. Depending on seed counts and germination results, this maybe the final year of this study. We did have some difficulty obtaining *M. pugnata* from the Logan bee lab. We also had one of the cages appeared to have been infected with *Rhizoctonia* which caused very little seed to be obtained from that cage.

A native pollinator study was continued for the second year. S. McClurg and B. Werner made all of the field observations and collections, while the pollination staff identified all of the collected information during the winter. The purpose of this study was to determine what native pollinators collect nectar and pollen from the selected accessions which were blooming this year and to obtain samples of several of these insects to determine the possibility of rearing them under lab conditions. A large number of the plants were perennial or biannual and we continued to make observations of them, however, all of the annual plants were replaced by several different annual species of germplasm. Climatic conditions such as temperature, precipitation, wind, time of day and cloud cover were observed and recorded to assist in determining if these conditions limited the type of pollinator present. This year we wanted to observe and collect pollinators which were not included in the prior summer's research. All insect samples were placed into a sample container, labeled with the date and the type of plant it was collected on and placed into a freezer for storage to be identified during the winter months. Some of the observed pollinators were determined to be difficult to rear based on either sight identification in the field and laboratory research, so no further research action was taken. Several Diptera species were collected and identified as possible pollinators distinct to sunflowers. We continued to see a numerous population of *Bombus* and *Megachile* on the majority of the plants. This study will be continued in 2003. We are also contacting the USDA-ARS "Bee Biology and Systematics Lab@ in Logan, UT to assist in the identification of the specimens and to give recommendations on a lab

rearing program.

A comparison study of greenhouse pollinators was conducted in July of 2002 in cooperation with K. Reitsma, L. Clark, S. McClurg and B. Werner. The insects used in this study consisted of honey bees, *Bombus* (drone), Osmia, alfalfa leaf-cutter bees and blue bottle flies. The insects were placed into 5 X 5 X 5 cages containing *Cucumis metuliferus*. Environmental data and some general insect observations were collected by the vegetable crew over a period of several days. Pollinator success was based on the number of fruits produced and the number of seeds per fruit. The highest amount of seed/fruit was produced in the honey bee cage. Several improvements were learned from this study first that the initial cage design required modification especially to contain the bumble bees in cages set on a gravel substrate. We found that the greenhouse was to warm for the *Osmia*'s survival and that the *Bombus* drones could not be successfully "split" from their colony and survive. The study will be repeated in the winter of 2003, however, the Osmia will be replaced by a research *Bombus* colony and the study will be replicated in two greenhouses utilizing an improved cage design.

We tested Osmia bees as greenhouse pollinators in a single cage of *Mililotus* sp. in May 2002. It was found that because of the warmer temperatures in the greenhouse that only about 20% of the bees emerged and of those that did very little flight and pollination occurred. In this study, after two weeks, the *Osmia* were replaced with honeybees.

Cooperation:

A cooperative study was carried out in July and August with Dr. Reid Palmer. The objective of the study was to observe the attractiveness of soybean flowers to alfalfa leaf cutter bees. Fifty domiciles were placed around the sides and down the center of the soybean test plot. Dr. Palmer and his assistants made all plot data observations. The NCRPIS pollination entomologist supplied all insects needed in the project and the expertise for determining needed domicile numbers. The entomologist later supplied Dr. Palmer and his crew with sweep nets and "kill jars" for the collection of native pollinators from their Texas soybean sites.

On November 27, The NCRPIS entomologist met with two representatives from the "Crop Research Institute Anhui Academy of Agricultural Science" in China. The individuals were touring the U.S. and Canada collecting information related to soybean research and were interested in the insects used for pollination. Information was sent which dealt with alfalfa leaf-cutter bees as pollinators on an a variety of crops, also included was a list of suppliers for the bees and the other equipment.

Thirty nucleus domiciles were built for Susan Stieve and Dr. David Tay of Ohio State University. The pollination staff also built 30 *Osmia* domiciles in addition to supplying samples of the feed containers which we use at the station. Several times during the summer, further information was supplied to either Susan or to her cooperators concerning how honey bees are handled at NCRPIS and how they are supplied to cages for pollination.

The pollination staff worked in cooperation with K. Reitsma and L. Clark to design a fly dish holder for the greenhouse cages. In the past, a large number of fly pupae have drowned because of water collecting inside the dishes. A holder was designed to attach to the top of the cage frame and an opening is left at the top of the screen to allow easy access. This dish design eliminated any further loss of pupae in these cages.

The pollination entomologist was contacted by Jerry Hayes of Dadant and Sons Inc. in Illinois. Jerry inquired about how the NCRPIS used *Osmia* bees, he was most interested in the techniques we use to obtain increases in populations and how the bee is reared, care for and how the pupae is over-wintered. The company was collecting information for the possible future selling of these bees.

The pollination entomologist was contacted by Charles Rife of Kansas State University inquiring about possible insects which could be used as pollinators

for *Brassica* sp. in a greenhouse. A literature search was prepared and the results were sent with a recommendation of possible pollinators which could be used in a greenhouse for the pollination of *Brassica*.

The pollination entomologist was contacted by Stephanie Bruner, an author of a local gardening magazine. Stephanie was inquiring about the use of *Osmia* bees as pollinators. A sample of the two inch domicile which is used in the cage pollinations at NCRPIS was sent to her. In addition, information was supplied on how the bees are used at the station, what plants the bees are applied to and how the pupae are over-winter. The entomologist also included a list of suppliers of bees and equipment.

While attending a training class in Mississippi, Harvey Haggard a retired entomologist and consultant inquired about suggested journal articles or books that addressed native pollinators of gardens and flower beds. Harvey was supplied with a list of books and journal articles which not only list possible pollinators for specific plants, but also explain how to promote their existence.

Assistance was given to Jim Robbins of the USDA corn lab, S. McClurg and B. Werner with an initial experiment on resistance of corn accessions to maize weevils. The details of this experiment are described in the entomology research section of this report. At a subsequent time, S. McClurg assisted with improved identification techniques which could be used to distinguish between male and female weevils.

Presentations:

On January 30, a presentation was presented to Ginny Roper's third grade class at Abbie Sawyer Elementary school. The presentation consisted of general information on honey bees, in addition to information on the other pollinators used at the station. Examples were shown of other hymenopterans which the children may have observed and confused with honey bees. Each child asked two questions either about bees, bee equipment or the plant introduction station and attempts were made to answer them completely. The class had been studying how scientists set up research and the steps they go through to reach their final conclusion.

On May 9, the control pollination entomologist was invited to speak at the Squirrel Hollow Outdoor classroom in Jefferson Iowa. Twenty presentations were given throughout the day to approximately 200 sixth graders. The focus of the presentations were general facts about honey bees, however other hymenoptera were shown and discussed. The children were allowed to try on the protective equipment, handle the tools and ask questions on how insects are used at the station for pollination. The staff was asked if they would participate next year and accepted the offer.

On September 20, several members of the station staff went to Abbie Sawyer Elementary school to speak to three classes of fourth graders. B. Van Roekel spoke on the use of honey bees as pollinators at the station, general information about honey bees and the products bees produce. B. Van Roekel also showed the equipment used for working with honey bees and allowed the children to handle and observe the items. The pollination staff spoke about the other hymenoptera pollinators used at the station and showed samples of several of these.

On November 9, the control pollination staff presented a workshop at the "Iowa Honey Producers" annual meeting on "the control of wax moth in stored combs". The focus of the workshop was to show the chemical, mechanical and environmental controls for wax moth larvae in stored honey combs. Also included were methods not recommended for wax moth control based on the method either being unsuccessful for the control of the moths or the chemical leaving residue in the wax and honey.

2003 Research plans:

We will continue the research for greenhouse pollinators. A study will begin in

February using an accession of *Cucumis* and pollinators consisting of honey bees, Bumble bees (research and a drone colony), alfalfa leaf cutter bees and combined house flies and blue bottle flies. We will use "HOBO" portable weather stations both in and out of the cages to collect temperature, humidity and light intensity data. These stations will replace the need to go into the cages with hand held instruments and eliminate the chances of the insects escaping. Observations will be made and recorded for two weeks of the insects activities. For the first week observations will be made on an hourly basis and the second week it will be determined if they need to be made on as regular of a basis.

A comparison study will be done in the greenhouse in which house flies (*Musca domestica)* and blue bottle flies *(Cochliomyia macellaria*) will be compared based on their capacity to pollinate. The crop which will be used is an unknown *Daucus* species. A total of two replications will be done using each fly species separate and both species of flies combined. A total of 100 pollinators will be placed in each cage or in the case of the combined Diptera, 50 of each will be placed into the cage. Success will be determined by the amount of seed collected at the end of the trial based on fly species and the amount of pollination activity observed for each species under the conditions in the greenhouse.

We possibly will need to repeat the sunflower pollination comparison study being that *Megachile apiculis* was replaced by *M. rotundata*. Presently we only have one year's results using these specific pollinators. However, if past research with honey bees and alfalfa leaf-cutter bees which was done by C. Abel and D. Wilson is found to show comparable results and the same plant accessions were used we will have enough data for publishing. If it is decided to repeat the study, we will use the same accessions of sunflower and the same pollinators which were used last year.

We will make observations of the Osmia bees which are presently being used for Brassica pollination. We hope to observe certain cages of bees which pollinate either a greater number of days or longer hours during the day especially in the spring and early summer. We will make daily observations of all of the cages starting in late May or early June. The bees we observe to be flying and pollinating later in the season will be kept separate after removal from the cage and the straws will be kept separate after removal from the domicile. These increase straws will be placed in specific cages in 2004 when we try to increase the number of these specific bees to increase their numbers. Our future through a selected breeding we will use these Osmia bees for the pollination of the Brassica accessions which will pollinate later into the summer before going into diapause.

We plan to continue cooperating with Dr. Reid Palmer and assist in determining the attraction of *Megachile rotundata* and honey bees to the male sterile lines of soybeans which he is researching. We also hope to derive benefit from observation of pollinators observed in Texas by Dr. Palmer and his graduate students. The transport and placement of pollinators and the identification of Samples will be done by NCRPIS entomology personnel; all field observations will be made by Dr. Palmer's personnel.

We plan to continue the native pollinator study. Our present plans are to continue to make observations of pollinators on the biannuals and perennials which were originally planted in the field; however we are anticipating planting several wild and cultivated sunflower accessions to the study and observing pollinating insects on them throughout the summer. Presently sunflowers are the largest users of honey bees in the caged fields, so a less work intensive pollinator would be of benefit to this program.

Research will continue to focus on improving blue bottle fly diets. In order to improve egg production, we will try various diet materials to find nutrients which maybe lacking in our present diet. We will begin development of an improved fly cage which is easier to clean and possess less fly escape problems. Possible materials being considered are rubber-mate containers which have been adapted for our needs and redesigning the wooden screen cages which we presently use by attaching the bottom and putting a latch and hinges on the top.

c. Computers and Telecommunications: (R. Luhman, M. Millard, and R.Stebbins)

Progress:

A. Equipment

At present (March 2003), the NCRPIS is equipped with 63 personal computers. Every permanent staff member is equipped with at least one personal computer. There are several computers used by multiple temporary individuals. Other hardware for computing/information management includes telecommunications between NCRPIS and the GRIN computer, bar-coding equipment, and miscellaneous data collecting devices. The NCRPIS is connected to Iowa State University Windows 2000 Active Directory. The NCRPIS currently has three member servers. More detailed information about NCRPIS computer hardware can be found in the ISSP.

B. Software

Standard client software for the NCRPIS operations includes Windows 2000 or Windows XP operating system. Microsoft Office Professional, Oracle, Papyrus reference software, Host Explorer, Adobe PhotoShop, Adobe Acrobat, Adobe Capture, Microsoft Exchange server, Veritas Backup Exec. Alternate software packages are not fully supported by computer personnel.

C. Documentation

To encourage more consistent use of software packages and other NCRPIS procedures, and to reduce errors, procedures and standards are documented and posted to the NCRPIS Intranet in Adobe Acrobat format. These procedures and standards are often embedded within NCRPIS committee meeting minutes.

D. Data entry

Data entry to GRIN is accomplished utilizing in house Oracle Forms or the WEB based GRIN system. Entry of data via telnet application to GRIN will be phased out. Bulk entry of data is often accomplished utilizing ODBC connections to the GRIN database or via FTP file transfer.

d. Seed Research and Computer Application Development (D. Kovach)

Seed Research:

This year I conducted an experiment to test the feasibility of controlling chalcid insect infestations in coriander seed. Experiments involved testing two treatments, moisture content determinations, germination tests, and insect emergence monitoring. One method showed promise. After subjecting the coriander seed to -156° C for 24 hours, (by holding the seed in the vapor phase of liquid nitrogen), subsequent monitoring for chalcid emergence suggested complete mortality. A second method, involving the storage of the seeds in an atmosphere of 90% nitrogen and 10% carbon dioxide for 72 hours, needs to be retested.

This work has a two-fold purpose: 1) controlling the chalcid insect infestation that often occurs in coriander seed, and 2) finding a method that can be applied to other crops. Early indications suggest LN2 treatments work very well with coriander. However, some crop types maintained at NCRPIS may be damaged by similar conditions. Modified atmosphere treatments, if successful in coriander,

could provide an alternative insect-control measure for these cold-sensitive crops.

Cooperative efforts continued this year with the National Center for Genetic Resource Preservation (NCGRP) on determining storage protocols for *Cuphea* seed. NCGRP personnel found that storing some species of *Cuphea* at -18° C may reduce viability. Research by Jennifer Crane and Dr. Chris Walters at NCGRP indicated that a warm-temperature treatment prior to seed imbibition for germination tests alleviated the damage experienced at lower temperatures. I served as liaison between Bill Van Roekel, Agricultural Science Research Technician, who produced seeds of two *Cuphea* accessions, and the researchers at NCGRP, and also reviewed a manuscript from that project that was recently submitted for publication.

In other work related to crops maintained at NCRPIS, Dr. Mark Widrlechner, Horticulturist, and Lisa Burke, Biological Science Laboratory Technician, are investigating the long-term dynamics of the viability of seeds stored under our storage conditions (typically, 4° C @ 28% R.H.). They hope to use this information to help develop models for regeneration targets as a curatorial management tool. I participated in this project by extracting and summarizing GRIN data for analysis. This involved writing an extensive program in PL/SQL to retrieve data from the NPGS database, writing analysis programs in SAS, and plotting results using CoHort software.

Computer Application Development:

I devoted approximately 25% of this past year to investigate the feasibility of adding Oracle9i Application Server (9iAS) and Oracle Forms9i and Reports9i to our Oracle9i database software. This was needed because the software vendor no longer supports Forms6 and Report6. A determination of whether to use Forms6i (as DBMU uses), go to Forms9i and Report9i in conjunction with 9iAS, use JDeveloper9i apart from 9iAS, or use some other vendor software was needed. This investigation will conclude in the first quarter of 2003. The successful installation and testing of 9iAS Infrastructure, Application Server, Portal and Forms9i showed good promise, but also revealed some limitations.

In 2002, I successfully installed Oracle9i Release 2 database on one of our servers, and preliminary tests revealed that the 9i database is very stable and easy to use. It has received high ratings throughout the industry. It can handle any type image needed. One drawback in the database imaging system is that there does not seem to be ‘front end’ software to support all types of image formats. We have thus decided to use the image formats that are within the Forms9i and JDeveloper9i capabilities.

Forms and reports developed or modified this past year were:

- Created a form and report for retrieving and presenting the station's order history (by CSREES region) for the past seven years.
- Created a form and reports for retrieving data regarding NCGRP ‘at risk' seed.
- Created a form for obtaining germination statistics to show the number of lots have never been tested or not tested in several years. Modified Germination Order Creation form to put individual lots needing testing (with same criteria as germination statistics) in an order.
- Modified Annual Report Statistics form for new data to be retrieved.
- Modified forms and reports as needed for requested changes and/or ease of use.

Website related:

- Maintained the station’s internet site: http://www.ars-grin.gov/nc7/
- Inherited, temporarily, the NC7 Woody Landscape internet site maintenance,

with the departure of Paul Ovrom, in October. This maintenance involved moving the web site to a new location and changing all within-site links from hard-coded to relative links.

Inter-Site and GRIN Database related:

I continued correspondence with Quinn Sinnott, Erick Abadie, Gorm Emberland, and Jimmie Mowder of the Data Base Management Unit (DBMU) to keep up-to-date regarding their software plans. This is very important in order for us to stay current with our software licensing.

Equipment and facilities related:

This past year I researched, requested, ordered, obtained and set up a new Zebra printer for corn crew usage. I also ordered additional bar-code readers for the station.

I developed or modified AutoCAD floor plans and selected furniture layout plans for the imaging room, new offices and work areas, the GEM cold-storage unit, network lines in farm headquarters building, and several versions of possible room assignments for personnel at the farm. I modified facility, room and network layout plans for the Tiger Team's Site Security Assessment, and also researched and obtained Architectural Desktop software for future use for facility plans.

I also made drawings for a Seed Splitter, based on a prototype developed by Jerry Scheuermann, Field Lab Technician II. These plans were requested for possible patenting by Iowa State University.

Supervision:

This past year, the station hired Maria Erickson, Agricultural Biological Science Technician, who became responsible for overseeing and conducting germination tests. I introduced Maria to NC7 staff; helped her in ISU orientation (computer account, etc.); assisted in obtaining germination training from the ISU Seed Science Center; trained Maria in the use of NC7 Oracle Forms; introduced Maria to ISU Seed Science Center Seed Lab director Dan Curry (Dan took us both on a tour of the center where Maria met a valuable seed technologist contact); requested from Computer Committee new computers for Maria and her crew; and worked with Maria in devising a plan to tackle our backlog of germination tests. Maria and her crew made outstanding progress in 2002. The number of accessions germination tested at the station in 2002 was just over twice the number tested in 2001.

EEO/HRM/CR and Personal Development:

I made every attempt to treat all co-workers and station visitors with fairness and equality. Discussed needs and agreed to assist station's civil rights representative in maintaining a web site for the Ames Area ARS Civil Rights Advisory Committee if the committee desired its continuance.

Seminars, Trips, and Other Training:

I attended the 24th Annual Seed Technology Conference (February 19, 2002) presented by the Iowa State University Seed Science Center, Ames, IA. The topic was: GMOs and the Seed Industry.

Plans for 2003

My plans for 2003 include attending a conference this summer on application development tools. This will aid me in creating forms and reports using the latest version of application development software.

This coming year includes plans for continued work on the seed infestation prevention project, continued development of specialized forms and reports to meet station needs, learning the new Oracle development tools and staying current

with software licensing, continued maintenance of the station's internet site, and providing computer-aided drawings for facility improvement as needed.

e. <u>Information Management: Germplasm Program Assistant (R. Stebbins) Germplasm Collections</u>

Acquisition:

The North Central Regional Plant Introduction Station (NCRPIS) acquired 635 new accessions in 2002. Of these new accessions, 183 were received from within the National Plant Germplasm System (NPGS). The majority of these came from the National Center for Genetic Resources Preservation (NCGRP) in Fort Collins, Colorado, among these were 72 accessions of *Zea mays* subsp. *mays*.

The remaining 452 accessions, received from outside the NPGS, included 259 accessions of *Zea mays* subsp. *mays*, 50 accessions of *Cucumis melo*, 47 accessions of *Cucurbita*, and 36 accessions of ornamentals. 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, 98 accessions received taxonomic re-identifications. Among these were 54 accessions of umbels. Also, 103 accessions were nominated for inactivation, including 61 accessions of ornamentals and 34 accessions of umbels.

Additionally, 296 accessions were assigned PI numbers. Included in this group were 147 accessions of *Zea mays* subsp. *mays* and 108 accessions of ornamentals.

Finally, 10 accessions were inactivated due to duplication. The inventory lots of these accessions were combined with the lots of their respective duplicates. This group included 6 accessions of *Brassica*.

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 files of accession information, corresponding with collectors and donors, Internet searches, and researching maps and GIS databases.

One of my projects involved working with Mark Widrlechner to prepare 105 accessions of ornamentals for PI number assignment. Any errors in GRIN were corrected, and reports were printed for a final check before requesting PI numbers.

I have continued to enter old passport information from logbooks for early Ames-numbered accessions. So far, passport information has been entered for approximately 4000 accessions. This project has uncovered other problems such as duplicate accessions and missing GRIN records. These problems have been corrected as encountered.

I updated passport information for 7 accessions held at the National Arboretum. These accessions were part of a larger group collected by Mark Widrlechner whose passport information had somehow been erased from GRIN.

I entered passport information for 23 accessions of ornamentals that were collected in Russia and donated to the station at the end of 2001. The trip

report was not finalized until 2002.

I researched and entered more precise coordinates of latitude longitude for 21 accessions of sunflowers.

I updated the passport information for several accessions collected in the Heilongjiang Province of China.

I added estimated coordinates of latitude longitude for a few accessions of Echinacea.

I have worked with the Medicinal and Nutriceutical Plants committee on a list of species with medicinal and/or nutriceutical uses. This list has grown to 1795 species and will soon be ready for distribution.

I supervised a newly formed position of Computer Clerk. This position was a temporary appointment filled by an Iowa State University student named Kyle Cavanaugh. Under my direction, his main duties were to create a digital archive of historical documents. Since his position was new to our station, all processes and procedures used to complete his work were essentially new as well, requiring considerable testing and development. Kyle's projects involved scanning a collection of books known as the Races of Maize, NCRPIS Annual Reports from 1948 to 2001, Woody Ornamental and Shelter Plant evaluation reports, and historic seed lists.

I coordinated communications with 11 foreign and domestic seed banks to request seed of a wide range of genera.

I drafted guidelines as to what constitutes a suspicious package to determine when such a package should be refused for safety reasons.

I updated the section of the Operations Manual that deals with accessioning germplasm to include guidelines for handling of genetically engineered germplasm.

I served as secretary of the Computer Committee. The committee is responsible for maintaining a modern and efficient computer system which includes budgeting, planning, repairing, and purchasing.

I worked with David Kovach to construct new shelving in the cold storage facilities for the GEM Project.

I helped install the station's first outdoor flagpole.

I prepared and mailed several ornamental seed lists to various cooperators.

I traveled to Peoria, Illinois to retrieve a 1999 Dodge Intrepid automobile. I towed the Intrepid back to Ames where it was repaired and now serves as the station's main office vehicle.

In early December, I began processing outgoing seed orders in preparation for the retirement of Linda Minor. I will continue to fill this role until a replacement is hired.

I also filled in as farm receptionist while this position was vacant. After a new receptionist was hired part-time, I continued to fill in during the afternoons for security reasons. I performed some of the duties of this position, including mail delivery and phone management.

Conclusions:

Compared to 2001, new accessions received at NCRPIS were down by 423 in 2002, a decrease of 40%. In maintenance areas, re-identifications were down by 38%, nominations to the inactive file were down by 53%, PI number assignments were down by 38%, and duplications were up by 150% compared to their 2001 levels.

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

f. Order processing (L. Minor and R. Stebbins)

During 2002, there were 1114 orders entered into GRIN. A total of 16,791 packets were distributed to requestors and evaluators throughout the world. Of the total packets distributed, 17% of these were sent to foreign requestors.

The number of orders entered into GRIN in 2002 was ca. 18% greater than that of 2001. In contrast, the number of requests received electronically this year was 516, a decrease of ca. 6% from 2001. Packet distribution was also down by 2,463 or ca. 13%.

We distributed 377 Initial Accession Performance Report forms in 2002. By the end of the year, 261 (69%) had been returned. The Summary Accession Performance Reports and Final Reports that were mailed out in 2002 totaled 286. Of these, 149 (52%) have been returned. The return rate on the Initial Accession Performance Report forms remained nearly the same as that of 2001.

Linda Minor, Clerk III, for many years in charge of order fulfillment announced that she would be retiring in early January, 2003.

g. Seed Storage (L. Burke, M. Arnold, M. Block)

In 2002, 2252 lots were stored, including both newly received lots and those either regenerated at Ames or at remote sites. Inventories of 4730 lots were reviewed to ensure accuracy of seed amounts, and new labels were printed for lots with outdated labels. We prepared 300 original lots for long-term freezer storage.

Seed orders prepared in 2002 included those for distribution, observation, germination, transfer and backup. There were 1444 lots (1331 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 16,901 packets to meet distribution and observation requests. Of these, 13939 were distributed domestically and 2962 outside the US. We transferred 920 inventory lots to other NPGS sites.

Major projects for 2002 included the prepacking program for NCRPIS crops (to date 962 distribution lots have been prepacked, insuring inventory accuracy and efficiency); development of a map and inventory supply tracking system for commonly used items; a large PI-number assignment project for maize, checking passport data against information on INIFAP DB and CIMMYT DB; preparation of 892 ornamental inventory lots (491 accessions) for transfer to the Ornamental Plant Germplasm Center in Columbus, Ohio and; completion of a Seed Storage Handbook to document seed-storage processes.

Training for 2002 included CPR/First Aid re-certification (Mary Arnold); Blood Borne Pathogen re-certification (Lisa Burke); New Web-Based Grin Training (Lisa Burke); USDA/ARS Civil Rights Training (Mary Arnold, Mary Block and Lisa Burke); Hazardous Waste Generators training (Lisa Burke).

Travel for 2002 included two trips by Lisa Burke to the Database Management Unit in Beltsville, Maryland for training and beta testing of the new web-based GRIN interface.

In 2002, 98 accessions received taxonomic re-identification. All affected seed samples were re-labeled by seed storage personnel. In addition, seed samples of 103 inactivated accessions were removed from the active collection and placed in inactive storage. PI numbers were assigned to 296 accessions with Ames numbers. New labels were made and cold storage locations and GRIN records were adjusted to

reflect these changes. Four accessions were identified as duplicates, and appropriate changes were made to those packets, to their locations and to GRIN.

One full-time permanent federal employee (Lisa Burke), one full-time temporary federal employee (Mary Arnold) and one part-time (Mary Block, 20 hours/week, nine months/yr) employee staffed the seed storage department in 2002. Mary Block's position was converted from a state to a federal position in August.

VII. Curatorial and Scientific Team Reports

a. Entomology (S. McClurg)

Progress:

Field

Maize – A replicated retest of three hundred thirty-six maize accessions (ninety-seven inbreds and two hundred thirty-nine populations) which were rated resistant in field tests from 1992 – 2001 were evaluated for leaf-feeding resistance to first-generation European corn borer in the field in Ames for curator M. Millard. Eighty-nine accessions (thirty-seven inbreds and forty populations) were rated as resistant in all three replications.

Three small maize test plots were planted and treated for cooperator C. Abel (USDA-ARS, Stoneville, MS) in the field in Ames. Fresh silks were collected and lyophilized from nine accessions for evaluation of resistance to corn earworm in laboratory diets. Finely milled silks were shipped to Abel for testing. Five accessions replicated four times were evaluated for leaf-feeding resistance to first-generation European corn borer. Four accessions were evaluated for stalk-tunneling resistance to second-generation European corn borer. Data on both corn borer plots was reported to Abel.

Sunflower – Thirty-eight accessions of cultivated sunflowers from the core collection were evaluated for resistance to sunflower moth in the field in Ames for curator M. Brothers. Data collection is in progress. Only eleven of the one hundred twelve accessions from the core collection remain untested to date.

Sunflower moth resistance rating values from tests conducted on two hundred fifty-one accessions of cultivated sunflowers in the field in Ames from 1994 - 2001 were normalized by comparing percent control values of individual accessions to percent control values of check accession "Hybrid 894" for the year tested. "Hybrid 894" is considered resistant to the sunflower moth in Ames, IA field tests. The normalized ratings show that the most resistant accessions of cultivated sunflowers come from three of the core group clusters. This data was presented at the Sunflower Insects meeting held in conjunction with the National Sunflower Association meeting in Spearfish, SD, June 23 - 25, 2002.

At the request of I. Larsen, S. McClurg developed a plan for scouting the cultivated sunflower increase plots from June – July, for sunflower moth, so that pesticides could be applied in a timely manner. Assisted I. Larsen in making proper identification of other insect pests in the cultivated sunflower plots and wild-type sunflower cages as needed.

In cooperation with S. Hanlin, M. Brothers, and I. Larsen, three accessions of sunflower were again evaluated for effectiveness of pollination by three bee species, including one species of sunflower leafcutter bee, in a replicated cage field test in Ames. Results are discussed in the "Controlled Pollination" section of this report.

Mixed Genera - In cooperation with S. Hanlin and several of the NCRPIS curators, we continued observations of 14 accessions of mixed genera for floral visits by

native insect pollinators (Hymenoptera and Diptera) in the field in Ames. Weather data and insect specimens were collected on *Agastache, Pycnanthenum, Monarda, Ocimum, Melilotus, Coriandrum, Anethum, Hesperis, Linum, Helianthus, and Tithonia*. Data was given to S. Hanlin for processing.

Cucumis/Cucurbita – Assisted the plant pathology project personnel with field collection and species separation of cucumber beetles and corn rootworm beetles from the exterior of field cage screens. C. Block wished to determine if the beetles can carry more than one plant virus, and furthermore if viral transmission was occurring when beetles fed on plant parts accessible through field cage screening.

Brassica – Former NCRPIS research entomologist Richard Wilson traveled to Hermiston, OR, to assist cooperator Gary Reed (OSU) in a final field evaluation of *brassica* for resistance to cabbage aphid. Two hundred and eight accessions were tested in single row plots; thirty-two of the one hundred and sixty-six accessions actually rated received only light aphid feeding damage. A replicated plot to retest twelve accessions which showed resistance in previous field evaluations in Oregon from 1998 - 2000 was also planted. Five accessions in the retest plot showed only light damage by aphids; three of these accessions were *B.juncea.* The five most resistant accessions originated in India, Pakistan, Nepal, and Turkey.

Greenhouse

Cucumis – In cooperation with K. Reitsma, C. Clark, and S. Hanlin, assisted in a summer, 2002 trial of insect pollination of *cucumis* in greenhouse cages. Five pollinators were tested, including: a *Bombus* drone colony, blue bottle flies, honey bees, alfalfa leafcutters, and *Osmia* bees. See the "Controlled Pollination" section of this report for discussion of data collected in July, 2002. The test will be repeated with most of the same pollinators in two greenhouses utilizing a different cage design in winter, 2002/2003.

Laboratory

Coriander - In cooperation with D. Brenner, and D. Kovach we continued investigation of the seed chalcid infesting coriander maintained by D. Brenner. Our overall goal is to determine the most effective method for producing large quantities of high quality seed without viable insect pests, so that harmful insects are not introduced to user community sites and there is minimal delay in making the coriander seed available for distribution. We performed seed dissections on 2001 Ames field increase seed lots to determine the extent of chalcid infestation present. Accessions selected for testing varied in seed size and maturation dates. Five of the nine accessions examined had 0 to 2% infestation, one accession had 9% infestation, while three accessions had 22 to 30% chalcid infestation in cleaned seed samples in winter 2001/2002. Test seed was left at room temperature in two locations (to allow for chalcid development and emergence) until we reexamined the seed in fall, 2002. Percent infestations of seed lots were similar to previous data, but it appeared that the chalcid larvae infesting the seed were beginning to dessicate in fall, 2002. We also dissected distribution lots of two accessions of coriander from year 2000 field increase that had been in cold storage for one year in fall, 2002. These seed lots had been considered highly infested at the time they were harvested in fall, 2000. Chalcid larvae found inside these seeds were definitely dessicated and nonviable after their post-harvest treatment of varying storage temperatures. In fall, 2002 we harvested excess rows of coriander in P. Lopez's 2002 field research plot for continued studies of chalcid infestation during winter, 2002/2003. Data collection is in progress. For discussion on tests to kill chalcid larvae infesting seeds by chemical means conducted by D. Kovach, see his section of this report.

Maize – In cooperation with maize curator M. Millard, and J. Robbins and L. Pollak of CICG (USDA-ARS, Ames, IA), assisted with the testing of eight total accessions of maize to determine if multiple aleurone layers in corn kernels have

any relation to resistance to feeding by three common stored insect pests. This was suggested by J.P. Santos (Purdue, M.S. Thesis, 1977) in his evaluation of a Brazilian corn germplasm collection. Angumois grain moth eggs were applied to all eight accessions in five different studies. Indian meal moths were applied to milled and whole kernels of three accessions. Maize weevils were applied to five accessions. Data collection and analysis is in progress.

Safety – Chemical laboratory areas and inventories were prepared for the scheduled EPA inspections to be held at ISU in April, 2002. Entomology Building safety displays were upgraded to include new information. In cooperation with S. Hanlin, wrote the Entomology project safety protocols.

Rearing – Iowa State University student Brent Werner was hired in February, 2002 to assume the major insect rearing duties formerly covered by S. McClurg (primarily the insects required for host plant resistance evaluations) and S. Hanlin (non-bee insect pollinators). Brent's work with blue bottle flies and houseflies is covered under the "Controlled Pollination" portion of the annual report. When Brent's student status changed with his graduation from ISU in August, 2002, he was given a USDA-ARS limited appointment, so that he could continue to provide us with consistent rearing of quality insect colonies through May, 2003. S. McClurg served as Brent's supervisor and primary source of solutions when problems developed with any of the insect colonies; they also collaborated on designing a new fly colony cage that would be durable, easily cleaned, and leak few insects which was a problem with the previous cages. In addition to the rearing work at NCRPIS, Brent assisted J. Robbins of CICG (USDA-ARS, Ames, IA) with the rearing of three maize stored insect pest species and the western bean cutworm.

A colony of sunflower moths is being maintained at NCRPIS in order to provide sufficient numbers of insects for the field evaluations of cultivated sunflowers.

A colony of green peach aphids was being maintained in the growth chamber in order to provide sufficient numbers of insects for greenhouse evaluation of *Brassica*. This colony was discontinued in August, 2002 to allow for repair of the growth chamber and because greenhouse evaluations have not been requested by the *Brassica* curator since 1999.

Other Activities:

During the past year S. McClurg served as the secretary of the Image Archive committee. She was also a member of the Computer Committee.

Plans for 2003:

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 may include: reaction to first and second-generation European corn borer and corn earworm in maize, and sunflower moth in cultivated sunflower. We plan to include more accessions related to the most resistant cluster groups in future sunflower moth resistance evaluations of cultivated sunflower.

S. McClurg will continue to process, archive and make data publicly available from past host plant resistance evaluations.

We will continue to work with seed infestation projects such as seed chalcid in coriander and stored pest products in maize.

S. McClurg will continue to offer support to all NCRPIS and GEM project personnel when insect pest identification/information is needed.

We will continue support activities for the NCRPIS insect pollinator program, assisting in the rearing and placement of bees and flies, as well as providing cooperation in pollinator studies proposed by S. Hanlin and NCRPIS curators.

In May, 2003, S. McClurg will be seeking another student employee to assist with insect rearing, when B. Werner's appointment expires and he leaves for graduate studies elsewhere.

b. Horticulture (M.P. Widrlechner, P. Ovrom)

Germplasm Collections

Acquisition: During 2002, we received 64 new accessions of ornamentals (Table 1). The largest groups were about 20 accessions obtained through NPGS-sponsored explorations in China and accessions obtained to enhance our holdings of *Echinacea* and *Hypericum*. An exploration proposal focusing on native trees and shrubs in Iowa, Michigan, and Minnesota was prepared by Mark Widrlechner, Robert Schutzki (Michigan State University), and Harold Pellett (Landscape Plant Development Center) and submitted to the Woody Landscape Plant Crop Germplasm Committee.

Maintenance:

In March 2002, as part of an NPGS-wide effort to establish a national center for herbaceous ornamental germplasm, about 500 accessions of original and increase seed of herbaceous ornamental germplasm representing 23 genera that had been part of our Horticulture Project were transferred to the Ornamental Plant Germplasm Center (OPGC) in Columbus, Ohio for maintenance. These collections were chosen on the basis of OPGC priorities and the new site's ability to handle the materials. Statistics presented in the Annual Report tables at the end of the Annual Report exclude activity in transferred accessions. Statistics reported below for distributions and other actions do include those conducted on transferred accessions before the transfer.

Availability:

During 2002, approximately 44% of the ornamental collections and 56% of the mint family plants were available for distribution (Table 1), figures similar to those reported in 2001 (44 and 49%).

Back-up:

Approximately 31% of the ornamental collections and 54% of the mint family plants are duplicated at NCGRP (Table 2), figures similar to those reported in 2001 (33 and 48%).

Regeneration:

Regeneration efforts continued at the levels established in 2001. The harvests listed in Table 2 include 70 successful cage increases and 26 woody ornamental seed increases. There were also 20 accessions of woody plants established from seeds and 30 accessions vegetatively re-propagated.

Viability Testing:

In 2002, 148 ornamental and 7 mint-family accessions were tested for germination (Table 2).

Distribution:

As summarized in Table 3, during 2002, 801 "order items" included all the distributions for the NC7 Trials (described in the following section), along with 13 plants, 802 cuttings, 5 leaf samples for DNA extraction and

427 packets of seed, which were distributed to fulfill other requests for ornamental plant germplasm. This group encompassed 50 genera; those most in demand were: *Echinacea* (149 packets and 5 leaf samples), *Calendula* (49 packets), *Potentilla* (26 packets), and *Sanvitalia* (21 packets). In addition, 22 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]	98	92	84	531	234
	99	92	83	658	272
	00	84	79	596	282
	01	94	85	671	365
	02	103	89	779	361
Mint Family	98	10	10	85	47
	99	3	3	8	8
	00	3	3	37	35
	01	5	5	42	42
	02	4	4	22	19

[1] Includes genera transferred to OPGC in 2002.

Characterization/taxonomy:

During 2002, the descriptor list for *Echinacea* was approved by the New Crops Crop Germplasm Committee. Data collection continued in the new three-year cage field. These data were used to help verify taxonomic identifications. The initial data set has been proofed, and, at the close of 2002, the format of the descriptor list was loaded into GRIN. These evaluation data will be loaded into GRIN in 2003, which will allow the research community to gain a better understanding of our collections and increase the efficiency of their use in research.

All other herbaceous ornamentals in the cage-increase field, and many of the tree and shrub accessions being regenerated, were checked to verify identifications. In all, six accessions were re-identified. During 2002, with the assistance of Robert Stebbins and Paul Ovrom, 43 images of ornamentals were added to our local database (see Table 4). These will also be loaded to GRIN in the coming year.

Evaluation:

During 2002, results from flooding and drought evaluations conducted during June/July 2000 on five *Betula* and four *Alnus* species were loaded into the GRIN database, and were published in the Journal of Environmental Horticulture.

Jeremy Kapteyn, working in Dr. James Simon’s laboratory at Rutgers University, completed an evaluation of *Echinacea* root samples (71

accessions) for caftaric acid, chlorogenic acid, echinacoside, cynarine, and cichoric acid. These data were provided during the summer of 2002 and will be loaded in GRIN in 2003.

The following evaluation data (see Table 4) were received from NC-7 Trial Site Cooperators and await loading to our Internet database (described further in the section “Coordination of the NC-7 Regional Ornamental Trials”).

Reports of planting (11 accessions distributed in 2002): 121 reports (and 59 from 2000 and 2001)

One-year reports (12 accessions distributed in 2001): 72 reports (and 73 from 2000 and 2001)

Five-year reports (13 accessions distributed in 1997): 35 reports (and 17 from 2001)

Ten-year reports (8 accessions distributed in 1992): 38 reports (and 28 from 2000 and 2001)

Enhancement:

There was no major progress to report with enhancement activities in 2002.

Coordination of the NC-7 Regional Ornamental Trials:

Plant Distribution - In 2002, 637 plants of 11 accessions (plus 18 replacement plants) were distributed to 29 sites for long-term evaluation, with an additional 200 plants provided to 12 arboreta and botanic gardens. As part of that process, in May, Paul Ovrom met with cooperators in Minnesota and North Dakota and delivered 137 plants of 11 accessions.

Many of the tree and shrub seed collections made in September 1999 in Ukraine have been germinated and are being cultivated for long-term testing in the NC-7 Trials, with two overall goals: finding well-adapted, new landscape plants for the North Central Region and testing scientific hypotheses about the relationships between soils, climates, vegetation patterns and woody plant adaptation. Seven of these accessions were distributed to Trial Sites in 2002. A follow-up report on the collection trip was prepared for publication in the Ukrainian journal, Fenix.

Computer-generated, "One-, Five-, and Ten-year Performance Report" forms were distributed to trial-site cooperators this spring. Four updates were emailed or sent to trial cooperators in 2002 to inform them about recent developments in the testing program. One of the major developments that connect us more closely to trial sites is the existence of our NCRPIS home page. Until his departure in October, Paul Ovrom continued to maintain our web site by posting trial results, images of trial plants and other information about the trials on the Internet. Evaluation results for plants distributed in 1984-90 and descriptions of all plants distributed for testing between 1990-2002 are available through this site.

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 will be placed on our website in 2003.

Germplasm activities in crops other than those curated:

Various requests for accessions with special horticultural or agronomic characteristics were handled by Mark Widrlechner, resulting in the distribution of 82 packets of seed.

With the help of Robert Stebbins, Germplasm Program Assistant, the Station's acquisition of new germplasm from Indices Seminum was coordinated.

Mark Widrlechner, Lisa Burke, and David Kovach assembled data on historical seed distribution rates and seed longevity under NCRPIS storage conditions to develop targets seed-regeneration quantities for rapeseed, corn, domestic sunflowers, and cucumbers. This information is being prepared for publication in Genetic Resources and Crop Evolution

Mark Widrlechner continued to work with Amalio Santacruz-Varela on a paper describing patterns of genetic and morphological variation among New World popcorn germplasm for submission to Crop Science in 2003.

Throughout 2002, Mark Widrlechner actively participated in a university-industry-ARS collaboration to establish the Ornamental Plant Germplasm Center (OPGC), a new National Plant Germplasm System site in Columbus, Ohio, that focuses on the conservation of herbaceous ornamental genera. He serves as the Agency's representative to administer a Specific Cooperative Agreement between ARS and The Ohio State University to fund the OPGC and has been assisting the new OPGC Director and Curator in the establishment of the Center and its integration within the NPGS.

Mark Widrlechner chaired an in-house committee on medicinal/nutriceutical plants, and assembled (with Robert Stebbins' assistance) a database that lists species used in traditional medicine and as nutriceuticals and displays NPGS's holdings for these species. He also was named co-chair of a PGOC subcommittee on Medicinal and Nutriceutical Plants charged with developing an NPGS-wide plan for enhancing the conservation and utilization of such germplasm.

Iowa State University and the University of Iowa received a five-year grant from the National Institutes of Health establishing a Center for Botanical Dietary Supplements to study variation and bioactivity in *Echinacea* and *Hypericum*. A subcontract was created from that grant to ARS, allowing Mark Widrlechner to continue as a member of the team of scientists supported by the Center. The subcontract supports the curation of *Echinacea* and *Hypericum* germplasm collections at the Station and the distribution of that germplasm so it can be evaluated for chemical composition, genetic diversity, and bioactivity.

Mark Widrlechner assisted Kathy Reitsma in writing a paper summarizing our *Daucus* germplasm collections that was published in the trade journal, Carrot Country.

An IPGRI-funded survey of germplasm requestors of *Amaranthus*, *Brassica*, *Cucumis*, and *Helianthus* to determine how our germplasm contributes to research and crop improvement and to assay users' perceptions of the NPGS was completed and analyzed in 2002. A manuscript coauthored by Mark Widrlechner, Luigi Guarino (IPGRI), and Candice Gardner summarizing the results of this project was submitted, but not accepted, for publication in Crop Science. Revisions will be made in 2003 for submission to another journal.

During 2002, Mark Widrlechner was involved with a number of other collaborative germplasm activities including an evaluation project on *Coriandrum* germplasm being conducted by Pedro Lopez, a doctoral candidate at Iowa State University, who focused on morphological and phenological characteristics during the 2002 field season; an evaluation of *Ocimum* germplasm for essential oil composition by Katerina Svoboda and Senga Oxenham, Scottish Agricultural University; and studies investigating interactions between cucurbits and downy-mildew pathotypes with Aleš Lebeda, Palacký University, Czech Republic.

Mark Widrlechner's other research and training activities:

Collaborations continue with Welby Smith of the Minnesota Department of Natural Resources in preparing a treatment of *Rubus* for a new book on the woody plants of Minnesota and with the staffs of herbaria at the University of Wisconsin, National Arboretum, and Ohio State University to identify and document their *Rubus* collections.

Mark Widrlechner's analysis of the geographic distributions of non-native woody plants known to be established in Iowa in relation to climatic analogs was published in the Journal of the Iowa Academy of Science. A follow-up project, with Jeff Iles, of the ISU Horticulture Department, analyzed the native ranges of non-native woody plants not known to naturalize in Iowa in relation to the ranges of those species known to naturalize and was used to develop a geographic-risk analysis published in the Journal of Environmental Horticulture. Mark and Jeff joined with Jan Thompson, of ISU's Department of Natural Resource Ecology and Management, to develop models that combine the geographic risk-analysis approach with biological attributes to build more comprehensive models. Initial results of that collaboration were presented in October, 2002, in Chicago at a symposium on invasive plants sponsored by the Chicago Botanic Garden.

Together with colleagues at Iowa State University, Mark Widrlechner continues to assist in the documentation of the flora of Ames and its dynamics by verifying the identification of woody plants and by making field collections, often in the vicinity of the Plant Introduction Farm, a potential introduction source for exotic plants. In 2002, this work resulted in the publication of a study on the dynamics of Ames flora in the Journal of the Iowa Academy of Science. An additional paper resulting from this work, describing the characteristics of the "lost" and "found" species in Ames over time is being prepared for the journal Conservation Biology.

Other Horticultural project training and staff development activities:

In 2002, Mark Widrlechner visited the Western Regional Plant Introduction Station in Pullman, Washington and Plant Genetic Resources of Canada in Saskatoon, Saskatchewan to meet with their staff and observe their regeneration, seed processing and storage operations. He also attended training sessions to satisfy continuing education requirements for tractor safety and state pesticide applicator certification.

Communications Activities:

Manuscript and Proposal Review:

Mark Widrlechner served as a peer reviewer for manuscripts submitted to HortScience, Journal of Heredity, and Crop Science. He reviewed grant proposals for the American Rhododendron Society, the Eastern Region of the International Plant Propagators' Society, and the Landscape Plant Development Center. In 2002, he was also appointed to the Editorial Review Board of the international journal, Genetic Resources and Crop Evolution.

Posters, Presentations and Seminars:

Widrlechner, Mark P. 2002. Environmental analogs and invasive woody plants. Invited presentation to Forestry 476, Iowa State University, 15 February.

Widrlechner, Mark P. 2002. The Woody Landscape Plant Crop Germplasm Committee: Germplasm status report. Invited presentation to the 2002 Annual Conference of the American Association of Botanical Gardens and Arboreta, Hamilton, Ontario, 8 August.

Widrlechner, Mark P. 2002. Saving seeds workshop. Reiman Gardens, Iowa State University, 12 September.

Widrlechner, Mark P., Jeffery K. Iles, and Janette R. Thompson. 2002. Developing a comprehensive strategy to assess the risk of naturalization of non-native woody plants in Iowa. Presentation to the Janet Meakin Poor Research Symposium: Invasive Plants—Global Issues, Local Challenges, Chicago, IL, 30 October. Presented in expanded form as an invited seminar to the ISU Natural Resource Ecology and Management seminar series, Ames, IA, 8 November.

Publications which appeared in print in 2002:

Graves, William R., Mark A. Kroggel, and Mark P. Widrlechner. 2002. Photosynthesis and shoot health of five birch and four alder taxa after drought and flooding. Journal of Environmental Horticulture 20: 36-40.

Kyle, S.K., K.P. Svoboda, D.R. Walters, M. Nishiki, and M.P. Widrlechner. 2002. Chemical composition of essential oils from a collection of *Ocimum* species (NCRPIS, Ames, USA); investigation of their antifungal activities and effects on fungal polyamines. International Symposium on the Chemistry of Essential Oils, Terpenes and Aromatics. Tokushima Bunri University, Tokushima, Japan, 18-21 October. Abstracts, pp. 255-257.

Kyle, S.K., K.P. Svoboda, and M.P. Widrlechner. 2002. Variability in the source of plant material: A case study of basil biodiversity and chemotypes. Bioforce Phytotherapy Research Conference, Glasgow, Scotland, 19 April. Conference Abstracts.

Reitsma, Kathleen R. and Mark P. Widrlechner. 2002. *Daucus* in the USDA germ plasm collection. Carrot Country 10(3): 10, 12.

Widrlechner, Mark P. and Jeffery K. Iles. 2002. A geographic assessment of the risk of naturalization of non-native woody plants in Iowa. Journal of Environmental Horticulture 20: 47-56.

Widrlechner, Mark P. and Kathleen A. McKeown. 2002. Assembling and characterizing a comprehensive *Echinacea* germplasm collection. pp. 506-508. Trends in New Crops and New Uses. Proceedings of the 5th National Symposium on New Crops and New Uses: Strength in Diversity, Atlanta, GA, 10-13 November 2001. J. Janick and A. Whipkey (eds.) ASHS Press, Alexandria, VA.

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. For 2002, he chaired the Written Preliminary Exam Committee for the Plant Breeding and Genetics Advisory Panel. He became Co-major Professor for Pedro Lopez, a Ph.D. candidate in Plant Breeding, and was appointed to Program of Study Committees for two Ph.D. candidates in Plant Breeding and an M.S. candidate in Sustainable Agriculture. He assisted Laura Merrick in teaching a 0.5 credit module of Agronomy 565D, Ethics in Professional Practice, dealing with plant genetic resources.

Conclusions and Plans for 2003:

<u>Curation</u>

We were able to sustain our active regeneration program at levels established during the last three years and were able to meet increased levels of demand for our collections (especially for *Echinacea*), but the departure of Paul Ovrom in October may lead to a reduction in activity level during the coming year. The search for a skilled replacement for Paul and the creation of a new curatorial position for medicinal plants will be among the top priorities for 2003.

Collection transfers to the OPGC should allow us to focus more closely on a smaller set of herbaceous ornamental genera, especially on those genera that also have medicinal, aromatic or industrial uses, and on woody landscape plants, which will be augmented through participation in an NPGS-funded exploration within the Midwest in 2003.

Research

Considerable progress was made on the following four research projects during the past year: analysis of the results of the IPGRI-funded users' survey; development of risk-assessment models to predict the invasive potential of non-native woody plants that integrate location-based approaches with biological attributes; the application of distribution history and seed longevity to the question of target quantities for seed regeneration; and the evaluation of various germplasm collections of horticultural crops for valuable characteristics.

Research efforts during 2003 will focus on refining comprehensive risk-assessment models for the invasiveness of non-native woody plants, preparing the study that examines long-term germplasm records and distribution history to estimate target quantities for seed regeneration for publication, and collaborative projects to evaluate our collections of medicinal and aromatic plants, emphasizing collaborations through the Center for Botanical Dietary Supplements. Mark Widrlechner will also participate in the completion of ongoing studies on the genetic diversity of our germplasm collections, including research on popcorn by Amalio Santacruz-Varela and coriander by Pedro Lopez. Studies will also continue

on the biosystematics of *Rubus* and the dynamics of the local flora, with special attention paid to the role of exotic species.

Staff Development

Plans for staff development for 2003 will focus on training for the new Agricultural Science Research Technician position and a new curatorial position for *Echinacea* and *Hypericum* funded by the Center for Botanical Dietary Supplements.

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

Research Progress:

Amaranthus (various species):
We conducted preliminary greenhouse evaluations a cross-section of PIs, from 30 species plus grain types, for resistance to Pythium stem canker, a common problem in amaranth production. The best resistance occurred in weedy species: *A. palmeri, A. tuberculatus*, *A. retroflexus*, and A. *spinosus*. None of the grain cultivars from *A. cruentus*, *A. hybridus*, and *A. hypochondriacus* species seemed to be more resistant than the 'Plainsman' check.

Maize (*Zea mays*):
The national maize germplasm evaluation program continued for a third year, with 2577 accessions sent to cooperating pathologists. Diseases under evaluation included gray leaf spot, southern corn leaf blight, maize dwarf mosaic virus, Fusarium and Diplodia ear rots. At Ames, we evaluated ~1100 maize inbreds for Stewart's wilt resistance. Heavy spring rains and standing water were followed by a hot dry summer. These factors contributed to poor stands in some plots and more variable disease development than expected for inbreds. The check plots performed well, but many accessions were not adequately scored. Data from PIs with good plant numbers and consistent reactions will be loaded into GRIN.

An extensive study was conducted to determine if the presence of chemical seed treatments affected the sensitivity of the Stewart's wilt ELISA in detecting *Erwinia stewartii*. The work was done in collaboration with the ISU Seed Science Center, Pioneer Hi-Bred Int'l and scientists at the Univ. of Illinois. In short, we found that none of the seed treatments negatively affected the assay.

Sunflower (*Helianthus annuus*):
Two disease nurseries were planted, the first to evaluate 45 wild *H. annuus* accessions for Alternaria leaf blight resistance and the second to evaluate 92 accessions (various species) for Septoria leaf blight resistance. The *Alternaria* nursery contained PIs that did well in previous Septoria evaluations. Most of the PIs had good *Alternaria* resistance. The top five accessions were PI 435419 (TX), PI 435421 (TX), PI 435424 (TX), PI 468451 (TX), and PI 547167 (IL). Nine of the 10 most resistant accessions were from Texas.

In the *Septoria* nursery, 13 species and several hybrids (e.g. *annuus* x *petiolaris*) were tested. Highly resistant (nearly immune) species included *H. atrorubens*, *H. giganteus*, *H. mollis*, and *H. occidentalis* subsp. *plantagineus*. Resistance in *H. argophyllus. H. petiolaris* and *H. praecox* was generally good, but more variable among accessions.

A joint project with Mary Brothers (sunflower curator), Tom Gulya, (USDA pathologist at Fargo, ND) and Robert Webster (National Germplasm Resources Lab) looked at using GIS and spatial statistical software to predict geographic locations where disease resistant sunflowers might be found. Two years of Septoria evaluation data were used for the model.

Disease notes and phytosanitary activities:
Field observations for plant diseases were made in the seed increase plots of *Brassica*, cucurbits, sunflower, and maize. Accessions were inspected to verify the presence or absence of diseases of phytosanitary interest.

***Brassica, Crambe* and related *Brassicaceae* genera:**
Regeneration plots were inspected on 14-June and on 3-July 2002. We attempt to inspect plots when plants are at full to late flowering. There were no diseases observed for 54 of 102 accessions on either date. The only disease observed all season was black rot, a bacterial leaf disease caused by *Xanthomonas campestris* pv. *campestris*. Black rot was noted on 48 accessions, ranging from a few infected leaves to 18 accessions with as many as 50% infected leaves. The *Camelina sativa* accessions seemed prone to leaf death (lower leaves) caused by heat and drought.

Cucumber and melon (*Cucumis sativus* and *C. melo*):
Disease observation notes were made on *Cucumis sativus* and *C. melo* accessions (in cages) on 9-Aug and on 28-Aug, 2002. Little disease was present until late August when powdery mildew (*Sphaerotheca fuliginea*) rose rapidly to high levels on some accessions. Anthracnose (*Colletotrichum orbiculare*) was present on three accessions, at trace levels (less than 10 leaves) on Ames 26717 and PI 390257 and on 50% of the leaves of PI 274902. Bacterial fruit blotch (*Acidovorax avenae* ssp. *citrulli*) was absent.

There was an unusual occurrence of bacterial wilt (*Erwinia tracheiphila*) on a few plants. The disease is normally absent on caged plants, but we suspect that plants were infected by cucumber beetle vectors that were feeding on leaves pressed against the sides of the cages. Beetle populations were extremely high for most of the summer.

Cucurbit virus-testing:
All cucumber, melon, squash and pumpkin seedlings were tested for squash mosaic virus (SqMV) by ELISA before transplanting (1252 plants from 101 accessions). One

infected plant was found, from a squash check variety. Insecticides were applied weekly to non-caged plantings, as there was tremendous insect pressure throughout the summer, mainly from spotted cucumber beetles and occasionally from aphids. In late June, virus symptoms were noticed in the squash and pumpkin field. We tested all plants for SqMV and removed plants from any infected hills. More virus symptoms were seen in mid-July. Those plants were infected with watermelon mosaic virus (aphid-borne WMV-2), and not with SqMV. Watermelon mosaic virus is uncommon at Ames and is not seed-transmitted.

Sunflower (*Helianthus annuus*):
The main phytosanitary disease for U.S.-grown sunflowers is downy mildew, caused by *Plasmopara halstedii*. All seeds were treated before planting with Allegiance (metalaxyl) fungicide. Four infected seedlings were found; we suspect these were due to inadequate fungicide coverage.

By early fall, Septoria leaf blight caused significant defoliation on many of the wild *H. annuus* accessions in cages. Few other disease problems were observed.

Corn (*Zea mays*):
We inspected the seed increase plots for Stewart's bacterial wilt symptoms during late August and early September. Stewart's wilt was not found until mid-August, but was common by early September.

Laboratory seed health testing:
We conducted phytosanitary lab tests on 124 maize seed lots for Stewart's wilt, three seed lots for Goss' wilt, and three seed lots for *Ditylenchus* nematodes. We prepared 31 additional declarations (ADs), supporting documents that accompany phytosanitary certificates for seed export

Seed testing results were entered into our local database and uploaded to GRIN.

Meetings and workshops:
Charles Block and Bill Van Roekel attended the Sunflower Research Workshop at Fargo, ND, the annual Seed Technology Conference at Ames, the American Phytopathological Society meeting at Milwaukee, WI, and the Cucurbitaceae 2002 Conference at Naples, FL.

We presented a poster at the APS meeting on "Pythium stem canker of grain amaranth". C. Block was a co-author on a poster with Univ. of Ill. researchers on "The effect of seed treatment chemicals on the *Erwinia stewartii* ELISA test"

We participated in the July RTAC station review and gave a presentation on plant pathology activities at the Station.

Other activities:

Charles Block:
Served as NCRPIS liaison for phytosanitary issues with USDA-APHIS and the IA Dept. of Agriculture and Land Stewardship. The main issues in 2002 were (1) allowing chemically-treated corn seed to be used in lab testing for Stewart's wilt bacteria, (2) identifying plant pathogens that could be considered threats to national security, and (3) developing a list of common plant pathogens that could be freed from some of the strict regulations on state-to-state movement of cultures.

Served as chair of the sunflower disease panel for the National Seed Health System. The panel reviewed seed health testing methods for *Alternaria helianthi*, *Plasmopara halstedii*, *Puccinia helianthi*, *Verticillium dahliae*, and *Sclerotinia sclerotiorum* in sunflower and made recommendations on acceptable lab tests.

Invited and arranged seminar in Plant Pathology for Dr. Tom Gulya (USDA-ARS, Fargo, ND) to speak on joint sunflower disease research.

Invited and arranged seminar in Agronomy for Dr. Robert Webster and Brian Silinski, from the National Germplasm Resources Lab, on "Spatial Statistical Protocols for Predicting the Distribution of Germplasm Diversity."

Hosted one-day visit and tour of our Station and the ISU Seed Science Center for Ms. Lu Jen Wen, deputy administrator for quarantine in China.

Hosted one-day visit and tour of NCRPIS and ISU Seed Science Center for Kulani Machaba, plant pathologist from Pannar Seeds of S. Africa.

d. Zea Curation (M. Millard, G. Crim, L. Pfiffner)

Construction:

Remodeling was completed on a new imaging room in 2002. The maize staff moved the three imaging computers and related hardware to the new room and setup new imaging work areas. The farm staff began remodeling the old imaging room for the maize curator's new office, and completed a furniture layout design. Procurement of new furniture was delayed until a 2003 federal budget was completed by Congress. The new arrangement will permit the curator to be adjacent to the maize work areas.

Equipment:

A third large bed flatbed scanner (Microtek 9800XL) was obtained in late 2002. The Epson 1640XL that we purchased previously for this process produces colored line artifacts on the images of ears and therefore can only be used for imaging kernels where the entire image is filled. The Microtek scanner's performance will be evaluated for imaging ear samples directly on the bed without production of image artifacts. Large bed scanners are needed for this work because of the large 25 ear samples we image. The larger bed allows us to complete the sample's final image with fewer imaging steps and less file manipulation.

The station obtained a portable HP DVD200E DVD writer, which is being used to archive maize tiff images on 4+ gig capacity disks rather than on the .7 gig CD format. This has greatly speeded up the tif archive process.

Computers were again cascaded into the maize processing room as other NCRPIS computers were upgraded. Eight machines are now available (six 400 MHz Pentium IIs and two 600 MHz Pentium IIIs) for data entry by the maize and other NCRPIS curatorial projects that overflow into the maize room. All were updated from older operating systems, mainly Windows NT to Windows XP to solve security and support issues.

Personnel:

There were no changes in the maize permanent curatorial staff in 2002. The staff consists of an ISU Curator II, ISU Field Tech II, and a GS-5 Federal term Biological Science Lab Technician. Ms. Pfiffner, the federal technician, received an award for outstanding performance in 2001-2002.

Research Progress:

The NAS-NRC Races of Maize bulletins were scanned into Adobe Acrobat PDF format for future release on CD and on the WEB, via the National Academy of Science's website. The intent of this project is to more widely disseminate these seminal descriptions of the maize variation that existed mid-20th century in Latin America and that is now hopefully preserved in genebanks somewhere in the world. Many of the currently accepted races were first describe in these bulletins. Student intern Kyle Cavanaugh completed the work and developed protocols and

documentation which will be used for future archival activities. Mark Millard, Candice Gardner, and Wilfredo Salhuana provided suggestions, testing and coordination. Thanks to Henry Shands, Center Director of the NCGRP, for providing funds to purchase a document scanner for the project, and to all those who provided as close to pristine reports as are available and feedback on the project.

The second GEM program accession GEMS-0002 was incorporated into the collection in 2002. GEMS-0002 was selected from the GEM FS8(A)S:S09 population which is derived from FS8(A)S (PI 536619). It has improved protein content over B73 and is intended as a breeding resource for the improvement and diversification of elite, non-'Lancaster Sure-Crop' related inbreds. It is considered somewhat unique in that it has a relatively high proportion of tropical germplasm, yet is able to impart earliness to hybrids.

The GRIN Database Management Unit (DBMU) at Beltsville released new GRIN forms for data maintenance. These forms are being released in a staggered order and all National Plant Germplasm System (NPGS) units are undertaking final debugging as they are being used in the production environment. The maize staff along with Ms. Lisa Burke, our seed storage technician, took a lead in implementing these forms in 2002. These forms should enhance data entry into the GRIN database, thus speeding up public availability of data. This is also significant because other GRIN software projects can soon be addressed, including enhancement of the GRIN public interface.

Simple sequence repeat (SSR) data was loaded into GRIN for the first time by the maize project. This is the first time that data of this type was loaded into GRIN by any NPGS project.

Acquisition:

During 2002, Table 1 shows 328 accessions were received, less than half what we received in 2001. These included 120 new accessions received from CIMMYT of lots for which they had excess seed. NCRPIS paid for shipping of these larger lots. Thirty-eight public inbred lines previously not held in the NPGS were acquired from Purdue University, including nine accessions with expired PVP certificates and 7 CSR accessions. Forty-eight were Brazilian accessions held at NCRGP and not at CIMMYT that needed to go through quarantine in Mexico. Because there was not enough seed to grow for regeneration after a quarantine grow-out would be extracted, these were sent to be regenerated by NCRPIS at Illinois Crop Improvement Association’s (ICIA) nursery in Puerto Rico in the 2002-2003 winter season. Several requests for endosperm mutant conversions of inbred lines for basic research use have been received. Dr. Hallauer of Iowa State provided 18 waxy conversions he rescued before retirement. Dr. Tracy of the University of Wisconsin provided a few sh2 and su conversions. My goal is to have a small set of lines that can be supplied in quantities greater than what the Maize Stock Center provides.

Regeneration:

There were 262 regenerations attempted in the field in 2002; this compares with 296 accessions in 2001 and 200 in 2000. Regenerations included 116 populations and 146 inbred lines. Also included were a number of Canadian synthetics, representatives of the Chilean race Choclero used in Chile as a type of sweetcorn, representatives of the popcorn race Curagua that may be the South American race most closely related to our yellow pearl popcorns, newly expired PVP-inbreds, a number of endosperm variant public inbred lines, and a number of public inbred lines from Purdue and Minnesota. Many of these regenerations were prioritized based on low quantities and/or low viability combined with client interests.

While moisture on the whole was adequate, the 2002 season presented a number of dry periods during pollination and for the second year in a row we irrigated the inbred lines. This year a moving gun designed for turf grass irrigation was used in conjunction with wide alleys, which allowed the gun to be self-propelled. This single gun covered an area that would normally require several guns for coverage, or multiple repositioning of fewer guns. This system appears to be a good compromise for our project in Ames; irrigation needs are irregular and uniformity is not critical.

Again we suffered through multiple windstorms during early pollinations, forcing us to stomp-stand several populations 2-3 times. The Curagua and Choclero races for the most part have extremely poor roots. This nursery had some of the worst damage by common smut (Ustilago maydis) in memory. Other breeders in the area also commented on smut prevalence. Chilean races, and especially the two races grown in 2002, are extremely susceptible to smut.

A management technique to assist in spreading pollination dates over a longer period of time in 2002 was tried. Regeneration plots were divided into 3 planting dates, consisting of early materials in mid-April, inbreds and a portion of the populations in early May and the remainder of the populations in mid-May. Even though a cooler than average, late April limited heat unit spread between the early and the middle planting dates, we successfully separated flowering of these two groups by about 5 days. We plan to exploit this technique more in the future.

Twelve maize accessions were grown in the Ames greenhouse in 2002

Thirty-two accessions were grown at the ICIA facility at Ponce, Puerto Rico. The maize curator and technician made the majority of the pollinations. NCRPIS funded the entire cost of this nursery, $16,700. Seed germination was excellent under ICIA's drip irrigation regime. Next year we are going to grow a number of accessions from Brazil with very low quantities of original seeds because of the exceptional stand establishment I saw there; this is not common in my experience in the tropics.

Seeds from two accessions of *Zea perennis* were harvested from four accessions grown in the Ames greenhouse during 2002. These accessions can be maintained clonally indefinitely; as sufficient seed quantities are harvested, the clones are discarded.

Twenty-nine accessions were grown on St. Croix for quarantine regeneration in 2002. St. Croix had one of the best regeneration nurseries they have ever grown for maize. This was even more significant as all the 29 accessions grown were partial failures in at least one previous nursery on St. Croix. Mr. Adolfo Quiles-Belen, under the direction of Dr. Ricardo Goenaga at the ARS Tropical Research Station at Mayaguez, Puerto Rico travels to St. Croix and supervises the maize nursery.

One Gaspe flint-like accession was increased in isolation at the NPGS site at Palmer, Alaska in 2002. The increase was only partially successful as it frosted earlier in August than normal and the planting only partially matured.

Dr. Craig Abel grew twenty-one public inbreds from the U.S. Southeast at Stoneville, Mississippi in 2002. Seed quality was poor due to drought conditions in this nursery.

Pioneer increased ten accessions at each of their facilities on the islands of Kauai, Hawaii and Puerto Rico in fiscal 2002. The NCRPIS is very grateful for

this assistance.

Syngenta increased ten accessions at their facility on the island of Kauai, Hawaii in 2002. The NCRPIS is very grateful for this assistance.

Maintenance:

Table 1 indicates that accession availability increased by 2%, or 534 accessions, in 2002. This was achieved by maintaining the number of regenerations managed by the project and its cooperators, and by enlisting the help of CIMMYT. CIMMYT accessions with excess inventory quantities, which were previously unavailable at the NCRPIS, were imported. Also, a number of the new accessions from CIMMYT were introduced in quantities which made them immediately available.

Activity in backing up accessions was improved over the previous year again. Twice as many accessions (415) were backed up in 2002 as in 2001. The project is putting increased emphasis on assignment of PI numbers to available, temporarily numbered Ames accessions, and then backing up the new PI. PI assignment prior to shipment to the NCGRP increases the efficiency of the entire backup process for the NPGS as a whole.

In 2002, 4,140 accessions were germinated compared to 1,567 in 2001 and 1,876 in 2000. This represents 23% of the collection. Suffice it to say that the maize project is up to date on viability testing, thanks to the collaboration of the maize staff and our germination technician, Ms. Maria Erickson, and the efforts of the temporary staff she supervises. Viability testing in 2002 detected 49 accessions (1.2% of those tested) that were less than 50% viable for the first time; 236 accessions (5.7%) tested between 50% and 84% viable for the first time. Distribution stops on accessions with viability less than 50%; the standard distribution quantity is increased from 100 to 200 kernels on accessions with 50-84% germination, quantities permitting.

Distribution:

We distributed 7,290 packets (Table 3) in 2002 compared to 7,269 packets in 2001. Approximately 630 fewer accessions were distributed in 2002 than in 2001. What was remarkable in 2002 was the distribution of 113 more orders to 75 more individuals than in 2001. The majority of this increase can be accounted for by a special request that was filled for Monsanto. Seven accessions were sent to 64 addresses in 89 location sets for a “History of Corn” demo. Monsanto indicated they would be happy to provide NPGS-NCRPIS publicity in conjunction with the demonstration plots, and tropical regeneration assistance in Hawaii in the 2002-2003 winter season. This is probably the most widely circulated demonstration planting NCRPIS has supported. Number of requests continues to trend upwards, reflecting our belief that requests are becoming better targeted and specific in nature.

CROP	Year	No. of Orders	No. of Recipients	No. of Items Distributed	No. of Accessions Distributed
Maize	1998	177	137	3288	2180
	1999	231	167	4536	2805
	2000	257	193	18480	10981
	2001	313	210	7269	4637
	2002	426	285	7290	4006

Characterization:
There were 8,834 data points relating to 15 ear descriptors on 450 accessions loaded into GRIN in 2002. This compares with 15,623 data-points on 847 accessions loaded into GRIN in 2001 and 11,675 data-points on 798 accessions in 2000. The reduced amount in 2002 reflects the elimination of the backlog that existed in the previous two years, with data entry only on accessions grown during the previous year.

Imaging work continued at the pace of previous years. There were 6,451 images obtained on 3,323 accessions in 2002, compared to 7,010 images obtained on 3,756 accessions in 2001 and 7,513 images obtained on 2,190 accessions in 2000. At least one image on 504 additional accessions was loaded onto GRIN in 2002 compared to 1,327 accessions in 2001. There is at least one maize image on 2,433 accessions on GRIN available to the public. There is at least one image on 12,841 accessions located on local files; a minimum of one image/accession will be transferred to GRIN. Additionally, we began converting 1,789 slide images of older maize regenerations via use of a slide scanner.

For the first time, simple sequence repeat data (SSRs) for any crop was loaded into GRIN. This trial run was conducted to determine a protocol for loading SSR data; it closely follows the presentation in the MaizeDB and MaizeGDB databases. Frequency data on 54 popcorn accessions obtained by Dr. Amalio Santacruz-Varela for his thesis work was loaded for the p-phi024-CCT locus for seven base pair values. After a review of these efforts, we will continue loading maize SSR data into GRIN.

Evaluation:

The maize disease resistance-screening program continued in fiscal 2002. There were 2,500 accessions distributed to 3 private and 2 public pathologists in 2002; this compares with 3,000 accessions to 7 pathologists in 2001 and 2,560 accessions to 10 pathologists in 2000. Since this project began in 2000, data has been obtained on response to gray leaf spot, eyespot, and anthracnose stalk rot, virulent race Rp1-D of common rust, maize dwarf mosaic virus, northern leaf blight, gray leaf spot, and southern leaf blight. Further discussions among the collaborative pathologists and the NCRPIS pathologist and maize curator need to take place in order to target high priority maize disease organisms, to develop methods for evaluation of late maturing materials, and to develop methods that can effectively be adapted to exotics with poor agronomic performance, which can confound research efforts.

Annual evaluation of popping expansion traits of popcorn and flint germplasm,

regenerated in NCRPIS' maize increase nursery, were initiated with Iowa State Univ. popcorn breeder K. Zeigler, starting with the 2002 Ames nursery. Seed was extracted during processing for the test. This process will be used to generate data on regenerations of tropical accessions in the future. It is critical that seed moisture is maintained at good popping levels, (?), and not fall to the 9-10% normal equilibration level of NCRPIS seed in cold storage. Seed does not pop as well following rehydration. There is also a xenia effect on popping, making control-pollinated seed desirable.

Two data sets were provided by Dr. B. Hibbard et al. of the ARS Plant Genetics Research Unit, Columbia, Missouri, on corn rootworm damage screening of 533 NCRPIS maize accessions were loaded into GRIN.

Data collected by Pioneer Hi-Bred International during increase of CIMMYT accessions in the 1980's were loaded into GRIN. Dr. Wilfredo Salhuana was responsible for the regenerations and the catalogues containing this data. Data on growing degree days to pollen shed of 1,053 accessions and growing degree days to silking of 536 accessions were loaded into GRIN on accessions held also by the NCRPIS and CIMMYT. This data was invaluable in planning regenerations in Puerto Rico for a number of these accessions.

Communication:

Two replications of a large observation-demonstration planting of 468 accessions from the United States were again planted in Ames in 2002. The purpose was to observe the variability among U.S. maize races, obtain maturity data on these materials from a second environment, and to provide ISU maize researchers and others an opportunity to observe variability which many maize researchers never see in their careers, let alone in one location. Additionally, this planting was reviewed by Dr. Tom Ulrich from the DOE's Idaho National Engineering & Environmental Laboratory, Idaho Falls; 48 samples were provided to him following the field review. Dr. Ulrich's objectives include examining and acquiring variable, diverse germplasm stover samples to subject to mechanical processing, separation into components, and evaluation of component materials for their potential to maximize ethanol production.

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.

2003 Project Plans

Hopefully the new GRIN maintenance forms will be fully implemented in 2003. I plan to work with the DBMU to enhance the public GRIN interface so that maize researchers find it more useful in their work.

Acquisition:

More GEM accessions (36+) are expected to be released for distribution by the NCRPIS in 2003.

In 2003, we wish to obtain accessions held by Major Goodman at N.C. State which were used in molecular and evolutionary studies. These valuable accessions are currently not held by NCRPIS, nor can they be obtained from other genebanks. In 2002, we initiated arrangements to transfer these accessions. Major explained that population size was not a consideration when he originally regenerated these accessions, and that samples from regenerations using larger effective population sizes would be better. He also provided helpful history on the collections and their identifiers that will help ensure that only unique accessions are

obtained. The NCRPIS maize project will continue to procure the core accessions (not already been incorporated into the collection) 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 2003.

The NCRPIS will continue its program of acquiring public materials and previously Crop Science registered accessions from public institutions. Accessions from Kentucky, Georgia, North Carolina, Missouri, Nebraska, and Kansas programs will be acquired in 2003.

Regeneration:

Regenerations in Ames will be maintained at 250-300 accessions annually. Resources need to be increased (or re-directed within the maize project) to allow for 300-400 accessions to be regenerated annually in the future to facilitate accomplishment of this goal. Dr. Widrlechner, in association with other NCRPIS staff, has documented that maize accessions are consistently lasting 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, calculates indicate that 300 regenerations/year are required to maintain the collection. Any additional accessions regenerated would contribute to eliminating the backlog of some 6,000 accessions.

The private sector will again be asked to help increase tropical accessions during their off season. Three companies contributed winter nursery resources in 2002-2003. The NCRPIS is asking other companies to increase between 10 and 100 accessions per year. The NCRPIS will continue its tropical maize increases during FY'03 with 93 accessions planted at ICIA in Ponce, Puerto Rico, and will consider contracting for such work with other providers.

Quarantine regenerations on St. Croix will continue at the 30-50 accession level during 2002.

NCRPIS will try to develop a relationship with CIMMYT and Peruvian collaborators that will enable them to provide us with seed from regeneration of highland tropical accessions that cannot be regenerated in environments currently available to us. Germplasm exchange and MTA restrictions must be resolved in order to accomplish this.

Maintenance:

The last of the Goodman tropical increases from Mexico will be backed up in 2003 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 maintained on schedule in 2003. This will be easier than in recent years due to increased efforts to in the past three years which have resolved viability testing backlog. This has also allowed viability testing of other crops at the NCRPIS to receive increased emphasis.

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.

Much of the data on the maizeDB database is being made available on a new database at Iowa State currently called MaizeGDB. We will be working with this database in 2003 to create more links to the maize data on the GRIN database. The idea is to have one stop shopping for all maize related data.

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 2003.

e. <u>Vegetables (K. Reitsma, L. Clark)</u>

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:

One hundred eighteen accessions were received and are listed by site-crop in Table 1. Eighty-eight of the accessions were collected from the United States as part of a cucurbit evolutionary study and the seeds were donated to the NPGS by Deena Decker-Walters, The Cucurbit Network, Maiami, FL. These accessions include two cucurbit varieties not previously represented in the NCRPIS collections - *Cucumis melo* var. *texanus* (45 accessions) and *Cucurbita pepo* var. *ozarkana* (39 accessions).

Maintenance:

Data for regenerations attempted and accessions harvested are found in Table 2. The 2002 *Cucumis sativus* and wild *Cucumis* species regenerations focused on accessions having low seed distribution quantities, while C*ucumis melo* and *Cucurbita pepo* regenerations focused on newly acquired germplasm. The *Daucus* regeneration efforts have primarily been directed towards making newly acquired accessions available. The 41 *Daucus* listed in the table are those accessions started in October 2002 for regeneration in field cages during the summer of

2003. Forty *Daucus sp.* were direct seeded into the field as annuals during the spring of 2002. All of these accessions were reidentified to various species of Torilis (NC7-umbels sitecrop), and maintenance responsibility was transferred to David Brenner. The *Daucus* and *Pastinaca* accessions listed in Table 2 as "# Harvested Regen" were those started in October 2001 for regeneration in field cages in the summer of 2002.

In addition to the regenerations in Ames, we received *Daucus* seed increases from R. Maxwell, Seminis Vegetable Seeds, Idaho (9 accessions), R. Freeman, Sunseeds, Oregon (10 accessions), and P. Simon, University of Wisconsin, Madison, WI (7 accessions). Accessions regenerated by Maxwell and Freeman were "at risk" old cultivars with low viability at NCGRP. These accessions were PI numbered and incorporated into the NCRPIS collection upon regeneration.

As accessions are regenerated, seed samples are sent to NCGRP for back-up. Four of the vegetable collections have better than 75% of their accessions backed up at NCGRP (Table 1). We received substantial original seed quantities on many of the new *Daucus* accessions, and these may be sent to NCGRP for back-up after viability testing in 2003.

In 2002, 249 germination tests (Table 2) were performed, most of which were conducted on seed increases from the 2001 regenerations.

Distribution:

Packet and accession distributions for the vegetable collections are summarized in Table 3. In 2002, 3619 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	1998	4	4	76	39
	1999	6	5	123	115
	2000	5	5	52	52
	2001	6	6	288	175
	2002	8	8	261	134
Cucumis	1998	49	40	1585	995
	1999	54	46	3064	2085
	2000	60	45	1555	1235
	2001	59	49	1230	934
	2002	73	62	3089	1938
Cucurbita	1998	15	15	114	98
	1999	16	15	170	137
	2000	19	18	457	363
	2001	22	20	288	156
	2002	20	17	165	132
Cucurbits - Mics.	1998	1	1	1	1
	1999	2	2	2	1
	2000	0	0	0	0
	2001	2	2	2	1
	2002	0	0	0	0
Daucus	1998	19	16	922	525
	1999	20	16	481	331
	2000	11	11	205	203
	2001	13	12	235	211
	2002	11	11	75	67
Ocimum	1998	7	7	211	70
	1999	7	7	206	88
	2000	7	7	245	75
	2001	5	5	97	79
	2002	8	8	20	18
Pastinaca	1998	0	0	0	0
	1999	2	2	8	8
	2000	0	0	0	0
	2001	0	0	0	0
	2002	2	2	9	8

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 *Cichorium* and *Daucus*. During 2002, one-hundred-seed-weights were loaded to the descriptor area of GRIN for 6708 vegetable accessions equaling 17459 observations. 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 the Dr. Mark Widrlechner (Horticulturist), taxonomic identities are reviewed and confirmed as each accession is regenerated. The 2003 re-identifications included: 3 *Cucumis* to other *Cucumis* species or to subspecies/variety level; 2 *Ocimum* to other *Ocimum* species; 52 *Daucus* to 4 *Daucus carota*, 3 *Daucus broteri*, 1 *Daucus* sp., 2 *Orlaya*, 41 *Torilis*, and 1 unidentified Apiaceae.

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 2001 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 awaiting oil analysis and DNA fingerprinting data for the NPGS *Ocimum* collection from Dr. Katerina Svoboda and her student Senga Kyle, at The Scottish Agricultural College Auchincruive, Ayr, Scotland, UK. Dr. Widrlechner and I are collaborating on a publication with Svoboda and Kyle regarding the evaluation work. Two accessions were reidentified to other species of *Ocimum* based on preliminary data provided by Svoboda and Kyle.

Publications which appeared in Print in 2002:

Reitsma, K. R., and M. P. Widrlechner. "Daucus in the USDA Germplasm Collection." *Carrot Country* Fall 2002:10, 12.

Future Plans:

Regenerations: We were very successful in regenerating the new accessions of *Cucumis melo* var. *texanus* donated to the NCRPIS last year, but not as successful on the *Cucurbita pepo* var. *ozarkana* accessions we received in 2002. The donor warned that we might encounter difficulty regenerating these samples due to very low viabilities. We will again attempt to regenerate those *C. pepo* var. *ozarkana* accessions with low viability in 2003. In addition to the new accessions of *Cucumis* and *Cucurbita*, we will continue to increase accessions where distribution quantities and percent germination have fallen below critical values as set on GRIN.

Forty-one new accessions of *Daucus* were started in the greenhouse in October 2002 for the summer 2003 field cages. Taxonomic identification and unknown life cycles are still an issue with *Daucus* regenerations, and continue to cause difficulty with planning for greenhouse and field space usage. Many of the newly acquired accessions have proven to be mixtures of annuals and biennials which require that their plant population be regenerated in both a greenhouse cage and field cage with resulting seed increases being bulked before storage. An additional 40 accessions of annual *Daucus* will be direct seeded into the field this spring for

regeneration.

Regeneration of hard to handle and wild *Cucumis* species will continue in the greenhouse as time, space, and labor allocation permits. We hope to regenerate approximately 18 accessions in two regeneration cycles in the Entomology greenhouse facility.

Germinations: In April 2003, viability testing will be performed on seed lots resulting from the 2002 cucurbit regenerations. Viability testing will continue during the summer months on the 2001 and 2002 *Daucus* regeneration lots, and on 5-year germination testing to monitor the viability of the distribution lots in the vegetable collections.

Characterization: We will continue to record characterization data as regenerations occur. Hopefully Oracle forms can be developed to assist in loading newly acquired characterization data into GRIN. Characterization data collected for *Cucumis melo* since 1997 will be loaded to GRIN as soon as possible in 2003. Two USDA-ARS scientists are preparing a proposal to be submitted through the Cucurbit Crop Germplasm Committee to use these data along with the molecular and disease evaluation data to develop a core for the NPGS melon collection. If possible, I hope to load all available characterization data for all of the NCRPIS cucurbit crops during 2003.

Evaluation: The Pollinator Program and the Vegetable Program will continue to collaborate on some small pollinator tests. One test involves evaluating whether blue-bottle flies will pollinate umbels more efficiently than houseflies in greenhouse isolation cages. A second collaborative project is planned to develop a year-round cage and pollinator program for regenerating *Cucumis* and *Cucurbita* in the greenhouse.

f. Crucifers and Grasses (R. Luhman)

The collection:
Thirty new *Brassica* accessions were added to the NC7 active collection during 2002 (Table 1). Twenty-eight of the new *Brassica* accessions were transfers from the Geneva site. The remaining two accessions were deposited at NC7 via The National Center for Genetic Resources Preservation.

Thirty-six new crucifer accessions were added to the NC7 active collection during 2002 (Table 1). Thirty-two for the new crucifer accessions were transfers from the Geneva site. Four accessions, three from Portugal and one from Missouri, are new to the NPGS.

Three new wild flax accessions were added to the NC7 active collection. Two of these accessions were collected in Poland and one was collected in Armenia. All three of these accessions are new to the NPGS.

One new Tridens accession was added to the NC& active collection. This accession was collected in Missouri and is new to the NPGS.

Percent available for the material that I curate has changed little in 2002 (Table 1). It is anticipated that percent available for the wild flax collection could increase quite dramatically once the 2002 seed regeneration is germinated and stored.

Regeneration and Maintenance:

In 2002, 148 Brassicaceae accessions were stored from the harvests completed in 2001. Fifty-eight of these 148 accessions are currently available for distribution. The remaining ninety accessions are unavailable due primarily to low germination. One reason for the low germinations in 2001 was due to an unusually high cabbage looper and aphid infestation during the regeneration

process. In 2002 we attempted regenerations for 36 *Brassica*, 61 miscellaneous crucifers and 91 wild flax accessions (Table 2). Many of these accessions were started in the Fall of 2001. More than 95% of the Brassica and miscellaneous crucifer accessions were harvested. Sixty-one percent of the wild flax regeneration was harvested. Forty-eight wild flax accessions were left in the field to over winter.

Germination testing of the entire *Panicum* collection continued in 2002 (Table 2). Germinations on the 2001 regenerations were also completed.

The percentage of the *Brassica* collection backed up at the National Center for Genetic Resources Preservation increased slightly in 2001 (Table 2). Material sent for backup either replaced lots currently held with better quality seed or provided new material.

Distribution:

During 2002, we distributed 1078 packets domestically and 128 packets internationally of the crops that I curate (Table 3), representing 940 accessions domestically and 100 accession internationally. A focus for Brassica orders continues to be phytoremediation (ca. 20 orders). There are four *Brassica* accessions generally supplied for phytoremediation requests. These four accessions were described in a paper published by Kumar et. al. in 1985 titled “Phytoextraction: The Use of Plants to Remove Heavy Metals from Soils”.

Crop	Year	No. Of Orders	No. of Recipients	No. of Items Distributed	No. of Accessions Distributed
Brassica	1998	36	32	1560	1201
	1999	53	46	2181	1123
	2000	69	56	1245	862
	2001	36	33	469	414
	2002	55	51	1125	932
Crucifers	1998	18	17	403	303
	1999	15	13	299	227
	2000	16	15	72	66
	2001	22	18	640	268
	2002	24	23	241	212
Echinochloa	1998	8	7	52	46
	1999	2	2	9	8
	2000	5	4	166	149
	2001	4	4	36	33
	2002	4	4	5	5
Wild *Linum*	1998	2	2	19	19
	1999	3	3	26	16
	2000	0	0	0	0
	2001	2	2	22	19
	2002	2	2	18	12
Misc. Grasses	1998	3	3	11	9
	1999	1	1	1	1
	2000	0	0	0	0
	2001	3	3	7	6
	2002	1	1	1	1
Panicum	1998	7	7	34	34
	1999	2	2	7	7
	2000	9	8	58	49
	2001	8	8	662	650
	2002	2	2	9	9
Setaria	1998	7	7	57	51
	1999	7	6	27	26
	2000	13	12	795	757
	2001	6	6	20	19
	2002	9	8	48	43

Observations:

We continued to perfect methods for capturing digital images of crucifers during maintenance operations (Table 4). Digital photographs were taken at full flower in JPEG format, downloaded to our server, and manipulated with Adobe PhotoShop Version. Full flower images were also taken by collecting a plant sample and scanning that sample in TIFF format with a flat bed scanner. We also continue to record images of silique samples on a flat bed scanner in TIFF format. Two hundred nineteen plant images were loaded to GRIN.

Descriptor observations were recorded during regeneration, and plant samples were taken for later descriptor observation data. Seven hundred eighty five observations for 158 accessions were transferred to GRIN in 2002 (Table 4).

Visitors and Meetings:

I attended the Forage and Turfgrass CGC at the Agronomy Society Meetings (November 2002).

Future Plans:

The 2003 growing season is currently underway. Brassicaceae accessions have been started in the greenhouse for transplanting to the field in early April. We anticipate regenerating ca. 100 accessions in 2003.

Over-wintering wild flax will be monitored for flowering times and harvested when appropriate.

We also may have a 2003 millet regeneration field.

I plan to continue to work with a graduate student in Agronomy as he works on determining duplicates in the Brassica collection and in determining if previous bulks that were made based on morphological characters are valid bulks.

g. *Amaranthus, Celosia, Chenopodium, Coronilla, Dalea, Galega, Marina, Melilotus, Perilla* and *Spinacia* (D. Brenner and S. Bruner)

Acquisition and inactivation (Table 1)

This was a comparatively slow year for acquisitions. More accessions were inactivated (42) than acquired (24). The inactivated accessions were primarily in-viable Umbelliferae accessions with few or no remaining seeds.

Most of the new accessions are *Coriandrum sativum*. Fourteen Mexican landrace accessions were donated by Dr. Abel Gil-Munoz, Colegio de Postgraduados, in Puebla, Mexico, and two advanced Canadian cultivars were donated by Dr. Slinkard, University of Saskatchewan, Crop Development Centre, Saskatoon, Canada. These new accessions will support the work of Pedro Lopez, a graduate student in ISU Agronomy working on *Coriandrum* with Mark Widrlechner.

Dr. Herman Gorz donated a genetic stock of *Melilotus albus* with resistance to stem canker *Ascochyta caulicola* (Laub.). He provided two accessions, one homozygous for resistance and the other homozygous for susceptibility.

Maintenance and distribution (Tables 2 and 3)

***Amaranthus* and *Chenopodium*:**

This was one of our biggest regeneration years for *Chenopodium*, with seventy accessions planted. Some of the accessions had an unusual inflorescence form with reduced nodes resulting in very dense flower clusters in parts of the inflorescence; PI 478411 is the best representative of this type.

***Melilotus* and other legumes:**

Seventeen *Melilotus* accessions were regenerated in 2002 from the 21 that were planted on October 2001. Most were selected to make the core collection available. Three were taxonomically re-identified. Eleven *Melilotus* accessions are growing for seed harvests in 2003.

The USDA-ARS Soil Tilth Laboratory generously donated growth chamber space used for chilling and storing the biennial plants until they were transplanted into the field. The same facilities and protocol were used for biennial Umbelliferae especially the parsley.

A regeneration of *Dalea foliosa* (Ames 26199), an endangered species was successfully pollinated by bees in a greenhouse cage.

***Spinacia*:**

Twenty-nine *Spinacia* accessions were sent to Mr. Matt Linder of Sakata Seed

Company in Salinas, California for regeneration in cooperation with Dr. Ed Ryder of the USDA-ARS. They delivered 27 new harvests from accessions planted in 2001 and harvested in early 2002. Cooperation with the Salinas groups will continue, on a reduced scale, now that most of the *Spinacia* accessions are available for distribution.

A slow-to-bolt spinach accession (NSL 6092) was regenerated in the campus greenhouse, after a history of failure in California. Another slow-to-bolt accession (PI 262911) was regenerated by David Ianson at the station in Palmer, Alaska.

Miscellaneous Umbelliferae:

After the completion of seed storage in early 2002, 28% of the miscellaneous Umbelliferae are available for distribution, an improvement from 25% in the previous year. Most of the newly available accessions are *Anethum* and *Coriandrum* grown in the field in 2000. One-hundred nine accessions harvested in 2001 await storage in 2003. After 2001, the backlogs of easier-to-grow annual genera are virtually completed. Regeneration progress will be more gradual in 2003 and beyond as my attention shifts to the more difficult to grow genera, such as *Angelica*.

Fifty-one accessions were directly seeded into the field on April 26, 2002. These were mostly *Coriandrum,* but also *Ammi*, *Anethum*, *Bifora*, *Caucalis, Chaerophyllum, Cuminum*, and *Foeniculum*. Unfortunately, establishment was not as good as in other years. Dr. Charles Block examined the plants and took soil samples from the field for greenhouse testing. Plant symptoms were similar to those caused by herbicide injury, but wind may have contributed to the injury. Lorox, a photosynthesis inhibiting herbicide, had been applied in the field. Herbicide sensitivity was confirmed in the greenhouse, so Lorox could have weakened the seedlings.

An additional 30 accessions, primarily *Petroselinum,* were transplanted into the field. Twelve accessions that did not flower during the summer 2001 were transplanted out of the field into pots, and most resulted in successful harvests in 2002, either in the field or greenhouse.

A representative slow-to-flower *Foeniculum* accession (Ames 20049) was planted on January 10, 2002 and transplanted into the field where it successfully matured seeds. In 2003 this method will be tried with more slow-to-flower *Foeniculum* accessions. This same method worked with a *Trachyspermum* and a *Sium* accession.

Twenty-one biennial accessions of *Petroselinum* and *Carum* were planted on September 27, 2001 for field-cage pollination in 2002. Eighteen accessions were harvested. The *Petroselinum* are difficult to grow successfully because the seeds mature slowly, the maturity is very late, and some of the plants do not set seeds under our conditions. However, this same method will be repeated for 2002-2003. The unsuccessful accessions will need to be grown in another climate for successful seed production. Our new biennial planting was on October 9, 2002, and included 21 *Carum*, and 20 *Petroselinum* accessions.

I am continuing to experiment with methods for growing miscelleanous genera of Umbeliferae. In 2002 we grew 22 of these genera. As in other years the perennial plants dug up at the end of the field season eventually flowered and matured seeds. In general they transplant well. Two *Angelica* accessions that grew in the field in 2002 were transplanted into pots and are expected to flower in the greenhouse in the spring of 2003.

Some of the field-grown *Coriandrum* and *Foeniculum* seeds were damaged by *Systole* sp., a seed Chalcid wasp. We started a chalcid working group that includes active research efforts by David Kovach and Sharon McClurg. The group is conducting experiments designed to understand infestation and emergence of chalcid insects in our seeds. Sharon McClurg has some very interesting data about the life-spans of dormant chalcid insects under our seed storage conditions. That data is summarized in her part of this annual report. Under our current post-harvest storage/handling conditions it appears that our seed chalcids die within two years of harvest. Further testing in 2003 should resolve more clearly the time and conditions in which chalcids in seeds become non-viable.

I harvested wild *Conium maculatum* seeds in the fall to find out if they were an

alternate host for chalcid insects. No emergence was observed in the fall of 2002; but the seeds will be kept through the 2003 growing season to find out if insects emerge.

Characterization/taxonomy/evaluation (Table 4)

A collaboration with Dr. Mihai Costea of the University of Guelph resulted in a proposed re-identification of nine cultivated vegetable *Amaranthus blitum* accessions to *Amaranthus graecizans* subsp. *aschersonianus*. This re-identification will become official in GRIN after a peer-reviewed publication on the topic. This revision is partly based on molecular systematics work at the University of Hong Kong by the research group of Mei Sun. I am pleased that our collection has a part in these and other taxonomic revisions that are substantial progress in the understanding and use of *Amaranthus*.

Pedro Lopez, a graduate student in ISU Agronomy working with Mark Widrlechner, grew 139 accessions of *Coriandrum* for research. The resulting information will improve our understanding of the collection.

A collaboration with Dr. Beiquan Mou, USDA/ARS Salinas, California resulted in the first twelve Spinach descriptors being entered in GRIN. We will seek more review of these descriptors before asking the Leafy Vegetable CGC committee to approve them in 2003. Dr. Mou also provided us with observation data and digital images of 338 spinach accessions for installation in GRIN.

Corinne Johnson Rutzke of Cornell University loaded spinach data and images on a Cornell www site, in 2001. In 2001 these data were linked to accessions in GRIN with 289 new URL links. Mark Millard was very helpful in guiding this GRIN update.

A major revision of the *Melilotus* descriptors was entered in GRIN. A commentary on the descriptors is in final revisions for posting on the NCRPIS www site. This commentary will be accessible via a link from public GRIN. The commentary has substantial bibliographies and other information to make the history of *Melilotus* research available to new researchers.

The Miscellaneous Umbelliferae collection’s taxonomic problems were improved by 54 re-identifications. The largest block of these were from a field planting where 32 *Daucus* accessions were re-identified to *Torilis* by Kathy Reitsma and Mark Widrlechner. I re-identified additional accessions; most with long-standing incorrect or partial identifications.

The observations loaded in GRIN this year included many from the backlog of amaranth observations taken in previous years. Data was also loaded into the new Melilotus and spinach descriptors for seed weight.

An unusual fiber sample of *Amaranthus australis* (PI 553076) was found in the 2002 field planting. Mice had removed thin fibers from near the stem surface and formed them into a nest. The fibers are thin and hair-like. I had never before observed long fibers in amaranth stems.

Accession distributions 1998-2002

Crop	Year	No. of Orders	No. of Recipients	No. of Items Distributed	No. of Accessions Distributed
Amaranth	1998	63	57	2746	1786
	1999	62	50	3682	2487
	2000	44	37	860	451
	2001	51	37	985	604
	2002	44	34	458	235
Celosia	1998	2	2	6	5
	1999	3	3	24	17
	2000	6	6	11	8
	2001	2	2	12	11
	2002	7	7	9	7
Legumes	1998	6	5	34	16
	1999	4	4	32	32
	2000	7	7	16	13
	2001	4	4	7	7
	2002	7	5	69	50
Melilotus	1998	11	9	213	154
	1999	9	9	287	254
	2000	16	12	712	554
	2001	13	11	57	49
	2002	5	5	43	42
Perilla	1998	1	1	3	3
	1999	4	4	61	20
	2000	6	6	41	21
	2001	7	7	41	22
	2002	4	4	26	22
Quinoa	1998	13	12	121	92
	1999	10	10	294	163
	2000	21	19	342	149
	2001	18	15	239	173
	2002	23	22	333	161
Spinach	1998	13	11	1395	309
	1999	11	10	1061	332
	2000	7	7	670	348
	2001	12	11	1736	354
	2002	12	11	767	362
Umbels	1998	9	9	127	116
	1999	14	13	150	87
	2000	11	11	107	88
	2001	15	13	105	94
	2002	25	20	305	213

Enhancement and/or utilization:

AMARANTHUS:

The enhancement project to reduce seed shattering in grain amaranths continues. Ten lines of back-crossed non-shattering trait with ‘Plainsman’ were grown in the field. One of the lines was found to not segregate for male sterility, and will be advanced for additional observation. This could be a partial solution to the poor yields associated with other non-shattering lines.

Surprisingly two rows of ‘Plainsman’ and all the ‘Plainsman’ derived lines lodged in the field due to pythium root-rot. The lines derived from ‘Elephant Head’ or *Amaranthus cruentus* did not lodge. This was additional evidence for the potential

benefit of making an 'Elephant Head' stem available for grain production.

Two lines (red and orange) of a new dense determinate, non-shattering ornamental *Amaranthus hypochondriacus* performed well, and the flowers stood up attractively from early August until killed by the frost, more than two months. Other ornamental amaranths have a shorter season.

Dr. David Baltensperger, of the University of Nebraska, now has two years of data indicating substantial amaranth grain yield improvement with his new breeding

lines, compared to the industry standard 'Plainsman'. These new lines are partly derived from NCRPIS germplasm.

Collaboration was continued with Charlie Block to enhance cultivated *A. tricolor* for disease resistance to *Phomopsis amaranthicola*. A cross was made between PI 604669 disease susceptible green vegetable, and PI 599683 a disease resistant wild roadside accession. Both F_2 and F_3 populations from the cross are available for study.

A similar cross between PI 603899 and PI 599683 resulted in two F_1 plants that were ill-formed and not fertile. This was un-expected since both parents are *Amaranthus tricolor* and should be cross-fertile.

MELILOTUS:

An active breeding program working with fine-stem, and low-coumarin traits is led by Dr. G. Ray Smith, of Texas A&M University. I visited his research facility in April of 2002.

Publications and presentations:

Brenner, D.M. 2002. Non-shattering grain amaranth populations. p. 104-106. *In* J. Janick and A. Whipkey (eds.)Trends in new crops and new uses. ASHS Press. Alexandria, Virginia.
On line at: http://www.hort.purdue.edu/newcrop/ncnu02/pdf/brenner.pdf

That Sea-beach amaranth recovers in USDA-ARS. 2002. Agricultural Research Magazine 80(8):19
On-line at: http://www.ars.usda.gov/is/AR/archive/aug02/sci0802.htm
A summary of my work written by staff writers at the magazine.

Project report: *Amaranthus, Celosia, Chenopodium, Perilla, Spinacia*, miscellaneous Forage Legumes and Umbelliferae. July 24, 2002, Oral presentation. North Central Regional Plant Introduction Station, RTAC Meeting.

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

Plans:

We will hold an Amaranth Institute meeting on August 14 and 15, 2003. Many people at the station are working on this including Lori Wilson-Voss and Charlie Block.

I plan to have a field amaranth planting most of which will be direct-seeded rather than transplanted. The planting will include three parts. (1) A demonstration planting of cultivars and useful traits. (2) An *Amaranthus tricolor* planting that will allow comparisons of possible duplicate accessions, and comparisons of more and less disease susceptible (*Phomopsis amaranthicola*) accessions and breeding lines. (3) Spaced plantings of segregating grain amaranth populations that are expected to have improved stem traits, and reduced lodging.

Acknowledgments:

Sam Flomo, worked full-time on the project in a temporary student classification. In early 2003 he was promoted to a continuing status as an Iowa State University, Professional and Scientific, Agricultural Specialist I employee. Andrew Muff was the main part-time student worker on the project after Jon Behrens left in early 2002.

Charlie Block and Bill Van Roekel, our pathologists, have helped me with useful advice and cooperation throughout the year.

h. Sunflower and Miscellaneous Asters (M. Brothers, I. Larsen)

The status of the *Helianthus*, flax, and miscellaneous aster germplasm collections is summarized in Table 1.

Acquisition:
Eight Crop Science Registered cultivated sunflowers were acquired in 2002. In addition, six accessions (three *Verbesina*, two *Helenium*, one *Viguiera*) were added to the miscellaneous asters collection.

Maintenance:
There was relatively little change in the percentage of available flax accessions in 2002 (Table 1). Twenty-two miscellaneous aster accessions were stored in 2002; availability for that collection increased 3 percentage points. Although availability for the cultivated sunflower collection remained at 88%, availability for the wild *Helianthus* species increased to 55%.

Regeneration activities for 2002 are summarized in Table 2. Greater emphasis continues to be placed on obtaining seed increases from perennial *Helianthus* species. In 2002, 25 perennial accessions were caged and insect pollinated in comparison to the 17 perennial accessions that were caged in 2001.

Twenty accessions of two annual *Helianthus* species and ten perennial *Helianthus* species were sent to the National Arid Land Plant Genetic Resources Unit (NALPGRU) in Parlier, California for regeneration purposes. Accessions of annual species will be caged for regeneration the summer of 2003 and the perennial species will be caged beginning 2004. We anticipate having 20 large pollination cages available for regeneration on a yearly basis.
As accessions are regenerated, we continue to send samples to NCGRP for back-up. Nearly the entire flax collection is duplicated at NCGRP, as well as 93 percent of the cultivated *Helianthus* collection, 60 percent of the wild *Helianthus* collection, and 23 percent of the miscellaneous asters (Table 2).

In 2002, 831 germination tests were conducted, including scheduled five-year tests and initial germination tests on new inventory lots (Table 2).

A pollinator study conducted in cooperation with the Entomology team was repeated in 2002 to test the effectiveness of various *Helianthus* pollinators.

Distribution:
The packet and accession distribution summaries for the miscellaneous asters, flax and *Helianthus* germplasm collections are provided in Table 3. In 2002, as in 2001, the majority of *Helianthus* germplasm packets (88%) were sent to requestors outside the United States.

Year 2002 requests for sunflower and flax germplasm decreased as compared to 2001. The distribution history for the miscellaneous asters, flax, and *Helianthus* germplasm collections is provided in the following table.

Crop	Calendar Year	No. of Orders	No. of Recipients	No. of Items Distributed	No. of Acc. Distributed
Misc. Asters	1998	8	7	132	67
	1999	8	8	15	14
	2000	8	8	87	40
	2001	6	5	10	7
	2002	8	6	15	11
Flax	1998	8	7	66	62
	1999	14	13	297	259
	2000	8	8	120	118
	2001	14	14	268	223
	2002	8	8	73	63
Cult. *Helianthus*	1998	43	31	1855	916
	1999	55	39	2114	1095
	2000	28	27	884	740
	2001	46	33	1500	766
	2002	47	39	628	458
Wild *Helianthus*	1998	28	22	547	426
	1999	35	29	704	448
	2000	21	15	820	588
	2001	36	29	1322	879
	2002	34	21	808	652

Characterization/taxonomy:
Plant and achene data were recorded for *Helianthus* increases, and plant data were recorded for flax increases (Table 4). In 2002, we captured 186 digital images of *Helianthus* seed (Table 4). These digital images remain to be loaded into GRIN.

Allele frequencies were calculated for the 112-accession cultivated sunflower core subset and a randomly selected array of 112 accessions. Information will be added to GRIN after CGC approval.

Evaluation/Utilization:
In 2002, *Helianthus* seed was distributed for evaluation of host-plant resistance to downy mildew, rust, *Sclerotinia*, sunflower moth, banded sunflower moth, red sunflower seed weevil, and sunflower stem weevil.

Enhancement:
C. Block continued an enhancement program to develop wild *H. annuus* populations resistant to *Alternaria helianthi*, *Septoria helianthi*, and powdery mildew.

Future Plans:
In cooperation with the entomology project, we will establish a planting of cultivated and wild *Helianthus* species to observe native pollinator activity.

Emphasis will continue to be placed on obtaining seed increases from accessions planted in our perennial *Helianthus* plots.

i. *Cuphea* and *Euphorbia* (J. W. Van Roekel)

Cuphea

Acquisition:

No new *Cuphea* accessions were added to the collection in 2002 (Table 1). However, two accessions were acquired for evaluation and potential incorporation into the *Cuphea* collection.

Maintenance:

Late 2002, M. Brothers began assuming curatorial responsibility for the *Cuphea* collection. Sixteen accessions are maintained in a greenhouse at the station headquarters because they are sterile or have not had successful seed regenerations. Duplicate plantings for most of these accessions are maintained in an Iowa State University campus greenhouse and at the Ornamental Plant Germplasm Center (OPGC) in Columbus, Ohio. All accessions maintained at the station headquarters were photographed, inventoried, and propagated by cuttings when appropriate.

Two accessions were increased during the summer to provide seed for NCGRP experimental purposes. Three accessions are currently being regenerated in the greenhouse and harvested seed will be used in a seed moisture study.

Distribution:

The 2002 *Cuphea* distribution is summarized in Table 3. The distribution history for the last five years is provided in the table that follows.

Crop	Calendar Year	No. of Orders	No. of Recipients	No. of Items Distributed	No. of Acc. Distributed
Cuphea	1998	6	5	25	18
	1999	12	11	110	98
	2000	10	8	122	89
	2001	16	12	713	498
	2002	12	9	255	222

Future Plans:

Dr. B. Roath and J.W. Van Roekel assembled a collection of slides depicting plant and flower traits for *Cuphea* accessions. These slides will be scanned and the images linked to the accession information on GRIN. This approach prevents further degradation of the images and also makes them more accessible for use.

A study will be initiated in cooperation with S. Duvick, GEM Quality Traits Lab, to determine if NIR technology can accurately measure seed moisture in *Cuphea*.

Regeneration efforts for this growing season will be considered based on viability, seed availability, and resources available for the coming season.

Euphorbia

Acquisition:

One new accession of *Euphorbia* was added to the collection in 2002. (Table 1)

Maintenance:

Regeneration was limited in 2002 to harvesting existing plants in the greenhouse and to vernalizing some accessions to induce flowering and seed production. Four accessions were grown outside after vernalization, with some seed harvested from three accessions.

Distribution:

Distributions for *Euphorbia* are included in Table 3. The distribution history for the last five years is provided in the table that follows.

Crop	Calendar Year	No. of Orders	No. of Recipients	No. of Items	No. of Accessions
Euphorbia	1998	0	0	0	0
	1999	2	2	2	2
	2000	3	3	37	37
	2001	1	1	1	1
	2002	4	4	8	6

Characterization/taxonomy:

None.

Evaluation/Enhancement:

None.

Future Plans:

At this time, regeneration efforts will be limited to using vernalization to induce flowering of greenhouse plants. These will be harvested as appropriate.

Year 2002	Table 2	# NCRPIS Accessions (Accs) Germed, # 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 Vegetative Harvested	Number Accs Made Available	Number Accs Growing
Brenner	NC7-amaranth	3,327	304	9	39	30	0	0	79	
	NC7-celosia	54	1	2	2	2	0	0	0	
	NC7-legumes	231	0	0	1	1	0	0	0	
	NC7-melilotus	924	276	30	10	16	0	0	1	
	NC7-perilla	22	4	18	2	1	0	0	0	
	NC7-quinoa	231	1	0	70	56	0	0	1	
	NC7-spinach	401	33	8	31	32	0	0	22	
	NC7-umbels	1,018	88	9	177	100	0	0	51	
	Total:	**6,208**	**707**	**11**	**332**	**238**	**0**	**0**	**154**	
Brothers	NC7-asters	318	0	0	3	1	0	0	11	
	NC7-flax	2,807	262	9	114	109	0	0	84	
	NC7-sun.cults	1,670	274	16	95	96	0	0	44	
	NC7-sun.wilds	2,151	295	14	112	98	8	0	102	12
	Total:	**6,946**	**831**	**12**	**324**	**304**	**8**	**0**	**241**	**12**
Luhman	NC7-brassica	1,989	145	7	10	36	0	0	68	
	NC7-crucifers	1,135	5	0	62	59	0	0	20	
	NC7-echinochloa	269	5	2	0	1	0	0	3	
	NC7-flax.wilds	160	0	0	39	56	0	0	0	
	NC7-grasses	117	0	0	0	0	0	0	0	
	NC7-panicum	968	165	17	0	1	0	0	6	
	NC7-setaria	995	16	2	0	1	0	0	5	
	Total:	**5,633**	**336**	**6**	**111**	**154**	**0**	**0**	**102**	
Millard	NC7-corn.kin	34	1	3	1	1	0	0	1	
	NC7-maize	18,057	4,140	23	394	365	0	0	461	
	Total:	**18,091**	**4,141**	**23**	**395**	**366**	**0**	**0**	**462**	
Reitsma	NC7-chicory	249	0	0	0	0	0	0	0	
	NC7-cucumis.cucs	1,349	42	3	31	28	0	0	42	
	NC7-cucumis.melo	3,097	66	2	48	47	0	0	62	
	NC7-cucumis.wilds	328	9	3	12	15	0	0	9	
	NC7-cucurbita	988	19	2	32	23	0	0	16	
	NC7-cucurbits.misc	2	0	0	1	1	0	0	0	
	NC7-daucus	1,060	113	11	41	46	0	0	97	
	NC7-ocimum	96	0	0	0	2	0	0	0	
	NC7-parsnips	71	0	0	0	15	0	0	0	
	Total:	**7,240**	**249**	**3**	**165**	**177**	**0**	**0**	**226**	
VanRoekel	NC7-cuphea	649	1	0	3	0	0	0	1	1
	NC7-euphorbia	218	0	0	0	4	0	0	0	
	Total:	**867**	**1**	**0**	**3**	**4**	**0**	**0**	**1**	**1**
Widrlechner	NC7-mints	121	7	6	2	9	0	0	7	
	NC7-ornamentals	2,006	148	7	64	87	36	0	63	

	Total:	**2,127**	**155**	**7**	**66**	**96**	**36**	**0**	**70**	
NCRPIS Total:		47,112	6,420	14	1,396	1,339	44	0	1,256	14

Year 2002 Table 3 # NCRPIS Accessions (Accs) Distributed, # Orders, # Recipients

CURATOR	GENUS CROP	Number Accs	Number Items Dist Domestic	Number Items Dist Foreign	Number Accs Dist Domestic	Number Accs Dist Foreign	Number Accs Dist Total	Percent Accs Dist	Number Orders	R
Brenner	NC7-amaranth	3,327	245	213	163	132	235	7	44	
	NC7-celosia	54	8	1	6	1	7	13	7	
	NC7-legumes	231	20	49	18	34	50	22	7	
	NC7-melilotus	924	32	11	32	11	42	5	5	
	NC7-perilla	22	26	0	22	0	22	100	4	
	NC7-quinoa	231	160	173	136	101	161	70	23	
	NC7-spinach	401	676	91	362	82	362	90	12	
	NC7-umbels	1,018	262	43	177	43	213	21	25	
	Total:	**6,208**	**1,429**	**581**	**916**	**404**	**1,092**	**18**	**127**	
Brothers	NC7-asters	318	14	1	11	1	11	3	8	
	NC7-flax	2,807	51	22	51	16	63	2	8	
	NC7-sun.cults	1,670	475	153	373	139	458	27	47	
	NC7-sun.wilds	2,151	868	30	647	29	652	30	34	
	Total:	**6,946**	**1,408**	**206**	**1,082**	**185**	**1,184**	**17**	**97**	
Luhman	NC7-brassica	1,989	1,023	102	895	74	932	47	52	
	NC7-crucifers	1,135	111	130	100	126	212	19	24	
	NC7-echinochloa	269	2	3	2	3	5	2	4	
	NC7-flax.wilds	160	18	0	12	0	12	8	2	
	NC7-grasses	117	1	0	1	0	1	1	1	
	NC7-panicum	968	1	8	1	8	9	1	2	
	NC7-setaria	995	33	15	29	15	43	4	9	
	Total:	**5,633**	**1,189**	**258**	**1,040**	**226**	**1,214**	**22**	**94**	
Millard	NC7-corn.kin	34	16	0	7	0	7	21	5	
	NC7-maize	18,057	6,833	457	3,932	377	4,006	22	426	
	Total:	**18,091**	**6,849**	**457**	**3,939**	**377**	**4,013**	**22**	**431**	
Reitsma	NC7-chicory	249	105	156	100	134	134	54	8	
	NC7-cucumis.cucs	1,349	1,557	457	1,167	386	1,196	89	26	
	NC7-cucumis.melo	3,097	358	504	338	445	663	21	35	
	NC7-cucumis.wilds	328	173	40	78	31	79	24	12	
	NC7-cucurbita	988	121	44	103	40	132	13	20	
	NC7-cucurbits.misc	2	0	0	0	0	0	0	0	
	NC7-daucus	1,060	34	41	33	37	67	6	11	
	NC7-ocimum	96	7	13	7	13	18	19	8	
	NC7-parsnips	71	1	8	1	8	8	11	2	
	Total:	**7,240**	**2,356**	**1,263**	**1,827**	**1,094**	**2,297**	**32**	**122**	
VanRoekel	NC7-cuphea	649	216	39	192	39	222	34	12	
	NC7-euphorbia	218	5	3	5	3	6	3	4	
	Total:	**867**	**221**	**42**	**197**	**42**	**228**	**26**	**16**	
Widrlechner	NC7-mints	121	18	4	18	4	19	16	4	

NC7-ornamentals	2,006	538	241	222	215	361	18	103
Total:	**2,127**	**556**	**245**	**240**	**219**	**380**	**18**	**107**
NCRPIS Total:	**47,112**	**14,008**	**3,052**	**9,241**	**2,547**	**10,408**	**22**	**880**

Year 2002 **Table 4** **# NCRPIS Accessions (Accs) Obs in GRIN, # Images in GRIN**

CURATOR	GENUS CROP	Number Accs	Number Accs Obs Trials	Number Acc Obs by Curator	Number Obs in GRIN for Yr	Number Acc Obs in GRIN for Yr	Number Acc Obs in GRIN Last Yr	Number Acc Obs in GRIN (all yrs)	Number Acc Images Recorded
Brenner									
	NC7-amaranth	3,327	129		1,635	483	25	3,283	47
	NC7-celosia	54	1		1	1	0	3	2
	NC7-legumes	231	0		0	0	0	84	2
	NC7-melilotus	924	0		2,939	913	0	913	13
	NC7-perilla	22	0		0	0	0	0	2
	NC7-quinoa	231	0		2	2	229	229	56
	NC7-spinach	401	0		1,709	401	0	401	338
	NC7-umbels	1,018	11		1	1	0	3	118
	Total:	**6,208**	**141**		**6,287**	**1,801**	**254**	**4,916**	**578**
Brothers									
	NC7-asters	318	1		0	0	0	4	0
	NC7-flax	2,807	0		0	0	105	2,804	0
	NC7-sun.cults	1,670	63		2,763	148	999	1,615	74
	NC7-sun.wilds	2,151	8		3,019	192	560	1,725	112
	Total:	**6,946**	**72**		**5,782**	**340**	**1,664**	**6,148**	**186**
Luhman									
	NC7-brassica	1,989	598		765	152	37	1,604	200
	NC7-crucifers	1,135	0		30	6	60	392	75
	NC7-echinochloa	269	0		0	0	0	10	0
	NC7-flax.wilds	160	0		0	0	0	2	0
	NC7-grasses	117	0		0	0	0	1	0
	NC7-panicum	968	0		0	0	0	0	0
	NC7-setaria	995	0		0	0	0	74	0
	Total:	**5,633**	**598**		**795**	**158**	**97**	**2,083**	**275**
Millard	NC7-corn.kin	34	0		0	0	0	0	1
	NC7-maize	18,057	2,068		13,048	3,040	5,465	14,852	3,323
	Total:	**18,091**	**2,068**		**13,048**	**3,040**	**5,465**	**14,852**	**3,324**
Reitsma									
	NC7-chicory	249	0		530	249	0	249	0
	NC7-cucumis.cucs	1,349	206	312	4,273	1,345	0	1,345	20
	NC7-cucumis.melo	3,097	0	736	7,509	3,088	0	3,089	42
	NC7-cucumis.wilds	328	0	289	0	0	0	292	15
	NC7-cucurbita	988	0	276	2,615	981	0	981	16
	NC7-cucurbits.misc	2	0		0	0	0	1	1
	NC7-daucus	1,060	0		2,532	1,045	0	1,045	24
	NC7-ocimum	96	2		0	0	0	0	0
	NC7-parsnips	71	0		0	0	0	0	0
	Total:	**7,240**	**208**	**1,613**	**17,459**	**6,708**	**0**	**7,002**	**118**
VanRoekel									
	NC7-cuphea	649	8		0	0	0	326	0

	NC7-euphorbia	218	0		0	0	0	0	0
	Total:	**867**	**8**		**0**	**0**	**0**	**326**	**0**
Widrlechner									
	NC7-mints	121	0		0	0	0	0	0
	NC7-ornamentals	2,006	13		80	8	0	31	47
	Total:	**2,127**	**13**		**80**	**8**	**0**	**31**	**47**
NCRPIS Total:		**47,112**	**3,108**	**1,613**	**43,451**	**12,055**	**7,480**	**35,358**	**4,528**

Year 2002 **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	01/01/1998 - 12/31/1998	63	57	2,746	1,782
		01/01/1999 - 12/31/1999	62	50	3,682	2,483
		01/01/2000 - 12/31/2000	44	37	860	451
		01/01/2001 - 12/31/2001	51	37	985	604
		01/01/2002 - 12/31/2002	44	34	458	235
	Total:		264	215	8,731	5,555
	NC7-celosia	01/01/1998 - 12/31/1998	2	2	6	5
		01/01/1999 - 12/31/1999	3	3	24	17
		01/01/2000 - 12/31/2000	6	6	11	8
		01/01/2001 - 12/31/2001	2	2	12	11
		01/01/2002 - 12/31/2002	7	7	9	7
	Total:		20	20	62	48
	NC7-legumes	01/01/1998 - 12/31/1998	6	5	34	16
		01/01/1999 - 12/31/1999	4	4	32	32
		01/01/2000 - 12/31/2000	7	7	16	13
		01/01/2001 - 12/31/2001	4	4	7	7
		01/01/2002 - 12/31/2002	7	5	69	50
	Total:		28	25	158	118
	NC7-melilotus	01/01/1998 - 12/31/1998	11	9	213	154
		01/01/1999 - 12/31/1999	9	9	287	254
		01/01/2000 - 12/31/2000	16	12	712	554
		01/01/2001 - 12/31/2001	13	11	57	49
		01/01/2002 - 12/31/2002	5	5	43	42
	Total:		54	46	1,312	1,053
	NC7-perilla	01/01/1998 - 12/31/1998	1	1	3	3
		01/01/1999 - 12/31/1999	4	4	61	20
		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
	Total:		22	22	172	88
	NC7-quinoa	01/01/1998 - 12/31/1998	13	12	121	92
		01/01/1999 - 12/31/1999	10	10	294	163
		01/01/2000 - 12/31/2000	21	19	342	149
		01/01/2001 - 12/31/2001	18	15	239	173
		01/01/2002 - 12/31/2002	23	22	333	161
	Total:		85	78	1,329	738
	NC7-spinach	01/01/1998 - 12/31/1998	13	11	1,395	309
		01/01/1999 - 12/31/1999	11	10	1,061	332
		01/01/2000 - 12/31/2000	7	7	670	348
		01/01/2001 - 12/31/2001	12	11	1,736	354
		01/01/2002 - 12/31/2002	12	11	767	362
	Total:		55	50	5,629	1,705
	NC7-umbels	01/01/1998 - 12/31/1998	9	9	127	116
		01/01/1999 - 12/31/1999	14	13	174	111
		01/01/2000 - 12/31/2000	11	11	136	117
		01/01/2001 - 12/31/2001	15	13	105	94

		01/01/2002 - 12/31/2002	25	20	305	213
	Total:		74	66	847	651
	Brenner Total:		**602**	**522**	**18,240**	**9,956**
Brothers						
	NC7-asters	01/01/1998 - 12/31/1998	8	7	132	67
		01/01/1999 - 12/31/1999	8	8	15	14
		01/01/2000 - 12/31/2000	8	8	87	40
		01/01/2001 - 12/31/2001	6	5	10	7
		01/01/2002 - 12/31/2002	8	6	15	11
	Total:		**38**	**34**	**259**	**139**
	NC7-flax	01/01/1998 - 12/31/1998	8	7	66	62
		01/01/1999 - 12/31/1999	14	13	297	259
		01/01/2000 - 12/31/2000	8	8	120	118
		01/01/2001 - 12/31/2001	14	14	268	223
		01/01/2002 - 12/31/2002	8	8	73	63
	Total:		**52**	**50**	**824**	**725**
	NC7-sun.cults	01/01/1998 - 12/31/1998	43	31	1,855	916
		01/01/1999 - 12/31/1999	55	39	2,114	1,095
		01/01/2000 - 12/31/2000	28	27	887	740
		01/01/2001 - 12/31/2001	46	33	1,500	766
		01/01/2002 - 12/31/2002	47	39	628	458
	Total:		**219**	**169**	**6,984**	**3,975**
	NC7-sun.wilds	01/01/1998 - 12/31/1998	28	22	547	426
		01/01/1999 - 12/31/1999	35	29	704	448
		01/01/2000 - 12/31/2000	21	15	820	588
		01/01/2001 - 12/31/2001	37	30	1,323	880
		01/01/2002 - 12/31/2002	34	21	898	652
	Total:		155	117	4,292	2,994
	Brothers Total:		**464**	**370**	**12,359**	**7,833**
Luhman						
	NC7-brassica	01/01/1998 - 12/31/1998	36	32	1,554	1,198
		01/01/1999 - 12/31/1999	52	46	2,172	1,119
		01/01/2000 - 12/31/2000	69	56	1,238	856
		01/01/2001 - 12/31/2001	35	32	460	408
		01/01/2002 - 12/31/2002	52	48	1,125	932
	Total:		244	214	6,549	4,513
	NC7-crucifers	01/01/1998 - 12/31/1998	18	17	403	303
		01/01/1999 - 12/31/1999	15	13	299	227
		01/01/2000 - 12/31/2000	16	15	72	66
		01/01/2001 - 12/31/2001	22	18	640	268
		01/01/2002 - 12/31/2002	24	23	241	212
	Total:		95	86	1,655	1,076
	NC7-echinochloa	01/01/1998 - 12/31/1998	8	7	52	46
		01/01/1999 - 12/31/1999	2	2	9	8
		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
	Total:		23	21	268	241
	NC7-flax.wilds	01/01/1998 - 12/31/1998	2	2	19	19
		01/01/1999 - 12/31/1999	3	3	26	16
		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
	Total:		9	9	85	66
	NC7-grasses	01/01/1998 - 12/31/1998	3	3	11	9
		01/01/1999 - 12/31/1999	1	1	1	1
		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
	Total:		8	8	20	17
	NC7-panicum	01/01/1998 - 12/31/1998	7	7	34	34
		01/01/1999 - 12/31/1999	2	2	7	7
		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
	Total:		28	27	770	749
	NC7-setaria	01/01/1998 - 12/31/1998	7	7	57	51
		01/01/1999 - 12/31/1999	7	6	27	26
		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
	Total:		42	39	947	896
	Luhman Total:		**449**	**404**	**10,294**	**7,558**
Millard	NC7-corn.kin	01/01/1998 - 12/31/1998	11	10	23	7
		01/01/1999 - 12/31/1999	8	8	19	6
		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
	Total:		40	39	91	34
	NC7-maize	01/01/1998 - 12/31/1998	177	137	3,288	2,180
		01/01/1999 - 12/31/1999	231	167	4,536	2,805
		01/01/2000 - 12/31/2000	257	193	18,480	10,981
		01/01/2001 - 12/31/2001	313	210	7,269	4,637
		01/01/2002 - 12/31/2002	426	285	7,290	4,006
	Total:		1,404	992	40,863	24,609
	Millard Total:		**1,444**	**1,031**	**40,954**	**24,643**
Reitsma						
	NC7-chicory	01/01/1998 - 12/31/1998	4	4	76	39
		01/01/1999 - 12/31/1999	6	5	123	115
		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
	Total:		29	28	800	515
	NC7-cucumis	01/01/1998 - 12/31/1998	49	40	1,583	994
		01/01/1999 - 12/31/1999	54	46	3,063	2,083
		01/01/2000 - 12/31/2000	60	45	1,555	1,235
		01/01/2001 - 12/31/2001	59	49	1,229	933
		01/01/2002 - 12/31/2002	60	48	3,089	1,938
	Total:		282	228	10,519	7,183
	NC7-cucurbita	01/01/1998 - 12/31/1998	15	15	114	98
		01/01/1999 - 12/31/1999	16	15	170	137

		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
	Total:		92	85	1,194	886
	NC7-cucurbits.misc	01/01/1998 - 12/31/1998	1	1	1	1
		01/01/1999 - 12/31/1999	2	2	2	1
		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
	Total:		5	5	5	3
	NC7-daucus	01/01/1998 - 12/31/1998	19	16	922	525
		01/01/1999 - 12/31/1999	20	16	463	313
		01/01/2000 - 12/31/2000	11	11	176	174
		01/01/2001 - 12/31/2001	13	12	235	211
		01/01/2002 - 12/31/2002	11	11	75	67
	Total:		74	66	1,871	1,290
	NC7-ocimum	01/01/1998 - 12/31/1998	7	7	211	70
		01/01/1999 - 12/31/1999	7	7	206	88
		01/01/2000 - 12/31/2000	7	7	245	75
		01/01/2001 - 12/31/2001	5	5	97	79
		01/01/2002 - 12/31/2002	8	8	20	18
	Total:		34	34	779	330
	NC7-parsnips	01/01/1998 - 12/31/1998	0	0	0	0
		01/01/1999 - 12/31/1999	2	2	8	8
		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
	Total:		4	4	17	16
	Reitsma Total:		**520**	**450**	**15,185**	**10,223**
VanRoekel						
	NC7-cuphea	01/01/1998 - 12/31/1998	6	5	25	18
		01/01/1999 - 12/31/1999	12	11	110	98
		01/01/2000 - 12/31/2000	10	8	122	89
		01/01/2001 - 12/31/2001	16	12	713	482
		01/01/2002 - 12/31/2002	12	9	255	222
	Total:		56	45	1,225	909
	NC7-euphorbia	01/01/1998 - 12/31/1998	0	0	0	0
		01/01/1999 - 12/31/1999	2	2	2	2
		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
	Total:		10	10	48	46
	VanRoekel Total:		**66**	**55**	**1,273**	**955**
Widrlechner						
	NC7-mints	01/01/1998 - 12/31/1998	10	10	85	47
		01/01/1999 - 12/31/1999	3	3	8	8
		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
	Total:		25	25	227	151
	NC7-ornamentals	01/01/1998 - 12/31/1998	87	80	475	193

	01/01/1999 - 12/31/1999	84	77	561	222
	01/01/2000 - 12/31/2000	76	72	496	216
	01/01/2001 - 12/31/2001	83	77	740	230
	01/01/2002 - 12/31/2002	103	89	779	361
Total:		433	395	3,051	1,222
Widrlechner Total:		**458**	**420**	**3,278**	**1,373**
Totals by Year	01/01/1998 - 12/31/1998	**672**	**573**	**16,178**	**9,780**
	01/01/1999 - 12/31/1999	**758**	**626**	**20,557**	**12,518**
	01/01/2000 - 12/31/2000	**755**	**632**	**28,708**	**18,288**
	01/01/2001 - 12/31/2001	**837**	**661**	**19,080**	**11,547**
	01/01/2002 - 12/31/2002	**981**	**760**	**17,060**	**10,408**
		4,003	**3,252**	**101,583**	**62,541**
NCRPIS Total:		**4,003**	**3,252**	**101,583**	**62,541**