ANNUAL REPORT FOR CALENDAR YEAR 2011
USDA ARS
National Clonal Germplasm Repository

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Joseph Postman, Plant Pathologist/Pear Curator
Barbara Reed, Research Plant Physiologist
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Dennis Vandeveer, Facilities Manager

daVinci Days fair goers stop by at the USDA ARS booth, 17 July 2011 for information. Bruce Bartlett answers their questions.

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Charles Hand, GRA, OSU, Hort.
Megan Mathey, GRA, OSU, Hort.
Wambui Njuguna, GRA, OSU, Hort.
Sukalya Poothong, GRA, OSU, Hort.
Fenghui Song, Visiting Scientist/China
Sugae Wada, Post Doc. OSU

Collaborator
Francis J. Lawrence
Maxine Thompson
Melvin Westwood

USDA ARS NCGR Corvallis, 33447 Peoria Road, Corvallis, Oregon

Kim Hummer, RL; Barbara Reed, Plant Physiologist; Joseph Postman Curator; Nahla Bassil, Geneticist

Annual Accomplishments for FY 2011

Stakeholder/Service

- More than 10,000 accessions of temperate fruit, nut, and specialty crops were conserved.
- More than 670 plant requests were processed and 7420 items were shipped in 2011.
- Organized the Society for Cryobiology meeting in Corvallis, July 2011; 155 attendees.
- NCGR staff hosted an open house with the City of Corvallis da Vinci Days Festival on 15-17 July 2011. About 55 people toured the blueberry field. More than 200 festival attendees toured our booth at the da Vinci Days Festival in town.
- NCGR staff member presented talks on "Accidental Making of a Researcher" at 'Discovering the Scientist Within', a Science and Engineering Workshop for Middle School Girls organized by OSU-February 12, 2011; >100 attendees.
- Participated on the 5 member Governing Board for USDA APHIS National Clean Plant Network.
- NCGR scientists collaborated with those at NCGRP, Ft. Collins, CO, on the evaluation of dormant hazelnut, pear, and currant shoots to determine cryopreservation protocols.
- Developed a seed identification manual to distinguish 17 commonly grown blackberry cultivars. http://ir.library.oregonstate.edu/jspui/bitstream/1957/16304/1/em9002.pdf

Research Accomplishment

- Discovered a new species of strawberry (with 10 sets of chromosomes) native to the Oregon High Cascade Mountains; named the species: *Fragaria cascadensis* Hummer.
- Determined that highbush ohelo (blueberry relative from Hawaii) has about 1 to 2 x the amount of proanthocyanadin type A oligomers (constituent active in reducing urinary tract disorders) as compared to cranberry.
- Improved initiation of pears and hazelnuts into tissue culture using grafted plants; improved growth medium for these plants.
- Identified several internal bacterial contaminants of hazelnut tissue cultures.
- Identified 22 very cold-hardy quince to be evaluated further for potential as productive, dwarfing pear rootstocks.
- Developed a set of red raspberry SSRs for fingerprinting red raspberry.
- Finished phylogenetic analysis of chloroplast genome sequences of 21 *Fragaria* species and subspecies which identified the western North American diploid *F. vesca* ssp. *bracteata* as the most likely chloroplast donor to the octoploids.
- Examined genetic diversity in 148 wild and cultivated black raspberry accessions using 21 SSR markers which indicated that wild black raspberry germplasm is a relatively untapped resource available for future breeding.
- NCGR staff members organized and participated in a two week germplasm expedition to Albania to collect diverse fruit and nut genetic resources
- Completed 2nd year of a 3 year tree rejuvenation effort of pear and hazelnut field collections.

Administrative Overview

Staffing Changes

The FY 2010 year for Agricultural Research Service was fraught with financial uncertainty. It began with the announcement of potential reduction in funding, and finished with the closure of 10 stations including our sister repository, the Palmer Arctic and Subarctic Plant Gene Bank. Some staff members resigned and took positions outside the agency. Permanent staff remaining at the time of the closure were given directed reassignments to other ARS locations around the country. Dr. Dan Barney was assigned to a Curator position in Ames, Iowa, under the direction of Dr. Candy Gardner. Dr. Nancy Robertson was assigned to a Research Virology position in Salinas, California, under the direction of Dr. Jim McCreight. The plant germplasm collections were distributed to other units. The Palmer equipment was surplused. The Palmer facilities were given to our on-site land owner and cooperator, University of Alaska, Fairbanks. We wish both these scientists the very best as they begin their new careers at other ARS units.

Dr. Dan Barney, former Curator at Palmer, Akaska, now assigned to Ames, Iowa.

Dr. Nancy Robertson, former Virologist at Palmer, Alaska, now assigned to Salinas, California

Dr. Barbara Gilmore, Geneticist for Palmer, Alaska, now assigned to Corvallis, Oregon.

Dr. Barb Gilmore, Post Doctoral Geneticist, worked for Palmer, Alaska, on determining fingerprints using simple sequence repeat markers for rhubarb and peonies. She has been transferred to Corvallis for a term position to finish those projects and begin molecular analysis of black raspberry.

Corvallis has resumed the responsibility for germplasm of *Ribes*, *Mentha*, and *Pycnanthemum*. The W6 Regional Plant Introduction Station at Pullman, Washington resumed the curatorial responsibility for *Rheum*. *Paeonia* was not reassigned or designated to another genebank at this time.

Plant materials that were lodged at Palmer have been transferred to NCGR-Corvallis, W6 Plant Introduction Station at Pullman, Washington, or the Alaska Plant Materials Center, Palmer, AK.

EEO/CR/Outreach

• Through a Research Support Agreement with Oregon State University one female and two male graduate students were trained. During the winter, 15 disabled high school students (program was funded through local school district grant) were trained in greenhouse management activities.
• During the winter an additional 3 disabled individuals from a local private organization (Work Unlimited) were trained in strawberry greenhouse activities.
• A return-to-work candidate was trained in conjunction with Oregon Vocational Rehabilitation.

Budget and Fiscal

Our base funding for Corvallis has remained at about $1.4 million since 2004. The combination of the two units, Corvallis and Palmer provided an increase in FTE. With the closure of Palmer that FTE will decrease back to about 13 FTE. The only flexibility in the budget is about $40k of seasonal workers. Increased costs without an increase in base funding could force reduction of those workers. As long-time employees retire, the unit may consider attrition to meet fund limits.

Our scientists have had success in obtaining supplemental non-base funding from new grants, such as the CSREES Specialty Crop Research Initiative. One SCRI grant finished (Ohelo project) and a new one was initiated (black raspberry genetics).

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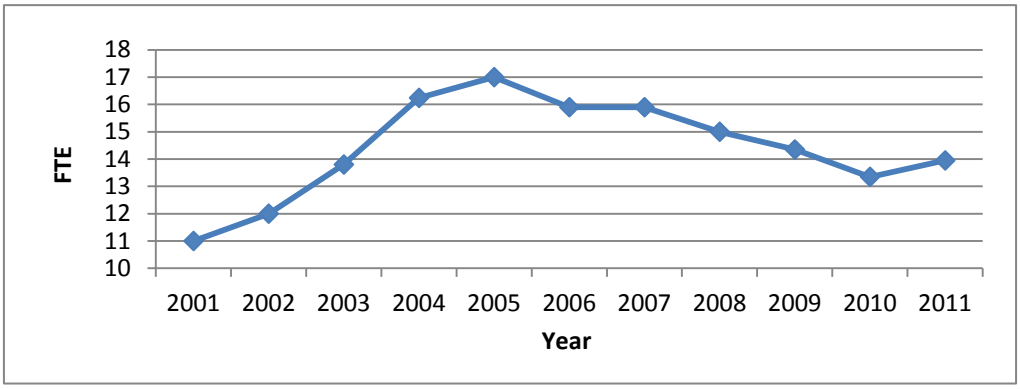
Federal Staffing



View from the Front Office

The sharp closure of the 10 locations in ARS brought clarity to our mind. We have entered a period of limited federal base funding for research in the United States. We scientists must determine how we can supplement our budget to accomplish the invaluable storage of plant genetic resources and the associated research. Each of us at the facility is reexamining how to do business. We have always been careful with our resources. Lights not in use are turned off. Paper and toner use must be reduced as we depend more on electronic media. Little details have become important. While germplasm will be provided and is being shipped in large quantities, more shipping costs and fees will be borne by requestors. All this is happening while administrative costs for security and safety are increasing. Collaborations with academic and industry partners will become more in vogue for all aspects of our operations. Perhaps permission will be granted for the establishment of foundation organizations for financial support of genetic resource preservation – beyond federal base funding. This would be a new concept in the operation of federal facilities. Despite these details we will keep the protection of our germplasm as our highest

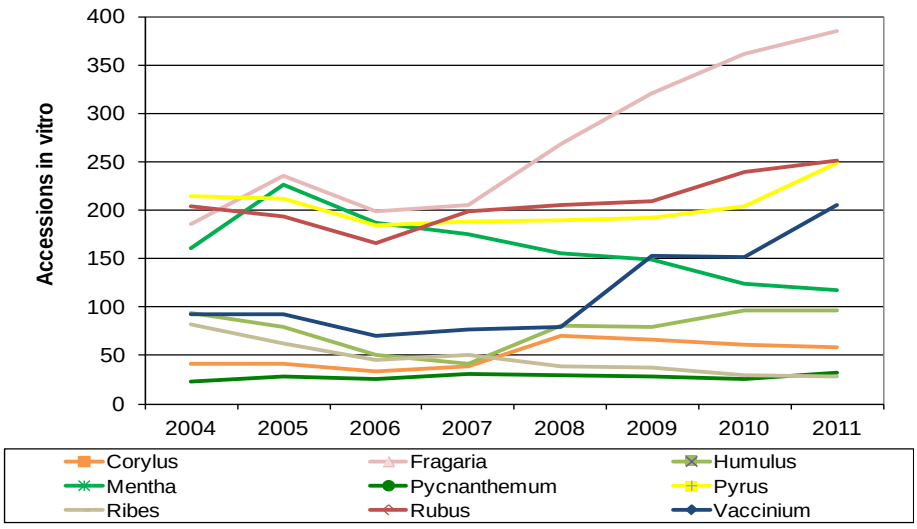
priority. Other less essential operations will be suspended until the funding climate turns around again. Tough financial times will be with us for a while.

Tissue Culture and Cryopreservation

By Barbara M. Reed and Jeanine DeNoma

The *In-Vitro* Collection

The *in-vitro* collection contains mostly the core and other highly requested accessions. Technician Jeanine DeNoma and helpers collected new accessions as plants were available. The spring and summer explanting season resulted in many accessions successfully initiated into culture and cold stored. By December 2011, 1423 accessions were in culture and most were in storage. We received the *Mentha* collection back from Palmer, AK. A graph of the tissue culture collections from 2004 to present are shown below. The size of each collection fluctuates over time depending on priorities for distribution and what plants are available for collecting in a particular year. In 2011 we instituted use of our improved pear medium for initiation of new accessions and found that the initiation rate increased from ~43% to ~82%. Pears that would not grow on the standard medium are now doing well on this new medium, both for initiation and for multiplication.



Storage experiments with the new medium are in progress. We try to have all accessions be free of bacteria and fungi. If any are found contaminated, they are discarded and recollected. The *Corylus* collection is gradually being reinitiated and carefully screened to provide more bacteria-free cultures.

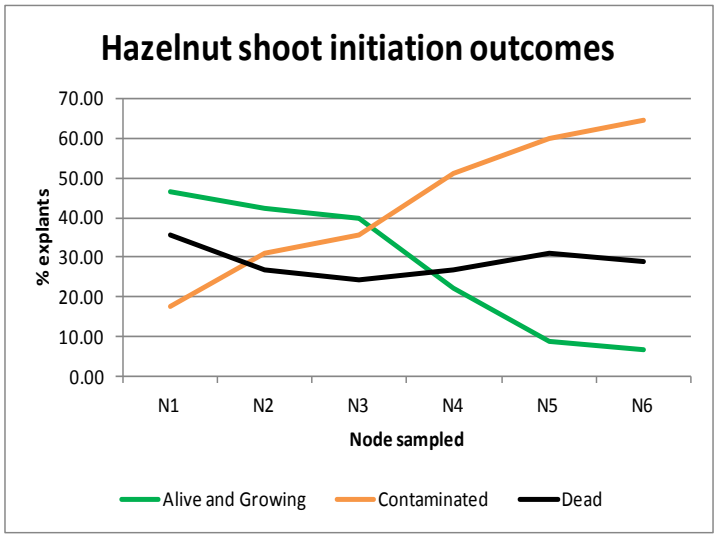
Medium Optimization for *Pyrus*

We finalized the pear medium optimization experiments initiated with grants from the Oregon Association of Nurseries and the Oregon Department of Agriculture**.** This project produced a wealth of data for improving pear micropropagation and manuscripts are in progress. The mineral nutrition greatly influenced plant appearance, shoot initiation, and elongation of pear. In 2008 we tested the overall mineral nutrients and found that meso elements (calcium, magnesium, phosphorous and potassium), iron and nitrogen were driving factors for many growth attributes. In 2009 we optimized the meso elements for 17 pear accessions and used this to provide an improved medium for the *in vitro* pear collection. In 2010 we determined the nitrogen ratios important for overall quality, shoot number and shoot length. When nitrogen compounds were tested in medium with the increased meso elements, low nitrogen produced more shoots on most genotypes, but also increased callus production and physiological disorders on some. The best concentrations of ammonium, potassium and nitrate varied with the cultivar but were less

important when the meso elements were increased. Iron concentrations in the medium were optimum for most pears at 1 to 1.25X MS levels. In 2011 we concluded the project with finalizing medium formulations and testing for rooting. We also began a project in 2011 to study dwarfing pear rootstock selections and cultivars and to optimize the medium for these important accessions. Dwarfing rootstocks are by nature short and slow growing so they provide some additional challenges for culture. The California Pear Board and the Washington Tree Fruit Commission (Pear section) are funding Dr. Reed and Dr. Sugae Wada (OSU Dept of Horticulture) for this project for 2011.

Corylus Culture

Graduate student Chip Hand is pursuing a MS project with funding from the Oregon Hazelnut Commission. We are developing improved *Corylus in vitro* culture medium using methodology similar to our pear studies, determining methods for initiating clean cultures and identifying some common bacterial contaminants. This study involves culture of advanced selections from the OSU hazelnut breeding program as well as named cultivars. The response of hazelnuts to mineral nutrients is quite different from the pears; we are seeing a greater diversity of optimal mineral combinations. It is likely that at least three new media will be developed for use with hazelnut.



Initiation studies of hazelnut cultures from grafted greenhouse-grown plants determined that the first three nodes below the shoot tip are the best for uncontaminated, growing shoots. The level of contamination is much greater for nodes 4-6 than nodes 1-3. About 30% of all explants die in culture although they are not contaminated. It is possible that initiation on the improved growth medium will decrease that percentage. Adding 25-30% more shoots to the alive and growing category would greatly increase the successful explant numbers. Studies on the effect of these improved medium formulations on initiation will take place in 2012.

Out of twenty bacterial isolates from hazelnut cultures, four distinctive types of colonies were observed in pure culture. The major bacterial contaminants were identified using 16S sequence analysis as a *Pseudomonas fluorescens*, a *Brevundimonas sp*. with two color forms (white and orange) and a *Bacillus sp*. OSU undergraduate student Nami Wada performed metabolic tests using the API system to determine the bacterial species. API 50CH identified *Bacillus pumilus* and API 20NE found that the two color forms were both *Brevundimonas vesicularis.*

Red raspberry Culture

Ph.D. graduate student Sukalya Poothong is developing an improved growth medium for raspberry cultivars. The standard medium is not optimum for many cultivars and she is using the surface response design used with pear to develop improved mineral nutrition for five cultivars.

Sukalya will study mineral content of shoot cultures grown on several mineral nutrient treatments and will also determine metabolomic changes caused by altering mineral nutrition.

Germplasm Storage by Cryopreservation (Long-Term Storage)

Our long-term storage is coordinated directly with Dr. Maria Jenderek of the Vegetative Propagation Group at NCGRP from plant materials supplied by NCGR. These are the accessions in long-term storage at NCGRP at the end of 2011. Some additional accessions are also stored at NCGR.

Genus	Accessions cryopreserved	Form cryopreserved	Technique
Corylus	5 species	embryonic axes	desiccation
Cynodon	25	shoot tips	encapsulation-dehydration
Fragaria	214	shoot tips	vitrification
Humulus	89	shoot tips	encapsulation-dehydration
Lolium	17	shoot tips	slow cooling or e-d
Mentha	54	shoot tips	vitrification
Pycnanthemum	25	shoot tips	encapsulation-dehydration
Pyrus	216	shoot tips	slow cooling
Ribes	91	shoot tips	encapsulation-dehydration
Rubus	157	shoot tips	slow cooling
Vaccinium	18	shoot tips	encapsulation-dehydration

Molecular Genetics

By Nahla V. Bassil

Graduate Students

Our laboratory has been working in collaboration with Chad Finn, USDA ARS Horticultural Crop Research Laboratory, Corvallis, OR. This collaboration has included mentoring two graduate students. The first one who has now finished his program, Dr. Michael Dossett, collected wild black raspberries and then analyzed the germplasm. He tested transferability of *Rubus* SSR primer pairs into black raspberry. He identified 27 primer pairs that appeared to generate polymorphic markers. He examined genetic diversity in 148 wild and cultivated black raspberry accessions using 21 polymorphic SSR markers. Black raspberry cultivars clustered tightly and showed higher than expected heterozygosity while that of wild accessions was low. Relationships between wild black raspberry accessions were poorly resolved and regional clusters were mostly absent from our analysis. Our results indicated that wild black raspberry germplasm is a relatively untapped resource available for future breeding. He has also used HRM to identify SNPs in monomorphic PCR products generated with SSR primer pairs in parents of a black raspberry mapping population. HRM of PCR amplicons, using these same primer pairs, was then used to genotype seedlings in this mapping population. The observed markers segregated in a Mendelian fashion based on the genotypes of the parent plants. Michael graduated in June 2011 and is continuing to analyze marker data for evaluating population structure and diversity in wild black raspberry populations.

Megan Mathey has just started her graduate program by fingerprinting 960 strawberry genotypes. She has analyzed the "supercore" along with 200 NCGR important founding clones and parents for US breeding programs. This research is being done in collaboration with Dr. Eric Van de Weg (Plant Research International, Wageningen, The Netherlands) and Dr. Andrew Jamieson, (Agriculture and AgriFood Canada, Kentville, Nova Scotia, Canada). We are genotyping these strawberries with an SSR marker that is linked to the Rpf1 red stele resistance gene and validating the disease response by inoculations.

L-R. Liz Alperin, Jeremy Jones, Megan Mathey, Michael Dossett, Nahla Bassil, April Nyberg, Barbara Gilmore, and Estefania Elorriaga

Projects Completed in 2011

Genetic diversity of *Corylus* species using trinucleotide microsatellites and universal cpSSR markers. We evaluated 114 *Corylus* accessions representing 11 species and 44 interspecific hybrids. Eight of 23 simple sequence repeat (SSR) markers generated easy-to-score alleles in all species and seven were highly polymorphic. For the seven, the average heterozygosity was moderate at 0.49 while allele number, genetic diversity and PIC were high at 11.71, 0.79 and 0.76, respectively. Neighbor joining clustering and structure analysis agreed with taxonomic analysis and supported inclusion of *C. maxima* in the large polymorphic species *C.*

avellana. Analysis also indicated that *C. californica* is a distinct species rather than a botanical variety of *C. cornuta*. Six universal chloroplast SSRS (cpSSRs) were polymorphic in *Corylus* and generated an average of 3 alleles per locus and 21 chlorotypes. Diversity at these cpSSRs was high and ranged from 0.33 to 0.64, with an average of 0.69. Incongruence in NJ topologies between the nuclear and chloroplast markers could be attributed to chloroplast capture during the ancestral diversification of the genus, or homoplasy. The phylogeographical relationships among the 21 chlorotypes in the 11 *Corylus* species support Asia as a refugium where several hazelnut lineages survived during glaciation and from which they reappeared only later after the dispersal event from Asia through the Mediterranean to Europe, and across the Atlantic to North America.

Analysis of phylogeny, sex function and age of *Fragaria* based on whole chloroplast genome sequencing. Completed phylogenetic analysis of chloroplast genome sequences of 21 *Fragaria* species and subspecies resolved the western North American diploid *F. vesca* ssp. *bracteata* as sister to the clade of octoploid/decaploid species. No extant tetraploids or hexaploids were directly involved in the ancestry of the octoploids. There was a strong geographic segregation of chloroplast haplotypes in subsp. *bracteata,* and the gynodioecious Pacific Coast populations are implicated as both the maternal lineage and the source of male-sterility in the octoploid strawberries. Analysis of sexual system evolution in *Fragaria* provided evidence that the loss of male and female function can follow polyploidization, but does not seem to be associated with loss of self-incompatibility following genome doubling. *Fragaria* has apparently attained its circumboreal and amphitropical distribution in the past 1.72 million years, and the octoploid clade is estimated to be less than 573,000 years old.

Projects in Progress in 2011

Genetic fingerprinting of the pear core collection. We are using multiplex PCR (Type-it Microsatellite PCR Kit™ (Qiagen, Valencia, CA) (catalogue # 206243) for fingerprinting the entire core collection using a universal fingerprinting set developed by the ECPGR. Comparison of the fingerprints of the eight reference accessions obtained from East Malling Research (EMR) to those maintained at the NCGR generated different profiles for 'Hosui'. Kate Evans (apple breeder, WSU) identified the EMR 'Hosui' as 'Shinsui'. We are re-analyzing this data and plan to finish fingerprinting the pear collection in summer 2012.

Developing genomic tools for blueberry. As part of an SCRI grant led by Jeannie Rowland, we have screened 827 SSR primer pairs from EST sequences in blueberry for polymorphism in parents of a tetraploid blueberry mapping population ('Draper' x 'Jewel'). Five hundred and seventy nine SSRs were evaluated in parents of the diploid blueberry mapping population [(Fla4B x W8520) x W85-23]. Polymorphic SSRs are shared with collaborators for constructing linkage maps in each of these crops. So far, 268 SSR loci were placed on 15 linkage groups in the tetraploid map and ~ 200 markers on the diploid map. We have also generated short read sequences using the Illumina Genomic Analyzer for each of the blueberry mapping parents and will be developing SNPs for use in mapping.

RosBREED: Enabling marker-assisted breeding in Rosaceae. As leader of the genotyping team in an SCRI grant led by Amy Iezzoni (MSU), we developed a 9K Infinium SNP chip for apple, a 9K Infinium SNP chip in peach and a 6K Infinium SNP chip in cherry for genome-wide scans. We are actively working with the strawberry research community on developing a high throughput SNP genotyping platforms for genome-wide scanning in strawberry.

NCGR Corvallis Tree Fruit and Nut Collections (as of 25 March, 2012)

Joseph Postman

Genus	Accessions	Taxa	seedlots	FLD locations	SH locations	in vitro backup
Amelanchier	50	11	54	19	2	0
Amelasorbus	1	1	0	1	0	0
Arbutus	2	1	6	0	1	0
Chaenomeles	13	4	1	9	2	0
Cornus	1	1	0	0	2	0
Corylus	744	21	0	735	100	56
Crataegomespilus	3	1	0	2	0	0
Crataegosorbus	1	1	0	1	1	0
Crataegus	17	7	0	4	0	0
Crataemespilus	1	1	0	1	0	0
Cydonia	125	1	22	129	28	0
Juglans	26	3	1	34	0	0
Malus	8	4	0	3	0	0
Mespilus	58	2	19	40	25	0
Peraphyllum	8	1	4	0	1	0
Pseudocydonia	2	1	1	7	3	0
Pyracomeles	1	1	0	0	0	0
Pyronia	7	1	0	5	2	0
Pyrus	2149	36	325	1995	412	251
Sorbaronia	7	4	0	5	2	0
Sorbocotoneaster	3	2	3	2	1	0
Sorbopyrus	11	2	0	10	0	0
Sorbus	146	48	0	71	15	0
total trees	3384	155	436	3073	597	307

New Accessions 2011 (see Appendix I)

Crop wild relatives of *Corylus* (5 seedlots), *Cydonia* (2 seedlots) and *Pyrus* (15 seedlots) from Albania were added to NCGR collections in late 2011 as a result of a two week joint expedition with John Preece of the Davis, California Repository. Postman and Preece traveled to Tirana, Albania on 11 September, 2011 and spent 15 days exploring rural parts of the country collecting seeds of temperate fruit and nut crop wild relatives. Their host, horticulture professor Dr. Endrit Kullaj, from the Agricultural University of Tirana, arranged and accompanied them on expeditions to the mountains surrounding the village of Theth in the north, to mountains and fruit-

growing regions around Korce and Permet in the southeast, to several districts close to Tirana, and to the coastal region between Vlore and the Greek border. Nearly 100 seed and plant samples representing 32 plant taxa were collected. Most samples were deposited at the USDA-ARS genebanks in Corvallis, Oregon and Davis, California, with smaller numbers of accessions going to Geneva NY, Ames IA and Beltsville MD. Duplicate samples were left at the Albania National Genebank in Tirana. The principal species collected were *Cornus mas, Corylus avellana, Ficus carica, Juglans regia, Malus sylvestris, Olea Europaea,* 2 species of *Pistacia*, 4 species of *Prunus*, *Punica granatum,* and *Pyrus amygdaliformis*.

Clonal additions to the NCGR tree fruit and nut collections include more than 35 hazelnut trees with origins in Armenia, Georgia, Russia, and Ukraine. More than 25 quince clones and seedlings from diverse origins including Armenia, Bulgaria, France, Georgia, Russia, and Turkmenistan. Particularly exciting among new *Cydonia* accessions are several fire blight resistant selections developed in Bulgaria. More than 45 pear genotypes were added to the collection from a dozen origin countries, including 4 perry pears and several U.S. heirloom cultivars (Appendix I). 'Perry' (or cider) pears are among the most requested group of accessions in recent years (see below).

Tree Collections Backup

Portions of the *Corylus* and *Pyrus* collection are backed up *in vitro*, as cryogenically stored meristems, and as small potted screenhouse plants. Of the 744 clonal hazelnut accessions, 7.5% are backed up *in vitro,* and 22% are backed up in a remote field collection in at the Parlier, CA genebank, and 5 accessions are backed up as isolated embryonic axes in liquid nitrogen. The NCGR *Pyrus* collection includes 1824 clonal accessions, with 13.7% backed up either *in vitro* and/or as cryo-stored meristems, and 22.6% backed up as small potted "bonsai" trees in a screenhouse.

Field Collection Rejuvenation and Relabeling

The 2nd year of a 3 year tree rejuvenation effort in the NCGR *Pyrus* and *Corylus* collections was completed. Trees are being hard-pruned to open up dense tree centers, remove low branches and suckers that had become an obstacle to tractor and human access, and lower tree canopies to improve access to fruit and scionwood. Increased airflow through trees will reduce incidence of fungal diseases and improved light penetration will allow for more typical fruit production so that phenotype characterization and photo-documentation of fruit characters can resume. All pear field accessions have been relabeled with durable, long-lasting tags that include barcodes.

Quince Cold Hardiness Evaluations

Very cold-hardy *Cydonia* genotypes were identified to be further evaluated for potential as productive, dwarfing pear rootstocks following the completion of a 3 year collaborative study with Todd Einhorn (Oregon State University). Beginning in autumn 2009, fifty clonal quince accessions with diverse origins were screened monthly from Sept to March to characterize their response to acclimation/de-acclimation conditions, determine minimum hardiness level, and identify tissue-specific sensitivity limits to sub-zero

CCYD 116 Miradzhi. Quince from Turkmenistan

temperatures. One-year-old shoot pieces were loaded into a programmable freeze chamber, and subjected to freezing at a rate of 4° C per hour. Samples were removed following one hour at each of five treatment temperatures (0, -10, -20, -30, and -40 °C), incubated at 20 °C for one-week, sectioned transversely, and observed under a stereomicroscope. Individual tissue zones (phloem, cambium, and xylem) were rated according to the degree of oxidative browning. The lowest exposure temperature sustained with minimum observable tissue injury (< 25 % browning) was used to report minimum hardiness level. Ambient temperatures (minimum and mean) recorded at the genebank gradually declined throughout early fall, providing good conditions for onset of cold acclimation and development of hardiness. Following cold acclimation, 25 quince accessions were capable of withstanding -30 °C without detectable levels of freeze injury. Thirteen of those were categorized as having low levels of tissue browning (likely survivability) following exposure to -40 °C. Under our climatic conditions, none of the pear accessions tested, including four previously reported cold-hardy accessions, appeared capable of withstanding -40 °C. Sensitivity to sub-zero temperatures was similar among xylem, phloem and cambial tissue, though phloem tended to possess slightly greater hardiness during December (peak hardiness period). Several quince clones exhibited freeze tolerance equal to or greater than the current 'Old Home' x 'Farmingdale' Pyrus clones widely used today in the US.

Most Requested Corylus, Cydonia and Pyrus Accessions from 01/01/2010 to 12/31/2011

Corylus

Rank	Accession	Taxon	Plantname	Total shipped
1	PI 557037	*Corylus avellana*	Barcelona	9
2	PI 637882	*Corylus avellana*	Gamma	8
3	PI 654983	*Corylus avellana*	Santiam	7
4	PI 657902	*Corylus avellana*	Jefferson	6
5	PI 617210	*Corylus avellana*	Lewis	5
6	PI 637884	*Corylus avellana*	Epsilon	5
7	PI 637902	*Corylus fargesii*	CCOR 822	5
8	PI 654984	*Corylus avellana*	Sacajawea	5
9	PI 657905	*Corylus avellana*	Yamhill	5
10	PI 557109	*Corylus avellana*	Closca Molla	4
11	PI 658547	*Corylus avellana*	Theta	4

Cydonia

Rank	Accession	Taxon	Plantname	Total shipped
1	Q 25981	*Cydonia oblonga*	Tekkes	15
2	PI 655057	*Cydonia oblonga*	Meech's Prolific	14
3	Q 25982	*Cydonia oblonga*	Sekergevrek	13
4	PI 502332	*Cydonia oblonga*	AR-232 - Uzbekistan	12
5	PI 655052	*Cydonia oblonga*	Majes Valley	12
6	PI 655048	*Cydonia oblonga*	Gamboa	11
7	PI 659063	*Cydonia oblonga*	Limon	11
8	PI 655047	*Cydonia oblonga*	Cooke's Jumbo	10

9	PI 559892	*Cydonia oblonga*	Pineapple	9
10	Q 25979	*Cydonia oblonga*	Ekmek	9
11	Q 25930	*Cydonia oblonga*	Bereczki	8
12	PI 655046	*Cydonia oblonga*	Van Deman	6
13	PI 655049	*Cydonia oblonga*	Tencara Pink	6
14	PI 655058	*Cydonia oblonga*	Krymskaya	6

Pyrus

Rank	Accession	Taxon	Plantname	Total shipped
1	PI 541262	*Pyrus communis*	Seckel	23
2	PI 541317	*Pyrus communis*	Red Pear	20
3	PI 541123	*Pyrus communis*	Barland	19
4	PI 541256	*Pyrus communis*	Rousselet de Reims	19
5	PI 541271	*Pyrus communis*	Taynton Squash	18
6	PI 541287	*Pyrus communis*	Yellow Huffcap	18
7	PI 277529	*Pyrus communis*	Sanguinole	15
8	PI 541156	*Pyrus communis*	Butt	15
9	PI 541195	*Pyrus communis*	Gin	14
10	PI 541320	*Pyrus communis*	Honeysweet	14
11	PI 231806	*Pyrus communis*	Normannischen Ciderbirne	13
12	PI 300693	*Pyrus communis*	Bartlett	13
13	PI 541273	*Pyrus communis*	Thorn	13
14	PI 541281	*Pyrus communis*	White Doyenne	13
15	PI 541431	*Pyrus communis*	Harrow Delight	13
16	PI 617584	*Pyrus communis*	Joey's Red Flesh Pear	13

Postman Extramural Funds 2011:

- Received $6800 from Washington Tree Fruit for Quince Hardiness study with Todd Einhorn
- Received $13,000 NPGS Germplasm Evaluation Grant ($4300 to Corvallis, $8700 to Fort Collins) – Central Asian pear species genetic diversity analysis with Gayle Volk and Chris Richards at Fort Collins.

Greenhouse Screenhouse Report

Missy Fix and Jim Oliphant

ACTINIDIA

Actinidia is maintained in the screenhouse as a back-up collection; at a minimum the accessions are housed for 3 years until the field plants are established. Plants are now also being sent to NCGR at UC Davis in California to become part of their permanent collection; greenhouse cuttings of 20 accessions were sent in February 2011. These accessions will continue to be maintained as back-up until they have been established at Davis. Currently, we have 59 backup accessions; there were 4 new accessions added in 2010 and 18 accessions were successfully re-

propagated this last year. Ten accessions were identified as non-hardy; within this group six are identified as 'tropical' and are housed in greenhouse 1 which provides the climate needed for these plants. The remaining four accessions were placed in greenhouse 3 which houses non-hardy genera.

RIBES

All core or non-hardy clonal accessions of *Ribes* are maintained in a tube house or greenhouse. To date 368 accessions are maintained as part of the permanent collection in tube house and of these 154 are core accessions and another 59 are non-cold hardy and are housed permanently in greenhouses. Thirty one accessions were successfully re-propagated as replacements in the collection; an additional 31 accessions were re-propagated and taken to the North Farm for field planting. There are also 551 seed lots. Seventeen accessions remain in quarantine awaiting virus testing. The *Ribes* collection was turned over to the ASPGRU facility, so propagating for in-house replacements is no longer required. Re-propagated accessions will now be turned over for field replacement as needed. We provided 58 plants to the field collection as requested this past year. Eleven new or replacement accessions were received in 2010; 44 accession cuttings from Heat Treated Backup and In House Quarantine were sent to ASPGRU in early 2010 for establishment. The *Ribes* collection will be maintained in our tube house until permanent plants have been established at the ASPGRU facility.

RUBUS

All clonal accessions of Rubus are maintained under screen. Accessions from tropical, subtropical, and high latitude habitats are maintained in the greenhouse of which there are now 202 accessions. In 2010, 208 accessions were repropagated for placement in the collection bringing the total number of accessions to 864 of which 267 are core accessions. The repository received 11 new accessions or replacements this year and six new seed lots; 268 accessions that had a screen house dates of four years or older were collected and re-propagated. In 2010, 16 of these accessions were readied for placement in the collection, the remaining are in various stages of slow root growth and will probably be ready for the collection in the fall of 2011. Regarding the Rubus of Concern, six of the remaining accessions are in this group and continued efforts are made to find workable propagation for these accessions. Forty nine plants were repropagated and handed over for the field collection**.**

Screenhouse/Greenhouse Facilities

by Missy Fix

We continued sanitation throughout facilities with an emphasis on weed control, in plant containers, floors inside the houses, and a wide buffer zone outside the houses. We installed automated irrigation system for benches holding Mint collection outside of the tubehouse. The rafters and sidewall screens of screenhouses were spray cleaned. We replaced siding and dry rot support on two screenhouses. We continued lath replacement on the screenhouses. We removed the *Photinia* hedge by the eastside parking lot, replacing it with a six foot cedar fence. *Photinia* attracts cane borers and other pests that kept infesting screenhouse plants. The new fence is a barrier that protects the seedbed area against wind and afternoon heat. This protected area has also been designated as an extra space for distribution

Jim Oliphant washes his boots before going into the headhouse.

plants. This past winter we removed all non-anchored benches and shelving, to clean and paint the headhouse. Benches were cut down or rebuilt which provided additional and more efficient work areas. The main purpose of this project was to provide workers with a clean and safe environment.

Quarantined Plants

By Jim Oliphant

At this time we have 244 accessions in quarantine.

Status of Quarantined Accessions at the Repository

Genus	Federal	State	In-House
Corylus			2 NCGR
Cydonia	17 Provisional Release		
Fragaria	1 Departmental Permit		
Humulus		20 Directors Exemption (seed)	117 NCGR*
Pyrus	67 Provisional Release		
Ribes		16 Directors Exemption	
Rubus	3 Post-Entry		
Vaccinium	1 Post-Entry		
Total	89	36	2

* Accessions with unknown viroid status

North Farm Activities

Joe Snead, Farm Manager

Once again the North Farm operation has seen quite a few changes in the last year. The *Ribes* field collection that had become backup collection for the Palmer Alaska repository is now back since the closure of that location. The *Ribes* field collection is now a primary collection for the Corvallis Repository. The *Actinida* collection is being established at the Davis California Repository. I will take several years for this to happen. In the mean time the North Farm planting will serve as a distribution source and backup collection. The *Humilus* field planting is continuing and some breeding is taking place there. The North Farm Repository field collections are healthy. However, the spring was wet and cold which creates great potential for fungal diseases. Several well timed sprays were applied to the *Ribes* and *Cydonia* collections. The minor genera collection is increasing slowly, as new acquisitions are planting.

The North Farm provides propagation material for distribution. About 70 accessions of distribution material were taken from the *Ribes* field collection. The *Actinida* collection had 100 requests this year. To help establish the Davis Repository collection hardwood cuttings were collected for the accessions that did not take in the first propagation attempts. Each of the

collections, *Juglans, Sorbus, Mespilus, Pyrus, Cydonia, Sambucus,* and Intergeneric crosses had distribution requests.

This was the final season for the blackcap (*Rubus occidentalis*) seedling trial. This planting was managed in cooperation with Dr. Chad Finn. The old field was cleaned out and two acres were sub-soiled, plowed and worked down and planted to grass. The field will need continued weed control for some time to come because of a Canada thistle infestation. Hopefully the infestation can be controlled in two growing seasons. There continues to be a good cooperative working relationship with other local ARS research units and Oregon State University Horticulture Department. There many cooperative research projects conducted on the farm this last year. A summer farm worker was funded by several ARS research scientists.

As reported last year the management practices and philology of the North Farm are continuing to include 'Green' and sustainable practices. Farmscaping for Beneficials is being further developed. To document these changes a North farm map was developed to illustrate where the changes are occurring. The plan involves establishing habitat or plantings for beneficial insects, birds and bats. Beneficial insects work as predators, parasites, and pollinators in the field situation. The North Farm has four existing beetle banks and more are planned. Small flowering shrubs were planted in the buffer strips in the *Ribes* cultivar field. The flowering shrubs provide nectar for beneficial insects to forage on when the population of target insects is low. The goal is to have different plants flowering from early spring to late summer. To aid the flowering shrubs in attracting beneficial insects many annual flowers were planted this year. Farmscaping for beneficials also involves improving the bird habitat. Twenty-five birdhouses were placed around the farm to attract Bluebirds. Bluebirds eat lots of insects and are a social bird that fit into the farm setting. We did not get the houses put out in time so when the Violet-green swallows arrived they used the nests. They are also very good insect eaters. Barn swallow nests were built and placed outside the barn, but there were no takers. The nests will be left up for one more season and see what happens. Raptor perches for control of western field voles were installed in areas where there are colonies of voles. We plan to attract American kestrels as predators to help control voles.

Two areas on the farm have been left natural as habitat. Eight acres of fallow grass land were left unmowed this year for several years for improved habitat for beneficial insects and small birds. While this was helpful in that respect these areas became reservoirs for the Western pocket gophers, once mowed it was easier hunting for gopher predators.

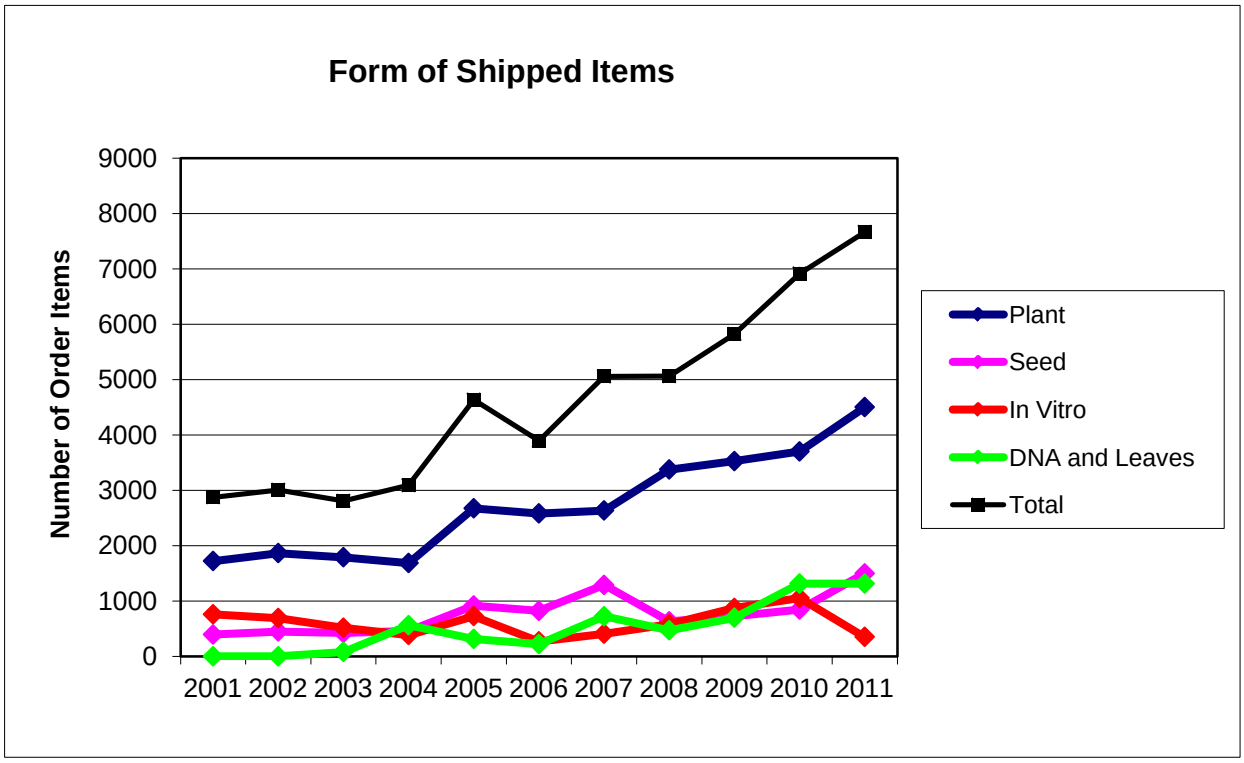
Composting continues to be important. First there were no piles of debris burnt on the farm last year, so there was no air pollution. A new composting area was developed at the west side of the old hops field. There are different piles of material based on the age of the material. Presently there are three main piles and an area to put brush for chipping. This totals about 150 cubic yards of material that will be added to our fields. The material comes from our greenhouse operations, other ARS operations, OSU Horticulture, and our own farm operations. We also get thirty yards of grape pumice from a local winery for free. Last year we used seventy five yards of compost on *Ribes* cultivar and species rows. We also chip brush to be used as mulch in our landscape beds.

Plant Distribution

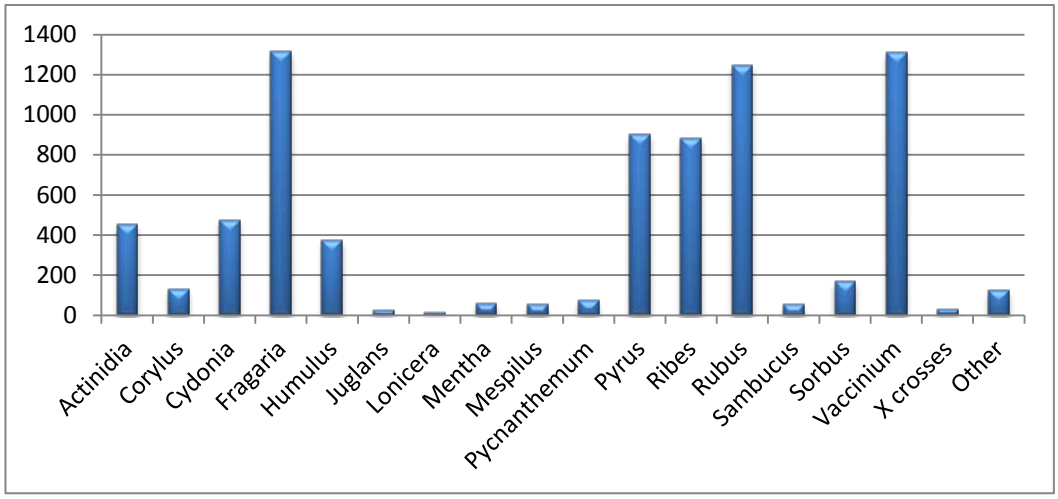
By Bruce Bartlett, Bio. Sci. Res. Tech., and Kim Hummer

Angelina Nachgorny packs boxes for shipping. These boxes were sent in 1 day.

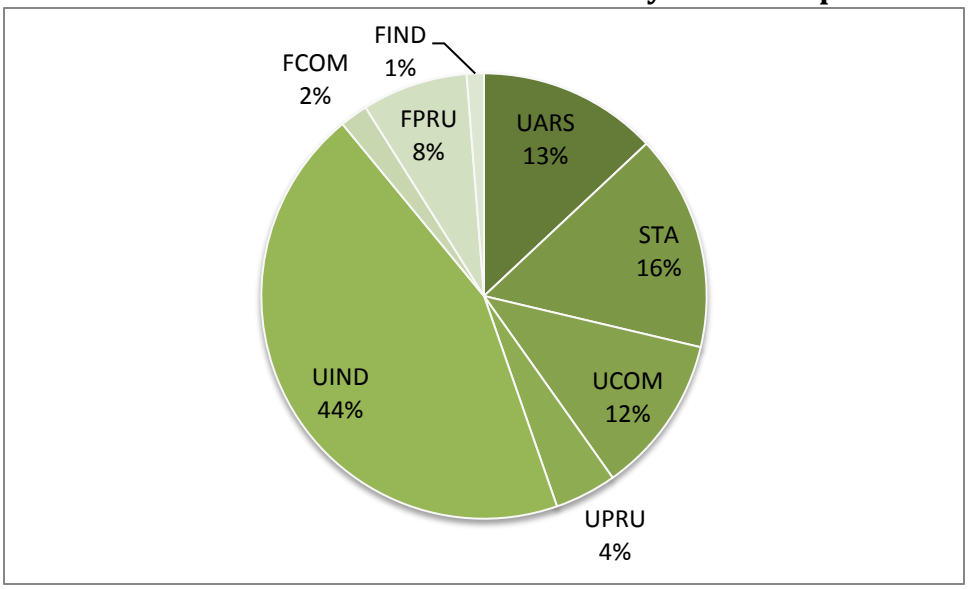
- 7,665 items were shipped as seeds, cuttings, runners, scionwood, rooted plants, tissue culture and DNA. Once again this is a record for number of accessions sent.
- 11% of all items shipped were sent to foreign requestors in 16 countries.
- Requests for DNA samples of our accessions, in the form of DNA, lyophilized leaves and fresh leaves, were 1,314 or 17% of the total number of accessions shipped.
- The berry genera, pears and quince topped the list of crops distributed.
- Domestic individuals, state agencies and universities, and ARS researchers received the most germplasm from Corvallis in 2011.



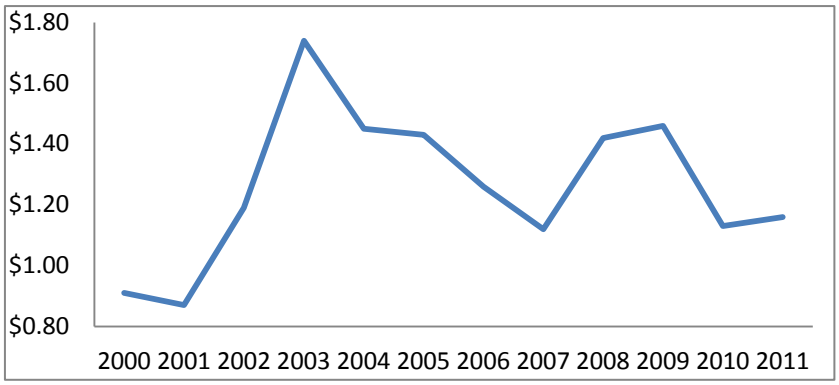
2011 Distribution by Genus



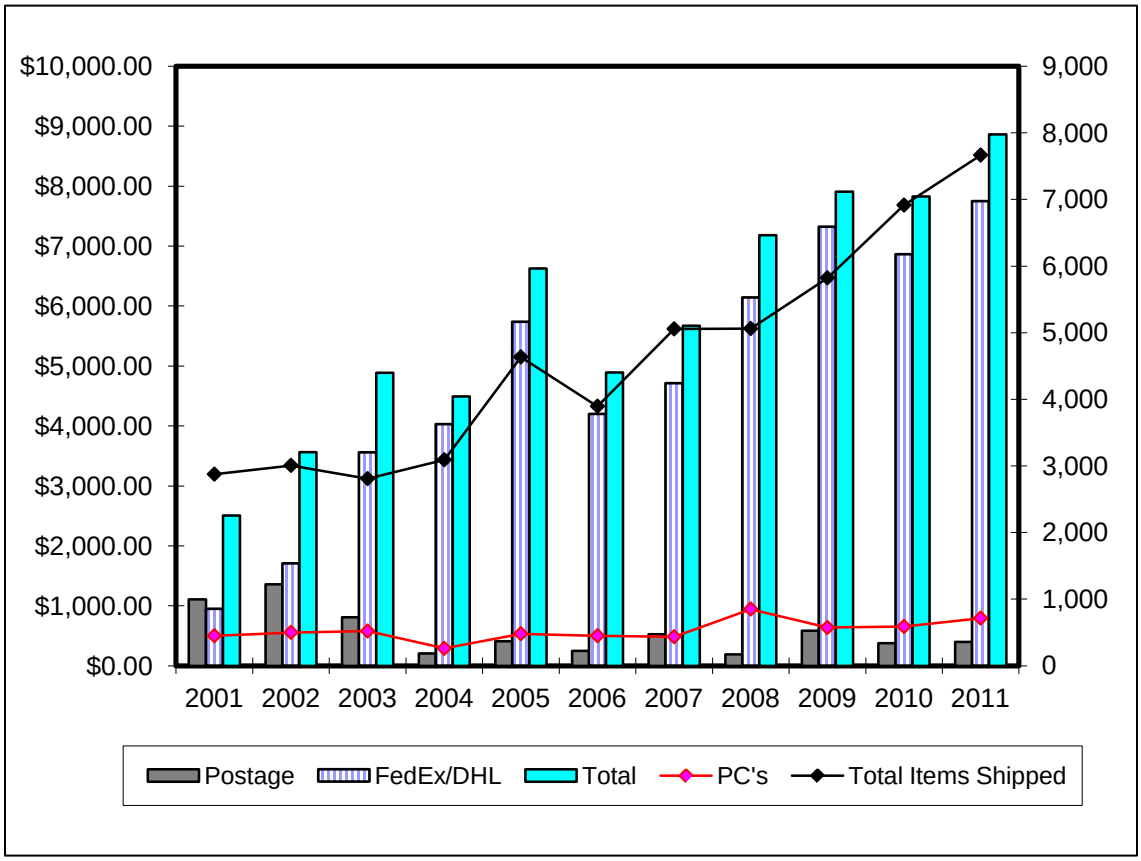
2011 Distribution from Corvallis by User Group



Shipping cost per Item from 2000 to 2011



We continued to have very low shipping costs per item ($1.16) on average during 2011. The average cost increased only slightly from $1.13 in 2010. Though shipping charges have increased significantly, this cost was kept low by having requestors pay shipping charges for their orders when possible.



Awards 2011

Compiled by: Yvonne Pedersen

Special Awards and Recognition

Barbara M. Reed was named a Fellow of the Society for Cryobiology at the 2011 meeting in July.

Jim Oliphant won the NPGS Special Recognition award for 2011. The plaque was presented at the PGOC meeting in July 2011.

Performance Bonus Awards for the rating period of 10/1/20010-9/30/2011.

Bruce Bartlett	Jim Oliphant
Nahla Bassil	Yvonne Pedersen
Jeanine DeNoma	Joseph Postman
Missy Fix	Barbara Reed
April Nyberg	Joe Snead

Time Off Awards for the rating period of 10/1/2010-9/30/2011.

Bruce Bartlett, Missy Fix, Jim Oliphant, and Dennis Vandeveer

Appreciation/Recognition

Aaron Williams, Safety & Occupational Health Specialist, the Corvallis Safety, Health & Environmental Management (SHEM) Committee members, and all Location employees for outstanding contributions toward workplace safety at the Corvallis Location. The Location had no reportable accidents for FY11.

Visitors during 2011

During Calendar Year 2011, 595 plus people came through the Repository's front door during business hours. Guests arrived in large or small groups, as organized class tours or as individuals. For outside tours, the repository had several extra events. About 55 people attended the 2011 Open House held 16 July 2011, in association with the City of Corvallis daVinci Days Festival. The Repository hosted a booth from Friday through Sunday that same weekend in "Greentown" at the daVinci Days Festival in town. Several hundred people stopped by the booth and sampled blueberries and obtained information on the unit at the festival. In addition about 25 members of the group "Slow Food Corvallis" toured the NCGR pear orchard on 18 August 2011.

Some groups used the Repository for their annual meetings such as the Oregon Hazelnut Commission, the Oregon Sweet Cherry Commission, and the Oregon Processed Vegetable Committee. Educational tours ranging from groups of 8 to 86 came from Willamette University, Home Orchard Society, Chemeketa, Linn-Benton Community College, Oregon State University, Corvallis School District, Linn Benton Community College, Greenhouse Plant Technology, various garden clubs, as well as the Greater Albany Public Schools to tour the facility for their horticultural experience. Fifty visitors toured the Repository as part of the Society for Cryobiology meeting held in Corvallis. In addition, the Corvallis Outreach Diversity and Equal Opportunity Committee arranged a tour to visit the three ARS Corvallis units for students and others interested, to see what the other units are researching.

There were also numerous general international visitors: 1 from the Netherlands, 1 from Canada, 3from India, 4 from China, 3 from Chile, 1 from Taiwan, 4 from Japan, 1 from Thailand, 4 from Slovenia, and 13 from France. Also, there were graduate students and a visiting scientist s working at the National Clonal Germplasm Repository from Kenya, Thailand, China, and Japan.

New Hazelnut, Pear and Quince Accessions received in 2011

Seed Accessions

CCOR	983	C. avellana ALB-2011-014	Albania
CCOR	984	C. avellana ALB-2011-030	Albania
CCOR	985	C. avellana ALB-2011-049	Albania
CCOR	986	C. avellana ALB-2011-056	Albania
CCOR	987	C. avellana ALB-2011-090	Albania
CCYD	162	C. oblonga - Gjirokaster Quince	Albania
CCYD	163	C. oblonga - Qinam Quince	Albania
CPYR	2965	P. communis subsp. pyraster ALB-2011-024	Albania
CPYR	2961	P. spinosa ALB-2011-001	Albania

CPYR	2962	P. spinosa ALB-2011-007	Albania
CPYR	2963	P. spinosa ALB-2011-010	Albania
CPYR	2964	P. spinosa ALB-2011-015	Albania
CPYR	2966	P. spinosa ALB-2011-028	Albania
CPYR	2967	P. spinosa ALB-2011-034	Albania
CPYR	2968	P. spinosa ALB-2011-038	Albania
CPYR	2969	P. spinosa ALB-2011-043	Albania
CPYR	2970	P. spinosa ALB-2011-064	Albania
CPYR	2971	P. spinosa ALB-2011-067	Albania
CPYR	2972	P. spinosa ALB-2011-070	Albania
CPYR	2973	P. spinosa ALB-2011-072	Albania
CPYR	2974	P. spinosa ALB-2011-078	Albania
CPYR	2975	P. spinosa ALB-2011-089	Albania

Corylus Plant Accessions

PI	637890	C. avellana ARM-02-009 - Kapan, Armenia	Armenia
PI	637891	C. avellana ARM-02-051 - Micha, Armenia	Armenia
CCOR	810	C. avellana ARM-02-053 - Armenia Vodka Man	Armenia
PI	637893	C. avellana ARM-02-173 - Shnogh, Armenia	Armenia
CCOR	949	Khachapura O.P. - Adjara	Georgia
CCOR	950	Dedoplis Titi O.P.	Georgia
CCOR	953	Chachapura O.P. - Lagodekhi	Georgia
CCOR	954	C. avellana G10-109	Georgia
CCOR	955	C. avellana G10-110	Georgia
CCOR	956	Zolotoy orekh O.P.	Georgia
CCOR	957	Khrustala O.P.	Georgia
CCOR	958	Lekuri O.P.	Georgia
CCOR	959	Khoji Tkhili O.P.	Georgia
CCOR	960	C. avellana G10-115	Georgia
CCOR	961	Apenuri berdznula O.P.	Georgia
CCOR	962	Gavazuri O.P.	Georgia
CCOR	963	Anakliuri O.P.	Georgia
CCOR	964	C. avellana G10-119	Georgia
CCOR	966	C. avellana Adygeysk	Russia
CCOR	968	C. avellana Homskij-1	Russia
CCOR	969	C. avellana Homskij-2	Russia
CCOR	970	C. avellana Homskij-3	Russia
CCOR	971	C. avellana Homskij-4	Russia
CCOR	972	C. avellana Krasnodar-4	Russia
CCOR	973	C. avellana Maikop	Russia
CCOR	974	C. avellana Sochi Inst.	Russia

CCOR	975	C. avellana Sochi-2	Russia
CCOR	976	C. avellana Sochi-3	Russia
CCOR	977	C. avellana Sochi-4	Russia
CCOR	978	C. avellana Alushka-Simferopol-1 large	Ukraine
CCOR	979	C. avellana Alushka-Simferopol-1 small	Ukraine
CCOR	980	C. avellana Alushka-Simferopol-2	Ukraine
CCOR	981	C. avellana Alushka-Simferopol-4	Ukraine
CCOR	982	C. avellana Nikita Botanic Garden	Ukraine

Cydonia Plant Accessions

Q	44715	Quince from Ioseb Tomashvili (GE-054)	Georgia
Q	44716	Skra Exp. Sta. Selection No. 1 (GE-067)	Georgia
Q	44717	Chacha Quince (GE-101)	Georgia
Q	35680	Hov. No.2	England
Q	45234	hvbrid V-7 (fire blight res.)	Bulgaria
Q	45235	hybrid I-83 (fire blight res.)	Bulgaria
Q	43201	Meeches Prolific	England
Q	39558	Yuz-begi 90-2	Turkmenistan
Q	39554	Zeakli 89-1	Turkmenistan
Q	39831	Zvezdnaia	Russia
Q	39832	Muskatnaia	Russia
Q	39551	Kichikara Dede 88-1	Turkmenistan
PI	655051	Bourgeault	France
Q	44764	Alena	Armenia
Q	44761	Ttvash Serkevil (Sour Quince)	Armenia
CCYD	161	Lisle	Ohio
PI	655044	Orange	Oregon
PI	660759	Pseudocydonia - Chinese Quince sdlgs.	China

Pyrus Plant Accessions

Q	25261	1-150	Nepal
Q	22421	14/109 F2-F-2	Romania
Q	22418	14/125 F2-3-131	Romania
Q	43936	Arlingham Squash (perry pear)	England
CPYR	2957	Bartlett - John Muir Gravesite No. 85	California
Q	39539	Birleshik 84-1	Turkmenistan
Q	29573	Camusina di Bonarcado	Italy
Q	29574	Camusina di Cagliari	Italy
Q	25057	Changpa Li	China
Q	44725	GE-135 Gulabi from Dedoplis Tskaro	Georgia
CPYR	2951	Gldani Pear G10-120 sdlgs.	Albania
Q	27965	Ho Mon	China

CPYR	2956	Horner 10 (rootstock)	United States
CPYR	2955	Horner 4 (rootstock)	United States
Q	43108	IC 20808	India
Q	43112	IC 20813	India
Q	43103	IC 22040	India
Q	44171	Julienne (perry pear)	France
Q	27968	Keshinugeamulti	China
Q	27439	Kharnak I	Pakistan
Q	29578	Limoni	Italy
Q	24302	Malti	Tunisia
Q	39531	Marut	Turkmenistan
Q	43939	Oldfield	England
Q	39601	P. communis	India
Q	39609	P. communis	India
Q	39605	P. communis	India
Q	35615	P. communis rootstock 217-26.12	Russia
CPYR	2953	P. pashia HBG 13803 #1	California
CPYR	2954	P. pashia HBG-13803 #2	California
Q	25267	P. pyrifolia	Nepal
CPYR	2892	P. sachokiana GE-2006-114	Georgia
CPYR	2952	P. salicifolia - G10-122 sdlgs.	Georgia
Q	28419	P. salicifolia A-53-14	Russia
Q	44753	P. salicifolia hybrid	Armenia
Q	27631	P. salicifolia Pall. N1	Russia
Q	43922	Plant de Blanc (perry pear)	France
Q	44266	Quince-Pear	Armenia
CPYR	2960	Rutter	United States Heirloom
Q	39530	Sholve	Turkmenistan
PI	654942	SIM 117-11	Alberta, Canada
Q	27437	Spin Tangoo	Pakistan
Q	27436	Sur Tangoo	Pakistan
Q	26692	Tama	Japan
Q	25047	Ta-Shian-Sui Li	China
Q	36683	Trupnjak	Macedonia

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1. Follett, P., F. Zee, R. Hamasaki, **K. Hummer,** and S. Nakamoto. 2011. Susceptibility of Low-Chill Blueberry Cultivars to Mediterranean Fruit Fly, Oriental Fruit Fly, and Melon Fly (Diptera: Tephritidae) J. Econ. Entomol. 104(2): 566-570.
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3. Gilmore, B., K. E. Hummer and N. Bassil. 2011. DNA Extraction protocols from dormant buds of twelve woody plant genera. J. Amer. Pom. Soc. 65(4): 201-207.
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5. Mota, J. **Hummer, K.** Williams R. 2011. Berry trials in the Azores. Acta Hort.918:753-758.
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8. Einhorn, T.C., Turner, J., Gibeaut, D. and **Postman, J.D.** 2011. Characterization of Cold Hardiness in Quince: Potential Pear Rootstock Candidates for Northern Pear Production Regions. Acta Hort. 909:137-143.
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10. **Postman, J.D**. 2011. Intergeneric pome fruit hybrids in Pyrinae, a subtribe of Pyreae in family Rosaceae. Acta Hort. 918:937-943.
11. **Reed, B.M**., V. Sarasan, M. Kane, E. Bunn, and V.C. Pence. Biodiversity Conservation and Conservation Biotechnology Tools. In Vitro Cellular and Developmental Biology – Plant. 47:1-4. 2011.
12. Wada, S. and **B.M. Reed**. Optimized scarification protocols improve germination of diverse *Rubus* germplasm. Scientia Hort. 130:660-664. 2011.
13. Wada, S. J.A. Kennedy and **B.M. Reed.** Seed-coat anatomy and proanthocyanidins contribute to the dormancy of *Rubus* seed. Scientia Hort. 130:762-768. 2011.
14. Wada, S. and **B.M. Reed.** Standardizing germination protocols for diverse raspberry and blackberry species. Scientia Hort. 132:42-49. 2011.
15. **Reed, B.M.** Choosing and applying cryopreservation protocols to new species or tissues. Acta Horticulturae 908:363-372. 2011
16. Kovalchuk, I., A. Nasibulina, and **BM**. **Reed.** Cold storage of cherry germplasm. Acta Horticulturae. 918:167-176. 2011.
17. **Reed, B.M.,** *E. Uchendu, S. Wada* and F. Zee. Alternative storage for germplasm of native Hawaiian berries. Acta Horticulturae. 918:113-120. 2011.
18. Höfer, Monika and **B.M. Reed** Conservation strategy of genetic resources in strawberry in Germany. Acta Horticulturae.918:139-146. 2011.

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3. Zee, F.T., Keith L., Follett, P.A., Bassil, N.V., **Reed, B.M**., Strauss, A., Arakawa, C., Kawabata, A., Hamasaki, R.T., Nakamoto S.T., Silva, J., Ikawa, A., Chang, Y., Love, K., Durst, B. and **Hummer, K**. 2011 'Kīlauea' and 'Red Button,' two 'ōhelo, *Vaccinium reticulatum*, cultivars from Hawai'i May 2011 (F&N-16).
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