Minutes

NRSP6 Technical Advisory Committee meeting 2014

July 25-26, Prosser WA

The meeting was hosted by Chuck Brown, the USDA/ARS Technical Rep. The time was selected to be the days immediately before the Potato Association of America meeting at nearby Spokane (see attached for TAC meeting venue details).

Friday, July 25th

Genebank (USPG) personnel: Max Martin, A. del Rio, J. Bamberg. Tech Reps: C. Brown, C. Miller (Emeritus). Quarantine: J. Abad. USDA/ARS/NPL: P. Bretting (phone in). Industry: L. Thurgood (Simplot), D. Ronis (Frito-Lay), C. Higgins & K. Muder (Norika America LLC), Local scientists and miscellaneous guests: R. Navarre, I. Astarini (guest of C. Miller), S. Sathuvalli, R. Cooper, L. Zhang, J. (Mrs. C.) Miller.

Minutes following are numbered according to the Agenda (attached).

1. Host C. Brown requested that distinguished guest and former SR Tech Rep Dr. C. Miller serve as Chair. Dr. Miller accepted chairman role and appointed Bamberg as Secretary.

Participants introduced themselves. Host C. Brown set the stage for the meeting with background of the Prosser station and agricultural history and significance of the region.

2. Agenda additions and prioritizing:

A specific agenda item was proposed related to acquisitions: In what way should the Genebank take responsibility for clonal maintenance of large mapping populations? Chairman Miller decided to address this immediately: The group had decided in 2012 that the SolCap panel of about 250 clones should be accessed, preserved and distributed by USPG. But when this was undertaken, it became apparent that many of those items are already easily available elsewhere and that many were not available in virus free form. The utility of SNPs for the wild species in the genebank remains to be confirmed, and other markers are gaining in popularity. Decision to revoke the 2012 directive for USPG to maintain the SolCap panel M/S/CU.

3. Review of Minutes from 2013 meeting and approval M/S/CU.

4. Chair Miller appointed Bamberg, Ronis and Abad to the Resolutions Committee.

Martin discussed how USPG accepts clones for which protection has expired. Patent rights may expire but breeders rights still apply. This has to be checked on a clone-by-clone basis.

5. Martin and Bamberg presented highlights of Lead AA R. Lindroth report (attached) and recapped points of conversations with AA Lindroth over the year, noting that the genebank's strong partnership with University of Wisconsin Department of Horticulture, UW Peninsula Ag Research Station, national SAES directors and OTT funding is expected to remain steady. The 2010 imperative by the latter for the genebank to attract industry funding is considered to be well satisfied. A midterm (2013) report prepared by Bamberg (attached) was favorably received.

7. Dr. Brown noted germplasm orders are up. Iron is a nutrient, that when missing, has devastating health consequences that potato germplasm can mitigate. R. Navarre discussed his related nutritional work involving germplasm contributing antioxidants, less toxic glycoalkaloids, reduced greening and other beneficial phytonutrients, all of which have been subjects of cooperative research with genebank staff. A discussion of the reputation of potato as a healthy food, the past and present contribution of genebank germplasm, and the economic and health impact on potato growers and consumers ensued. Written reports were submitted by other US and Canadian Tech Reps (attached).

12. NPL P. Bretting called in at 11 AM and reviewed his report (attached). The demand for germplasm and germplasm information has grown, but financial inputs have not been as reliable, considering sequesters and furloughs. In FY14, base funding increases were awarded to about half of the NPGS genebanks, potato being among those. NPGS international links continue to expand, but our access to foreign collecting has not improved. On the topic of acquisition, Dr. Abad related the story of a recent import of 55 Peruvian cultivars hand carried by an individual with an APHIS permit that was issued in error. It was emphasized that we must be vigilant to avoid imports that are imprudent or illegal with respect to both phytosanitary and germplasm ownership. Finally, we were reminded that a compelling story of how our germplasm is being used and is having positive impact on the public helps our national administration better support us.

9. Industry Reps: Dr. Ronis described the Frito-Lay breeding program and confirmed that they heavily use USPG germplasm and are enthusiastic about its past and future value to US breeding efforts. L. Thurgood of Simplot confirmed their new Innate products, developed with USPG germplasm, are expected to be very successful. Discussion on general needs for potato improvement identified nutrients that impact consumer health, uniformity for processing, and better flavor as priorities.

10. Bamberg presented the genebank Annual Report for CY2013 with updates to the present (attached). Staff members Dr. A. del Rio and M. Martin added comments pertinent to their

areas of responsibility. The report included notes on activities of USDA/ARS research staff Jansky and Spooner. Bamberg emphasized that details of all the genebank administrative reports and plans, as well as full documentation of the germplasm is available on-line. Finally, a breakdown of expected spending of the FY15 NRSP6 budget, as well as plans for the new USDA/ARS base funding addition was presented.

14. Dr. Abad reviewed details in his written report (attached). Genebank staff noted that under Dr. Abad's leadership, quarantine now does a rapid and thorough job of detecting and eliminating pathogens that would threaten the genebank and national potato industry. Dr. Abad's lab also gives the genebank technical advice and assistance on potato pathology problems, and participates with us on research. The group acknowledged their agreement and thanks with applause.

The Friday "Business meeting" day ended with a brief tour of the local labs, and a visit to Dr. Brown's anti-nematode research plots on the Prosser station.

15. The resolutions committee met to prepare resolutions (see below) that were unanimously approved by email after the meeting.

16. Since none of the original officers for 2014 served, it was proposed that these same individuals be slated to serve next year. It as decided that the tradition of meeting at Sturgeon Bay on alternate years should apply for 2015, especially since it will be the final year of the current (FY11-FY15) project (the meeting date will be set later).

New TAC officers for 2015:

DeJong =Secretary
Holm = Chair
Brown = Vice Chair

Saturday, July 26.

Dr. Brown led the group on a tour of the local industry, beginning with grower Randy Mullen. Randy's father was an early potato grower on the first land irrigated in the Columbia Basin, also known as Block One. He has been an officer in the Washington State Potato Commission in one capacity or another for 25 years. On the day we saw him he was digging Shepody for the early French Fry Market for Lamb Weston. We saw Shepody being processed at the Simplot plant in Moses Lake after lunch. His usual crop is a clone of Russet Norkotah selected by Creighton Miller. He and his partners run their own highly automated mechanized shed. His potato spreadsheet is highly sensitive to national supply. In 2014 the economics were against his profit line primarily because Idaho still had substantial stock in storage. He believes the future lies in diversity and is experimenting with a dark yellow flesh European variety, Agata. In the afternoon, we toured the Simplot fry processing plant at Moses Lake.

Respectfully submitted,
John Bamberg, Acting Secretary

RESOLUTIONS of the NRSP6 TECHNICAL ADVISORY COMMITTEE
At its annual meeting, Prosser, Washington, July 25-26.

The NRSP6 Committee hereby resolves to extend...

Appreciation and congratulations to Dr. Chuck Brown and local associates for hosting a highly productive and enjoyable meeting.

Thanks to the Genebank staff for their excellent work in their germplasm distribution, research, and outreach activities.

Recognition, with thanks, to Dr. Jorge Abad for his enthusiastic and efficient management of the APHIS potato quarantine unit, without which the Genebank's service would not be possible.

Appreciation for the participation of Industry; their financial contributions, advice, and help with steering NRSP-6 toward practical applications.

Special thanks to former SR Tech Rep Dr. Creighton Miller for stepping in on such short notice and serving ably as committee Chair.

APPENDIX CONTENTS

NRSP-6 TAC14

Meeting Schedule

Prosser, WA
July 25-26, 2014

THURSDAY, JULY 24th

Suggested arrival and lodging at Prosser: Best Western Wild Horse Inn

FRIDAY, JULY 25th

8:00AM: Business meeting (members arrive)

SATURDAY, JULY 26th

Road tour at host Brown's discretion, PAA delegates returning to Spokane.

INSTRUCTIONS FOR TELECONFERENCE CALL:

Scheduled for 9 AM to 3 PM PDT.

TO CONNECT WITH YOUR *TELEPHONE ONLY* (no computer):

1. Choose one of the following numbers to dial:

* Toll-Free Number (in USA): 888-844-9904.

* Caller-Paid number: 816-423-4261

* Blackberry (Toll-Free Number): 888 844 9904 x 4410800#

* A number in your country or in a country close to you (may be toll free): https://www.teleconference.att.com/servlet/glbAccess?process=1&accessNumber=8888449904&accessCode=4410800

2. When prompted, enter the Meeting Access Code: 4410800#

Although this conference will begin with telephones only, if the conference leader instructs you to also connect your computer to the conference, you may do so by clicking here: https://connect16.uc.att.com/usda/meet/?ExEventID=85178886&CT=M

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AGENDA

NRSP6 TAC 2014 BUSINESS MEETING

Friday, July 25, 2014

Preliminaries

1. Welcome, introductions, announcements, distribution of documents (Brown & Holm)
2. Approve, add to, schedule and prioritize agenda items
3. Review of 2013 minutes
4. Chairman Holm appoints Resolutions Committee

Reports and topics for discussion

5. Lead AA (Lindroth)
6. Other regional AAs (Nessler, Ashworth, Curtis)
7. Regional and USDA Tech Reps (Holm, Douches, DeJong, Yencho, Brown)
8. Agriculture and Agrifood Canada (Bizimungu)
9. Industry and other cooperator perspectives/reports (Ronis, Krucker, others)
10. NRSP6 Project Sturgeon Bay leadership (Bamberg, Martin)
11 USDA-Madison taxonomy and enhancement (Spooner, Jansky)
12. USDA/ARS Madison, MWA, & NPL admin (Simon, Matteri, Bretting, Wisler)
13. NIFA (Thro)
14. APHIS/Quarantine (Abad)
15. Review and approve resolutions
16 Elect new officers and set next meeting venue

NRSP6 Technical Committee Meeting
June 25-26, 2014
Administrative Advisor (Lindroth) Report
(Lindroth did not attend meeting)

Continuing transitions at UW-Madison

The University of Wisconsin System has a new president, Ray Cross, who previously served as chancellor to University of Wisconsin-Extension. The University of Wisconsin-Madison has a new Chancellor, Rebecca Blank, and economist who served previously as Acting Secretary of the U.S. Dept. of Commerce. With new administration in place from the position of system president to college deans, the UW is looking forward to a time of stability!

Chancellor Blank is considering options for a new campus budget model; CALS Dean Kate VandenBosch is serving on the budget model committee.

The College of Agricultural and Life Sciences (CALS) at UW-Madison completed a year-long strategic planning process in 2013 that identified priority themes for the college (Food Systems, Bioenergy and Bioproducts, Healthy Ecosystems, Changing Climate, Health and Wellness, Economic and Community Development). Over the last year subcommittees have met to address how to implement the strategic plan framework in key areas of college activity. One such initiative is a review of the College's Agricultural Research Stations (including the Peninsular Station, home of NRSP-6). The review committee is charged with revising the overall Ag Res Stations mission statement and devising guiding principles to aid in decision-making for specific stations. Once again, I do not anticipate any significant cuts to the Peninsular Station within the next year.

State funding for UW-Madison was substantially cut for the current biennial (2-yr) budget period. The CALS budget continues to be severely constrained, as costs of operation have increased while resources have diminished. One consequence of that fiscal reality is that our faculty base continues to erode.

On the positive side, Jeff Endelmen a plant breeder with expertise in potatoes, is now established in a faculty position in the Dept. of Horticulture. Erin Silva, a former staff scientist (Agronomy) with expertise in organic production, has begun a faculty position in the Dept. of Plant Pathology.

Arlen Leholm, former Executive Director of the NorthCentral Regional Association (of land grant universities) retired in November 2013. Jeff Jacobsen, formerly of Montana State University, has assumed the new role of Executive Director. Jeff has chosen to be stationed at Michigan State University.

NRSP6 Funding Scenario

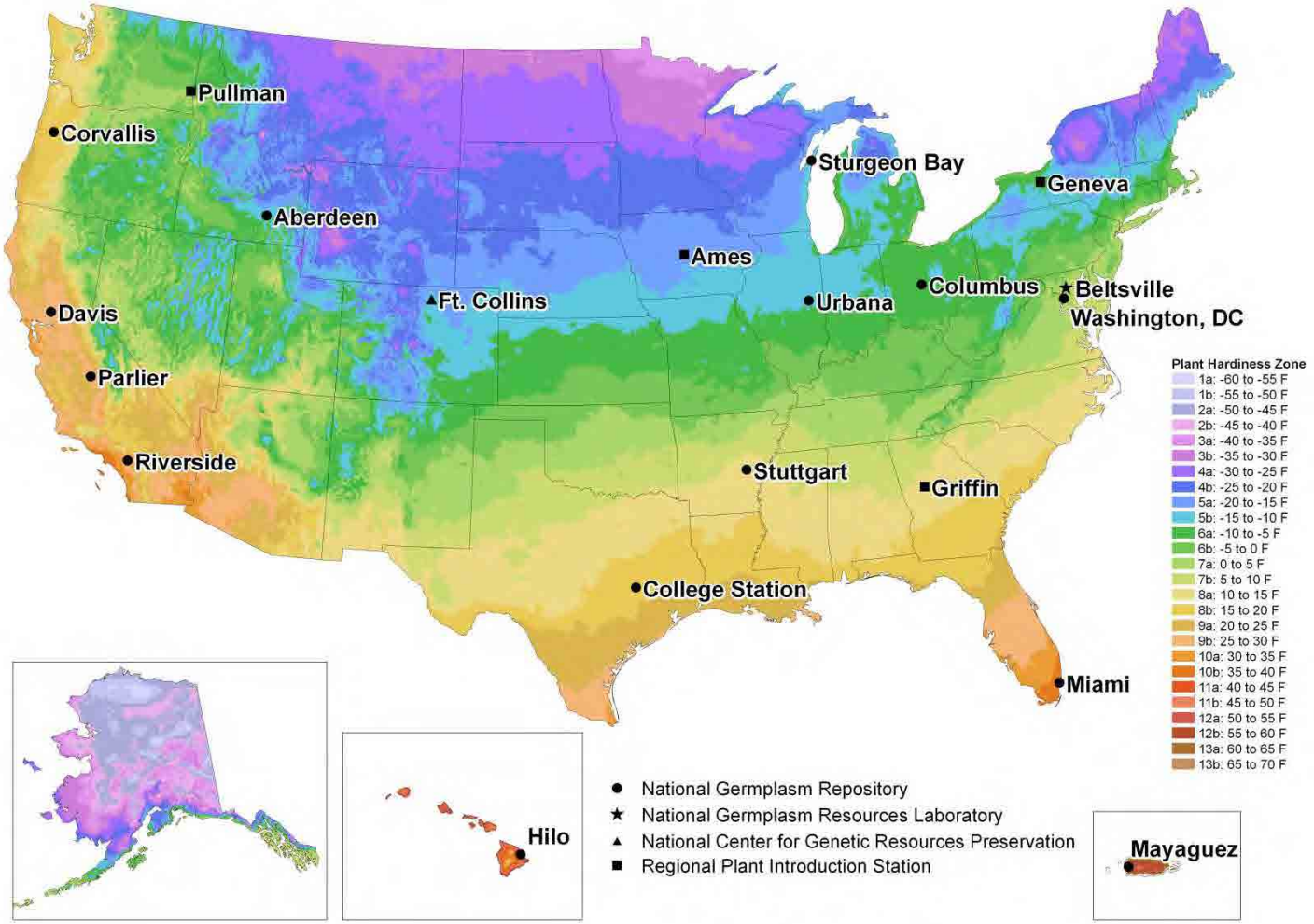
Congress approved FY14 funding for USDA at near the levels of 2012, restoring most of the funds cut during last year's sequestration. Projections for the federal FY15 budget suggest little change to most of the USDA-NIFA budget lines, with the exception of a modest increase for the AFRI (Agriculture and Food Research Initiative) budget. We can anticipate that federal OTT funding for NRSP6 will remain stable for the next year. Note also that USDA-ARS has provided a modest annual increase in funding to the Potato Genebank. John Bamberg and staff have done a fine job of securing funds from industry sponsors over the last several years and we hope that those funding sources will continue.

The National Plant Germplasm System: 2014 Status and Prospects

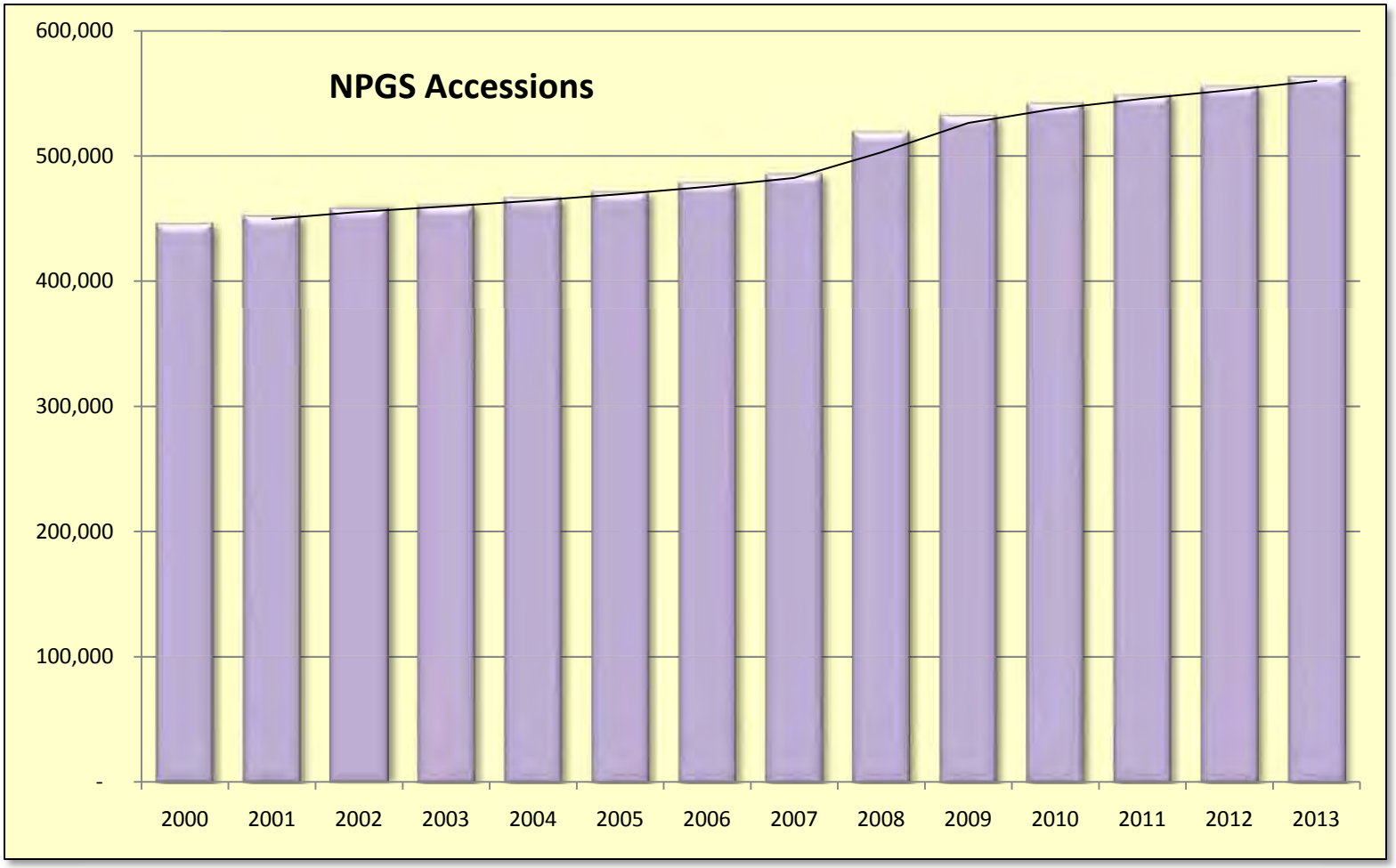
Peter Bretting

USDA/ARS Office of National Programs

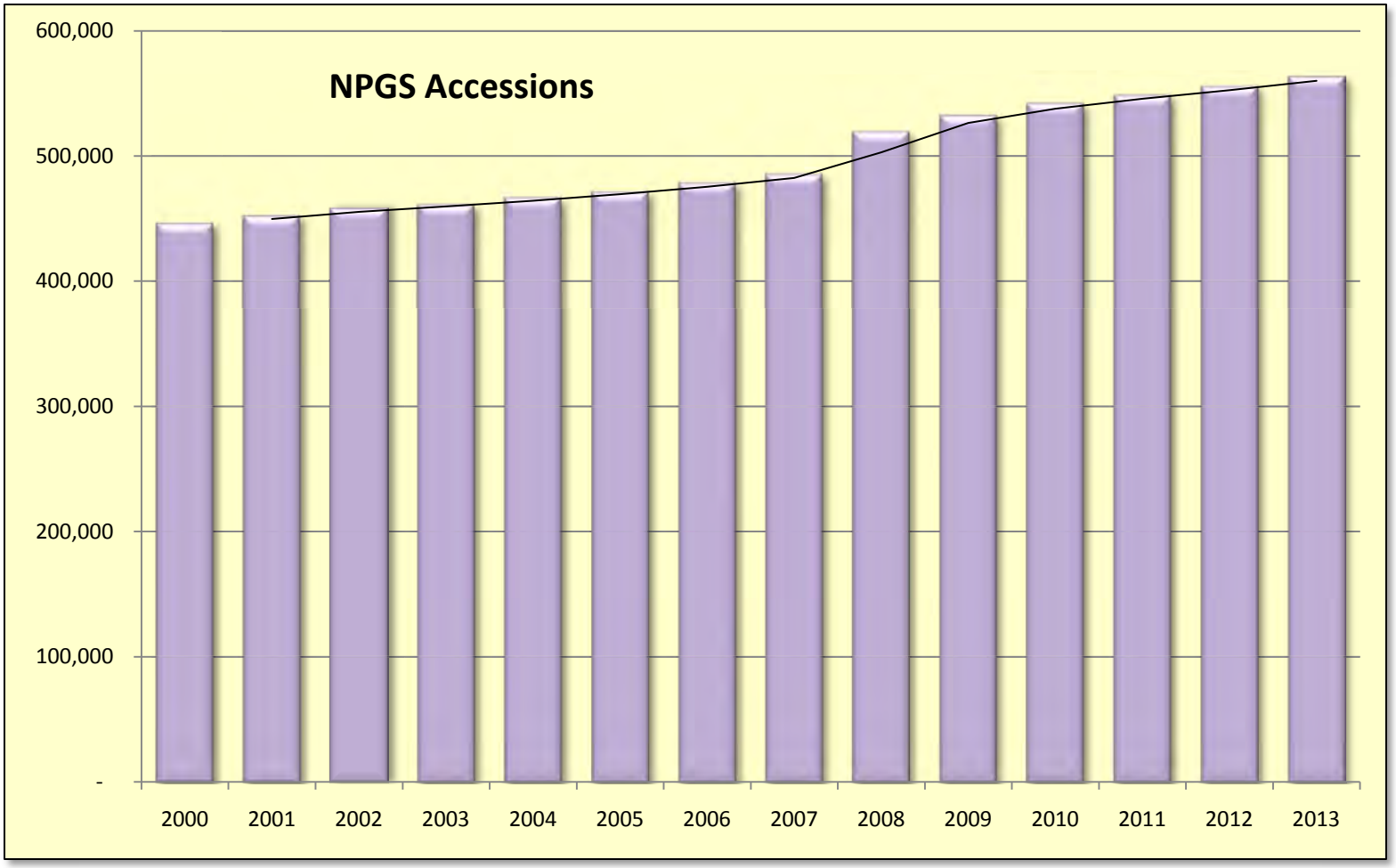
USDA National Plant Germplasm System (NPGS)



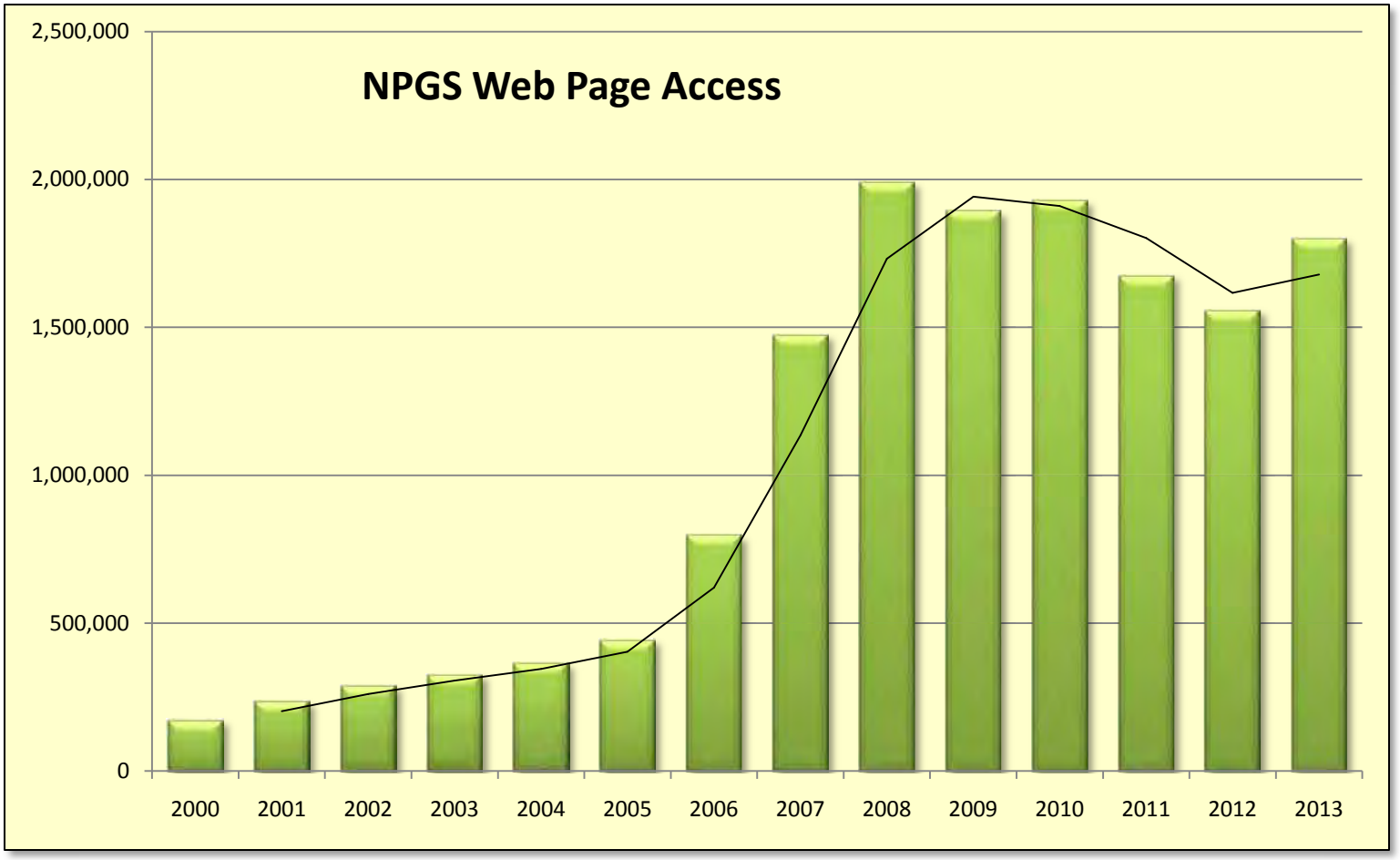
NUMBER OF NPGS ACCESSIONS 2000-2013



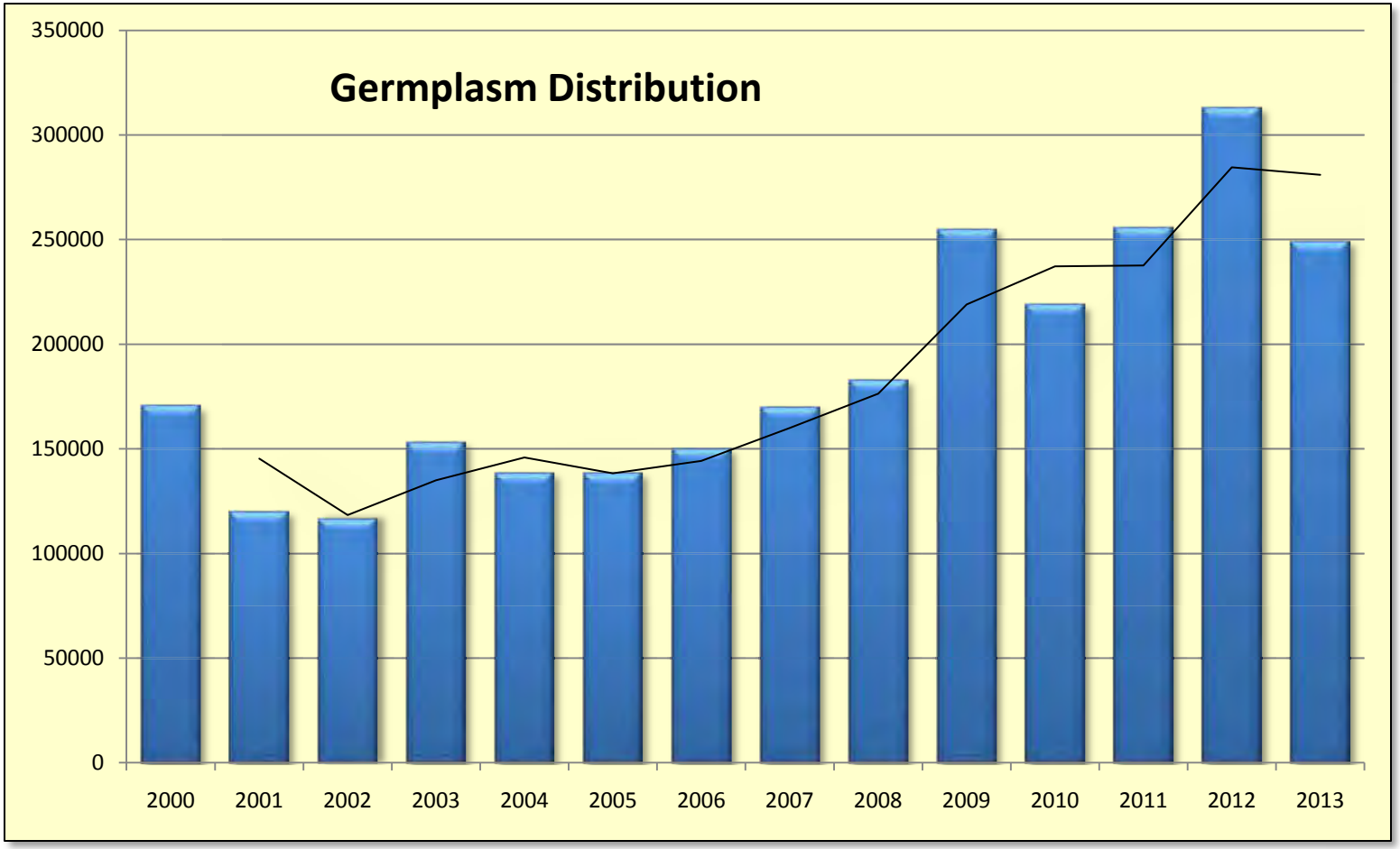
Number of NPGS Accessions 2000-2013



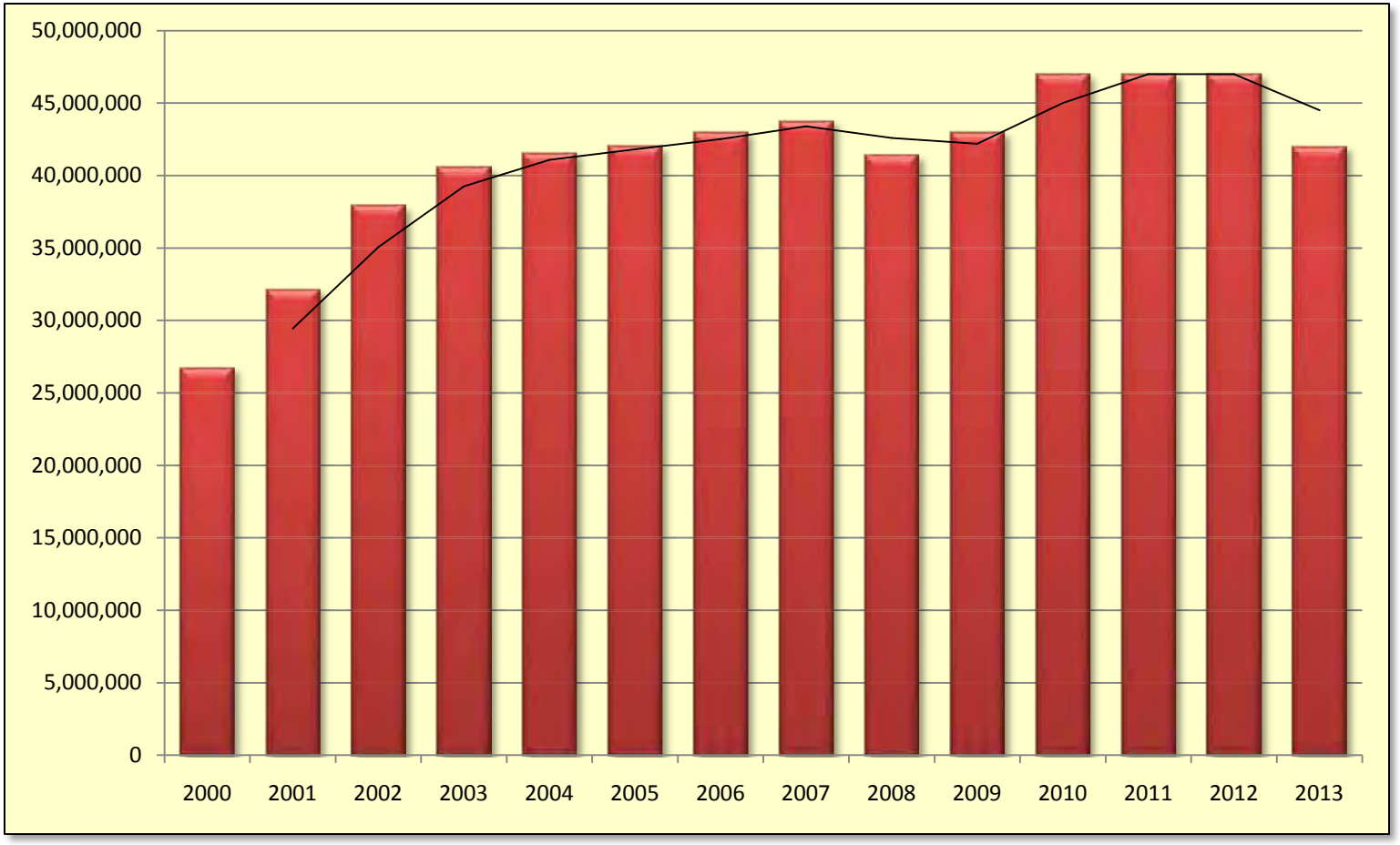
DEMAND FOR NPGS INFORMATION 2000-2013



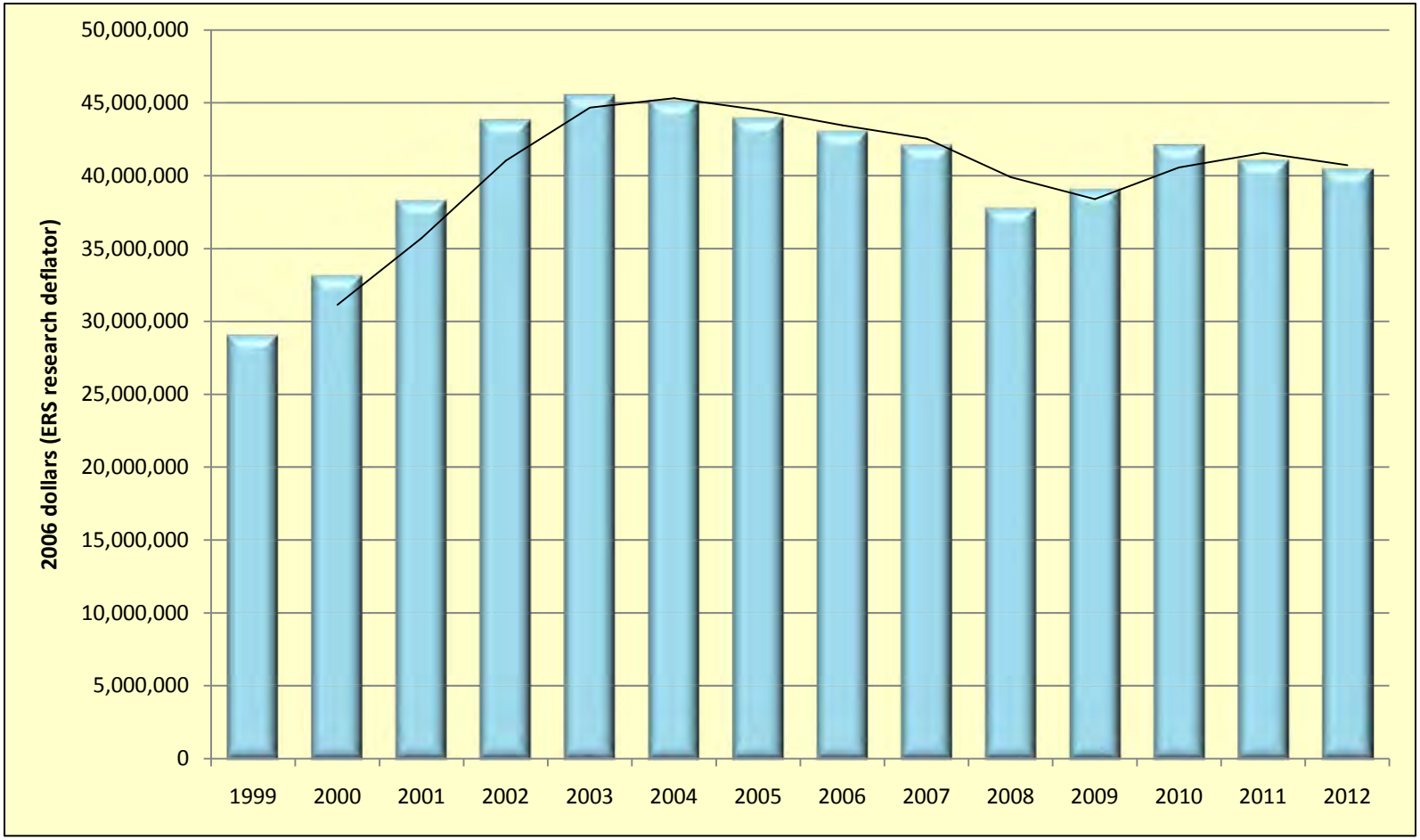
DEMAND FOR NPGS GERMPLASM 2000-2013



ARS National Plant Germplasm System budget 2000-2013



ARS National Plant Germplasm System Budget, Real, 1999-2012



Notable NPGS Developments

- **1-17 October 2013: Furlough**
  - **Only designated key personnel permitted to work.**
  - **No germplasm lost.**
  - **No germplasm distributed; GRIN off-line.**
  - **Delayed harvests, delayed shipments to winter nurseries.**
- **FAO International Treaty on Plant Genetic Resources for Food and Agriculture**
  - **Seed industry advocates US ratification.**

Notable NPGS Developments

- **Stronger and more extensive international partnerships**
  - **Hosted CGIAR Genebanks Annual General Meeting at NCRPIS, Ames.**
  - **Global Crop Diversity Trust: Developing international project for increasing the use of PGRFA (especially crop wild relatives)**
  - **PRC, S. Korea, Canada, Mexico, Colombia national genebanks: training at NPGS**

2014 NRSP-6 Germplasm Utilization Report from the North Central Region

Compiled and Submitted by
David S. Douches, NC representative
July 20, 2014

University of Wisconsin
Felix Navarro and Jiwan Palta

Our ongoing strategies include the use of lines derived from the crosses made with several wild species obtained from the NRSP-6 genebank including *S. andigena, S. brevidens, S. bulbocastanum, S. chacoense, S. curtilobum, S. demissum, S. gourlayi, S. leptophyes, S. phureja, S. raphanifolium, S. stenotomum, S. sucrense and S. tarijense*. The traits that this germplasm contribute to our breeding effort include fungal, bacterial, virus and nematode resistance as well as chipping and French fry quality. We have on hand over 250 lines derived from these species that are used in our program. For example the newly released (White Pearl) and advanced chipping breeding lines W2324-1, Nicolet (W2133-1), Tundra (W2310-3), Lelah (W2717-5), W2978-3, and W5015-12 in our program were developed by using *S. tarijense* as the maternal grandparent providing chipping ability (*S. chacoense* also contributed on the paternal side of the pedigree). Our selections for late blight resistance include several wild or native species in their background such as *S. bulbocastanum, S. demissum, S. acaule, S. phureja, S. simplicifolium and S. stoloniferum*. We have a PVY selection project in collaboration with Amy Charkowski and Shelly Jansky in which we are screening resistance from existing varieties and germplasm from sources such as *S. andigena, S. stoloniferum, S. demissum, S. chacoense, S. jamessi* and *S. pinnatisectum*. Several clones with *stoloniferum* and *andigena* sources of PVY resistance and corresponding molecular markers for PVY resistance are being used in a marker assisted selection project to facilitate introgression of PVY resistance to susceptible potato clones. Other breeding clones obtained from the the NRSP-6 genebank are actively used to generate specialty potato varieties due to the richness of these accessions to provide novel color and shape and other valuable attributes for this segment of the market. We have developed breeding lines that are in early and late stage of selections. One of these lines is a purple fingerling (W10251P/PW fing) that has been identified to be released as a potential specialty potato variety in the near future.

In addition we are conducting following projects in co-operation with NRSP-6:

The frost resistant breeding clones have been developed in cooperation with NRSP6 staff using S. *tuberosum*, S. *andigena*, S *commersonii*, and S. *acaule.* Elite clonal selections from this population have been evaluated at Hancock, Wisconsin and had good tuber type and cold hardiness to -5^{o}C. New lines are being developed using these good tuber type and *S. andigena* to select for better performance under Peruvian Highlands.

In 2012 we conducted research to study polymorphism for a candidate genes associated to frost tolerance such as the steroyl-acyl carrier protein (ACP) desaturase (SAD) desaturase gene which catalyzes the desaturation of steroyl-ACP and provides changes in membrane lipid composition associated with variability for cold tolerance. For this pupose we are using several wild species including *S. sanctate-rosae, S. commersonii, S. demissum, S. megistracrobolum, S. cardiophyllum, S. polyadenium, S. bukasovii, S. acaule, S. chacoense and S. piurae*. In addition, F2 and BC_1 populations,generated from a cross made between the frost tolerant *S. commersomii* x *S. cardiophylum* (frost sensitive) accessions obtained from the NRSP-6, is being used to identify and validate molecular markers associated with frost tolerance using the SAD gene.

We have developed progenies segregating for tuber calcium and soft rot resistance, using *S. microdontum* and *S. kurtzianum* species as parents. In cooperation with NRSP-6, we are evaluating these progenies to understand the genetics of tuber calcium uptake. In addition the entire collection of *S. microdontum* is being evaluated for tuber calcium and soft rot resistance.

We are also using a population derived from backcrosses of Atlantic to *Solanum microdontum* to study genetics of tuber calcium uptake and tolerance to heat stress. Large phenotypic variability has been found in greenhouse study for response to heat stress as high as 35 ^{o}C.

We are continuing the cooperation with CIP to conduct calcium application trials in the highlands. We are getting impressive yield improvement with in-seasons calcium applications. These studies suggest our parallel ongoing program with NRSP-6 staff to enhance calcium uptake efficiency from *S. microdontum* introgression might also have application in some locations in the Andes.

We are also continuing our collaborative research on potato tuber as a source of potassium. Potato potassium is in a unique position to mitigate hypertension, which has huge health and economic impact. Potassium levels in the tubers are also correlated to the incidence of black spot bruise. We screened the 25 species of the mini-core collection and found significant species differences in K uptake potential. We are now testing 200 cultivars and breeding stocks for K.

In addition tuber acidity is being characterized in 25 species that form the mini-core collection at NRSP-6. This parameter is being evaluated in relationship to skin color and calcium uptake efficiency.

Christian Thill
University of Minnesota

Evaluation and characterization of cultivated and wild potato species germplasm for genes of economic interest and incorporation of these genes into the cultivated Solanum

gene pool reflect the primary uses of Inter-Regional Potato Introduction Project (NRSP6) germplasm.

We evaluated 400 lines for LB resistance, 475 lines for CS resistance, and 470 lines for PVY resistance and virus expression. For the first time in 15 years LB disease spread was not observed in our LB nursery due to hot, dry summer growing conditions. However, nine MN breeding lines with LB resistance (previous studies) were selected for tuber traits and will be used in breeding. LB resistance in these lines is derived from Tollocan, Zarevo, and Atzimba, and from crossing Solanum species S. bulbocastanum, S. cardiophyllum, and S. pinnatisectum with tetraploid breeding lines.

Twenty-two MN russet lines had CS resistance equal or better than 30 nationally breed lines tested in the national CS trial.

Solanum bulbocastanum Dun. is resistant to late blight, , green peach aphid, and potato aphid. S*olanum tuberosum* + *S. bulbocastanum* somatic fusions were created for introgression of these resistance genes into the cultivated gene pool. Among the 63 lines screened, nine expressed resistance to green peach aphid and five lines expressed resistance to potato aphid. Virus resistance field screenings over 4 years indicated 29 lines were resistant to PVY and five were resistant to PLRV. Of those, two were resistant to both PVY and PLRV. Lines were tested with markers linked to R genes for resistance to PVY as well as the marker for late blight resistance. Line K7G-319 has pyramided resistance to both aphid species. Line K7G-329 has pyramided *M. persicae*, *M. euphorbiae*, PVY and late blight resistance This study has shown that somatic hybridization can be used to introgress aphid resistance from wild potato species that are sexually incompatible with *S. tuberosum*.

Davis JA, EB Radcliffe, CA Thill, DW Ragsdale. Resistance to Aphids, Late Blight and viruses in Somatic Fusion and Crosses of Solanum tuberosum L. and Solanum bulbocastanum. Am. J. Pot. Res 2012. DOI 10.1007/s12230-012-9272-1. **DISEASE RESISTANCE**

Late blight we evaluated 590 lines for resistance. Lines B0718-3, AWN86514-2, B0718-3, AWN86514-2, and AF4191-2 continue to show LB resistance. Another 42 MN lines have equivalent resistance. A second MN breeding population developed by crossing LB resistant lines Tollocan, Zarevo, and Atzimba, and from crossing Solanum species *S. bulbocastanum, S. cardiophyllum,* and *S. pinnatisectum* with tetraploid breeding lines has facilitated the development of 50 germplasm lines with significant LB resistance. 2012 NCR variety trial reports performance of lines submitted.

Common scab we evaluated 575 lines for resistance. Lines MSQ279-1, MSR169-8Y, Superior, B1992-106, A01010-1, A00286-3Y, AF2850-9, and MN18747 show resistance to CS. Among MN germplasm, 21 lines had no CS and another 35 lines had limited surface lesions. 2012 NCR variety trial reports performance of lines submitted.

North Dakota State University

Susie Thompson

Utilization of Germplasm Resources from NRSP-6

The overall goal of the NDSU potato breeding program is to identify, develop, and release superior, multi-purpose cultivars, that are high yielding, possess multiple resistances to diseases, insect and other pests and abiotic stresses, have excellent processing and/or culinary quality, and that are adapted to production in North Dakota, Minnesota, the Northern Plains, and beyond. Germplasm enhancement and dedicated crossing blocks are used in hybridizing to develop resistance to biotic and abiotic stresses, and in improving quality traits. The potato improvement program emphasizes disease, insect pest, and stress resistance, including late blight, cold-sweetening, Colorado potato beetle, *Verticillium* wilt, pink rot and *Pythium* leak, sugar end, silver scurf, *Fusarium* dry rot, PVY, and aphid resistance breeding. In developing durable long-term host-plant resistance to these pests and stresses, breeding efforts include germplasm enhancement, incorporating resistance and improved quality attributes through the use of wild species, wild species hybrids, and the use of released cultivars and advanced germplasm from around the globe, in order to meet our research objectives of: 1) Developing potato (*Solanum tuberosum* Group Tuberosum L.) cultivars for North Dakota, the Northern Plains, and beyond, using traditional hybridization that are genetically superior for yield, market-limiting traits, and processing quality; 2) Identifying and introgressing into adapted potato germplasm, genetic resistance to major disease, insect, and nematode pests causing economic losses in potato production in North Dakota and the Northern Plains, and 3) Identifying and developing enhanced germplasm with resistance to environmental stresses and improved quality characteristics for adoption by consumers and the potato industry. Durable host plant resistance is a key element of an integrated approach to pest and stress management, and may result in economically sustainable production due to reduced input costs and limited environmental impacts. Primitive and wild species derived material has been used in the NDSU breeding program since 1930. Currently, primitive varieties, including Gps. Andigena and Phureja, and species and species-hybrids including *S. acaule*, *chacoense*, *demissum*, *etuberosum*, *fendleri*, *vernei, raphanifolium*, *bulbocastanum, berthaultii,* and *polytrichon* contributing resistance to pests, pathogens and stress are being utilized in the breeding program. Additionally, many species such as *S. chacoense, fendleri,* and *raphanifolium* bestow enhanced quality attributes such as high dry matter content and processing ability.

Specific examples of our efforts include an integrated approach to insect pest resistance, late blight, and improved quality attributes. The Colorado potato beetle (CPB), *Leptinotarsa decemlineata* Say, is the most significant insect defoliator of potato in North America (Mowry and Sandvol 1995), resulting in loss of total yield, grade, and quality. Host-plant resistance to CPB utilizing potent glycoalkaloids, specifically leptines contained in the North Dakota breeding line ND2858-1, in combination with glandular trichomes, occurring in *Solanum berthaultii* (Plaisted et al. 1992) and other species, offers a unique host-plant combination strategy. Green peach aphid is the predominant vector of PVY in the northern plains (Radcliffe and Ragsdale 2002); however, recently soybean aphid has been identified as a significant vector, although it is less efficient in

transmission, huge numbers of the pest makes its contribution to PVY transmission considerable . Physical, mechanical, and chemical attributes, or a combination may render a genotype resistant to GPA. For example, glandular trichomes associated with *S. berthaultii* (Hawkes) impede the aphid's ability to move and probe, thus providing both physical and chemical resistance. *S. etuberosum* also contributes resistance to aphids and viruses (Novy and Helgeson 1994; Novy et al. 2002, 2004). In 2013, we accessed 18 accessions (*S. cardiophyllum, S. jamesii, and S. stoloniferum*) from the Potato Introduction Project at Sturgeon Bay to enhance our insect resistance breeding efforts. Aphid vectored viruses, particularly Potato Virus Y (PVY) have significantly impacted certified seed potato production in ND and across North America during the last decade. High incidence of virus in seed fields results in rejection of the lot, and in reduced availability of desired cultivars. The NDSU potato breeding program combines several facets in developing late blight resistant selections. These include a dedicated crossing block of parents for hybridizing. A detached leaf assay is used to assess progeny families for resistance using a mixture of P. infestans representing all 11 Avr genes. Resistant seedlings are field tested and selected for agronomic traits in addition to field resistance in replicated trials. Many of the materials in our crossing block, and advancing through our program, are backcrosses with lines derived from somatic fusions involving *S. bulbocastanum* (Helgeson et al. 1998). NDSU releases with diploid ancestry are NorValley (Novy et al. 1998), Dakota Pearl (Thompson et al. 2005), and Dakota Diamond (Thompson et al. 2008). All are cold-chipping cultivars with Gp. Phureja in their pedigree and Dakota Diamond also has *S. chacoense* in its pedigree. Our recent release, Dakota Russet, has *S. raphanifolium* contributing cold sweetening resistance.

The NRSP-6 Potato Genebank and Potato Introduction Project are invaluable to our potato breeding and improvement efforts at NDSU, by allowing access to cultivars and Solanum species accessions from around the globe. 'Pre-breeding' using this material is conducted by programs such as those of Drs. Shelly Jansky, Kathy Haynes, and Rich Novy and our program often accesses their materials for use as parents, or via unselected seedling tuber exchange.

Michigan State University
David Douches

Germplasm Enhancement

We are refocusing our diploid breeding effort to incorporate the dominant Sli gene, which imparts self-compatibility (SC), into our germplasm base. The source of the gene is *S. chacoense* M6 from Shelley Jansky's program. Last year we made hybridizations and some selections. Another round of crossing is taking place to establish a recurrent selection program that is using *S. phureja, S. berthaultii, S. tarijense, S. chacoense, S. microdontum* and *S. raphanifolium.* These germplasm sources have been interbred and are also now being hybridized to Atlantic and Dakota Diamond haploids. These species have been chosen over the years because of late blight resistance, PVY resistance, beetle resistance, verticillium wilt resistance, chip-processing quality, high solids, dormancy and yellow flesh. Some of the selections are being used to develop populations for genetic studies that will be SNP

genotyped. Our ultimate goal is to develop inbred diploid lines that can be used as true-breeding varieties or be parental material in F1 hybrids. The inbred lines also can be used in 4x-2x crosses. We have crossed a set of *S. berthaultii* PIs that have high densities of leaf trichomes to the SC parent lines we have at MSU. The goal is to select SC hybrids that can be used to develop RIL populations that fix the desirable trichome traits.

We have also used the species *S. berthaultii* for developing a mapping population to conduct QTL analysis for late blight resistance, tuber dormancy and tuber number and size. The population was SNP genotyped last year. This population is currently in the field for field late blight data collection to complement the detached leaf bioassay data collected this winter. Right now we have a major late blight QTL on chr. X. Tuber dormancy is preliminarily mapped to chr. IV, V and VII.

We are also working with John Bamberg to SNP genotype four species that differ in breeding systems to better understand how to manage these species in the gene bank. A manuscript is being worked on this summer.

Abstract of paper submitted to Plant Genome:

Taxonomy and Genetic Differentiation Among Wild and Cultivated Germplasm of *Solanum* sect. *Petota*

Michael A. Hardigan[1], John Bamberg[2], C. Robin Buell[1], and David S. Douches[3]*

Due to their adaptation to a diverse set of habitats and stresses, wild species of cultivated crops offer new sources of genetic diversity for germplasm improvement. Using an Infinium array representing a genome-wide set of 8303 single nucleotide polymorphisms (SNPs), we evaluated phylogenetic relationships and allele diversity within a diversity panel of germplasm from *Solanum* sect. *Petota*, the group containing tuber-bearing species and landraces of potato as well as cultivated potato (*Solanum tuberosum* L.). This diversity panel consists of 75 plant introductions (PIs) representing 25 species and provides a diverse representation of tuber-bearing *Solanum* germplasm. To determine the relatedness between current species classifications and SNP-based genetic distances, we generated a phylogeny based upon random individuals from each PI that, with few exceptions, revealed general agreement with taxonomic grouping of species in *Solanum* sect. *Petota*. Genotype comparisons between our *Solanum* sect. *Petota* diversity panel and a panel of 213 tetraploid cultivars and breeding lines revealed that the average genetic distance between landraces was higher than between cultivated clones, indicating a greater extent of diversity between populations of native Andean landraces than among modern cultivars and breeding lines. Analysis of allele frequencies at individual SNP loci between the *Solanum* sect. *Petota* diversity panel and tetraploid cultivars revealed loci with extreme divergence between cultivated potato and its tuber-bearing relatives. Interestingly, a number of these loci are associated with genes related to carbohydrate metabolism and tuber development, suggesting potential roles in domestication of potato. Our SNP data offers a new taxonomic

view of potato germplasm, while further identifying candidate alleles that likely differentiate wild germplasm and cultivated potato and underlie key agronomic traits.

Report to the NRSP-6 Technical Committee

Prosser, WA, July 25-26, 2014

B. Bizimungu, Agriculture and Agri-Food Canada

I) Introduction and utilization of potato accessions from NRSP-6 Project

In 2013, accessions from the Potato Introduction Station (NRSP-6, Sturgeon Bay, WI) were supplied to researchers at six (6) Canadian institutions including Agriculture and Agri-Food Canada, totalling 97 units.

II) Utilization of potato accessions from NRSP-6 Project in breeding

Agriculture and Agri-Food Canada (AAFC) is a major user of nrp6 material as part of the national potato breeding and germplasm enhancement project. A major focus is on the incorporation of genetic resistance to major diseases and pests (including late blight, PVY, PLRV, *Verticillium* wilt, blackleg and the Colorado potato beetle), as well as cold-induced sweetening resistance into parental lines and adapted cultivars. Sources of new traits recently obtained from NRSP-6 project include: i) *S. oplocense* as a source of resistance to colorado potato beetle and chipping quality, ii) *S. demissum* and *S. bulbocastanum* as source of resistance to late blight, iii) *S. chacoense* as source of resistance to late blight, Verticillium wilt, Colorado potato beetle resistance, and of chipping quality, and iv) *S. pinnatisectum* as source of resistance to late blight and colorado potato beetle.

Continued or New research interest in breeding for disease resistance and new nutritional quality traits (such as antioxidant properties and resistant starch) have resulted in increased use of nrp6 accessions or their derived material in breeding and genetic studies. Germplasm carrying nrp6 material is progressing through various stages of breeding spanning from hybridization and early generations selections to the national adaptation trials conducted at seven sites in six provinces. The latter stage takes places after 6 years of breeding and selection conducted at Agriculture and Agri-food Canada's breeding substations in Benton Ridge, NB under rain-fed production systems and Vauxhall, AB under irrigated production systems. Following the national trials, advanced selections are released to the industry for further testing for a period of up to 5 years, after which promising ones are officially named and registered for commercial production in Canada. In 2013, three (3) new AAFC selections have successfully completed industry testing and were granted national registration. Overall, 26 cultivars (listed section IV) originating from Canadian, USA and European breeding programs were registered in 2013.

III) Potato Gene Resources Collection

The Agriculture and Agri-Food Canada's Potato Research Centre in Fredericton, NB is custodian of the Canadian potato genetic resources. The Canadian potato genetic repository is one node in the national gene banks system, which is coordinated through Plant Gene Resources Canada (PGRC, web site http://pgrc3.agr.gc.ca). It contains 167 clones, including modern Canadian-bred potato cultivars, heritage cultivars, and selected

breeding parents which are maintained *in vitro* or as tubers. A backup collection is maintained as micro-tubers at Plant Gene Resources Canada (PGRC) in Saskatoon, SK. In addition to the long-term preservation of collection accessions, activities of the potato gene bank also include their evaluation for utilization purposes. Material from the collections is available on request to researchers and academic communities in Canada and around the world for breeding, research and heritage preservation. A standard material transfer agreement is required before seed is released.

The current potato genetic resources newsletter (including annual report) and several back issues may be accessed (browse for the newsletter by title) on the Government of Canada Publications website (http://www.publications.gc.ca).

IV) Cultivars release

Cultivars granted national registration in Canada in 2013 (Source: CFIA):

Orchestra
Yukon Gem
Defender
Melody
Musica
AAC Alta Cloud (CV98112-3) *
AR2007-2 *
Milva
Alpine Russet
Classic Russet
Clearwater Russet
Mazama
Modoc
Premier Russet
Princess
Alta Blush
Cecile
Marilyn
Sifra
Europrima
Tebina
AB-AN
Arbor Globe (PR90-18-3)
AAC Alta Rose (CV00088-3) *
Mozart
Parella

* Agriculture and Agri-Food Canada

V) Recent Publications/Conferences

- Bizimungu, B., Bach, S., Sullivan, J.A., Fan, M.Z. and Yada, R.Y. (2014). Genotypic and environmental variation in potato flour rheological properties and their association with dietary carbohydrate profiles. Proceedings of the 19th Triennial conference of the European Association for Potato Research, Brussels, 6-11 July 2014.
- Bizimungu, B., Hawkins, G., Mikitzel, L., and Murphy, A. (2014). Use of Near-infrared Spectroscopy (NIRS) to Predict Dry Matter Content and Starch Composition in Potato Tubers. Proceedings of 2014 NORTHEAST POTATO TECHNOLOGY FORUM, Fredericton, March 12-13, 2014.
- Bizimungu, B., Kawchuk, L.M., Wahab, J., Waterer, D.R., Konschuh, M.N., and Lynch, D.R. (2013). "AAC Alta Strong potato variety- A new option for French fry processing and fresh market uses." 97th Annual Meeting of the Potato Association of America (PAA), Québec City, QC, Canada, July 28-August 2, 2013.
- Li, X.-Q., Haroon, M., Luo, S., Bizimungu, B., Xiong, X., Zebarth, B.J., and Tai, H.H. (2013). "In vitro and field testing of drought tolerance of potato clones." 97th Annual Meeting of the Potato Association of America (PAA), Québec City, QC, Canada, July 28-August 2, 2013.
- Li, X.-Q., Xu, C., Liu, X., Haroon, M., Liu, J., Xie, C.Y., Meng, F., De Koeyer, D.L., Leclerc, Y., Donnelly, D.J., and Murphy, A.M. (2013). "Identification of the major enzyme and genes controlling cold sweetening in potato tubers during storage." 97th Annual Meeting of the Potato Association of America (PAA), Québec City, QC, Canada, July 28-August 2, 2013.
- Tai, H.H., Goyer, C., Platt, H.W., De Koeyer, D.L., Murphy, A.M., Uribe, P., and Halterman, D. (2013). "Decreased defense gene expression in tolerance versus resistance to Verticillium dahliae in potato." Functional and Integrative Genomics.
- Tai, H.H., Worrall, K., Pelletier, Y., De Koeyer, D.L., and Calhoun, L.A. (2013). "Metabolites from CPB-resistant wild Solanum species." 97th Annual Meeting of the Potato Association of America (PAA), Québec City, QC, Canada, July 28-August 2, 2013.
- Tai, H.H., Goyer, C., Platt, H.W., De Koeyer, D.L., Murphy, A.M., Uribe, P., and Halterman, D. (2013). "Decreased defense gene expression in a potato clone with tolerance to Verticillium dahliae." 9th Canadian Plant Genomics Workshop, Halifax, NS, Canada.

Summary of the Clonal and True Potato Seed Testing

at

The Plant Germplasm Quarantine Programs

NRSP-6 Technical Committee Meeting

Prosser, WA/ June 25-26, 2014

Jorge Abad, PhD
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Potato, Sweet Potato and Cassava Quarantine Programs
Plant Protection and Quarantine (PPQ)
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Introduction

The mission of the Potato Quarantine Program (PQP) is to test germplasm for pathogens as a condition for the entry of this valuable plant germplasm into the United States. Special emphasis is given to the detection of viruses, viroids and bacteria including phytoplasmas. This program is the first line of defense against the inadvertent introduction of new potato diseases into the USA. Such diseases have the potential to create both economical and environmental burden to the crop. In addition, in our program, any infected material is subjected to therapy for the elimination of pathogens and then retested to ensure the success of the treatment. In the end, all the accessions received in our program are released to the requesters. Furthermore, PQP has a strong and an efficient collaboration with the NRSP-6 promoting: the acquisition, sanitation and further use of clean germplasm.

Accomplishments

Our program keeps very high standards in pathogen detection tests for potato diseases. We perform very sensitive, state of the art molecular tests, routinely: RT-PCR and PCR with generic primers for: luteoviruses, carlaviruses, potexviruses, potyviruses, geminiviruses and phytoplasmas and qRT- PCR (real time) to detect *Potato yellow vein virus,* a potentially damaging and true-seed transmitted virus. Furthermore, in collaboration with the International Potato Center (CIP) in Peru, we are identifying difficult unknown viruses by next-generation sequencing analysis, a new method where no specific primers are needed. Curiously, we continue using a sound biological test under optimum conditions that ensures the interception of unknown or unusual viruses. ELISA and the current molecular based methods will not allow the detection of those viruses. For this test, we mechanically inoculate 12 different indicator plants and perform grafting onto healthy potatoes.

Our primary stakeholders continue to be potato breeders from universities, government and the private industry. We are also continuing our collaboration with the NRSP-6 US Potato Genebank by introducing more potato accessions through our quarantine program and cleaning their infected accessions by therapy. This season, a total of 14 accessions were imported and/or treated by therapy for the Genebank. Of the seven virus-infected accessions that were sent to us from Sturgeon Bay, four clones completed therapy and testing therefore released back to Genebank. The remaining three accessions have completed therapy and will be tested this year. Thermotherapy and chemotherapy were used in the treatments. Additionally, this year we have requested seven more cvs. for the Genebank, all from the International Potato Center in Peru.

Clonal and True Potato Seed Testing at the Potato Quarantine Program

This season there were 105 potato clones in our program. From those, 98 clones were received, as *in vitro* cultures. After testing, we released 56 accessions. Nine clones either died or did not grow, and 40 clones tested positive for either carlaviruses or Potato leaf roll consequently remain in therapy.

For TPS, 48 seed lots were introduced this season. Twenty two were discarded at the donor's request, 26 were tested and only 18 were released because eight more accessions were discarded at the request of the donor (Table 1). One more year we have surpassed our yearly quota (75 clones) for potatoes.

Table 1.- 2013-2014 PQP Potato Testing Season

Clonal Potatoes

There were 105 potato clones in the PGQP in the 2013-2014 season.

1	clone was received in 2011	
1	from Chile	for G. Secor
6	clones were received in 2012	
1	from Poland	for C. Brown
1	from Japan	for M. Martin
1	from Germany	for L. Ewing
1	from Germany	for Valley Tissue Culture
1	from The Netherlands	for Valley Tissue Culture
1	from Germany	for C. Keller
98	clones were received in 2013	
	all were received *in vitro*	
42	from Chile	for G. Secor
6	from Ethiopia	for K. Perry
5	from France	for K. Perry
11	from Germany	for Valley Tissue Culture
2	from Germany	for F. Goktepe
11	from The Netherlands	for Valley Tissue Culture
10	from The Netherlands	for N. Champouret
2	from Peru	for M. Martin
9	from Peru	for R. Shakya
1	from Scotland	for J. Wallace

Of these 105 clones:

6	died before testing began	
2	arrived too late for testing	
1	was discarded (a replicate of a released clone)	
96	were tested	
	40 were positive	(Carlavirus, Luteovirus)
	56 were released	

True Potato Seed

There were 48 TPS lots in the PGQP in the 2013-2014 season.

30	from The Netherlands	for J. Bragg
18	from The Netherlands	for J. Debons

Of these 48 seed lots:

22	were discarded at the request of the donor before testing commenced
26	seed lots were tested
	18 were released
	8 were discarded at the request of the donor after testing commenced

ANNUAL REPORT
Calendar Year 2013 - June 2014

NRSP-6: UNITED STATES POTATO GENEBANK

Acquisition, Classification, Preservation, Evaluation and Distribution of tuber-bearing *Solanum* Species.

COOPERATIVE AGENCIES AND PRINCIPAL LEADERS

State Agricultural Experimental Stations		Representative
Technical Representatives		
Southern Region		C. Yencho
Western Region	Chair (2014)	D. Holm
North Central Region		D. Douches
Northeastern Region	Secretary (2014)	W. De Jong
Administrative Advisors		
Southern Region		C. Nessler
Western Region		L. Curtis
North Central Region	Lead AA	R. Lindroth
Northeastern Region		E. Ashworth

United States Department of Agriculture		
ARS		
Technical Representative	Vice Chair (2014)	C. Brown
National Program Staff		P. Bretting
		G. Wisler
Midwest Area		R. Matteri & P. Simon
NIFA		A. M. Thro
APHIS		J. Abad
NRSP-6 Project Leader		J. Bamberg
Agriculture & Agrifood Canada		B. Bizimungu

PROGRESS AND PRINCIPAL ACCOMPLISHMENTS

A. Acquisitions and associated work

In 2013, we collected 16 germplasm accessions from the southwest USA under the BdRFK (Bambergs, del Rio, Fernandez, Kinder) prefix. Another major accomplishment was to collect DNA samples from *S. jamesii* Mega-populations at the top and bottom of the range, especially the huge population at Mesa Verde. We are using DNA markers to find out if such populations are such incubators for diversity that they are the only place one needs to collect. We also tested new ideas for collecting when propagules are poor: 1) collecting in *vitro* in PPM medium needs no sterile hood and rescues clones that will not root in soil, 2) AFLP data has shown that collecting pollen captures unique alleles, 3) simple insecticide application to collected fruit prevents fruit fly grubs from destroying seeds. We made the first reported discovery and collection of potato from the Dragoon mountains. We confirmed that *jamesii* still exists at the historic Faraway Ranch site, despite being unable to find it there since 1995. USDA/ARS/Plant Exploration Office supplied $5K and has again in 2014. Detailed trip report for 2013 and plan for 2014 are available on request.

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Mesa Verde *jamesii* mega-population-- millions of plants over 100+ acres

The genebank imported 7 elite breeding stocks from other countries and accepted 7 elite "M" clones from the Shelley Jansky program.

The NRSP-6 web page (http://www.ars-grin.gov/nr6) was updated to include all new stocks and screening information. Clients who have ordered from NRSP-6 within the past four years were contacted three times in 2013, informing them of new stocks of true seed, tubers, in vitro plantlets, or other samples. We used email and the website to extend technical instructions of various types. For example, a technique for breaking tuber dormancy was fine tuned to give reliable and uniform results, even for very deep dormancy tubers.

Better dormancy breaking techniques

B. Preservation and Evaluation

A total of 170 accessions were increased as botanical seed populations and 1900 clonally. Over 720 potato virus tests were performed on seed increase parents, seedlots and research materials. Germination tests were performed on 1489 accessions, ploidy determinations were made on 60 accessions, and tetrazolium seed viability tests were done on 50 seedlots. Taxonomic status was assessed on all stocks grown. A total of 7122 units of germplasm were distributed in 249 orders. Orders were filled within one week of receipt. Nearly 200 field plots were planted to verify that seed multiplication efforts last year resulted in offspring seedlots that matched their parents. We used SNPs (cooperator Douches from MI) to assess partitioning of genetic diversity in model potato species with a view to understanding their best management.

With help of cooperators, we made progress evaluating and improving germplasm on several ongoing projects. Over 1800 field plots at USPG, about 1500 seedlings tuberized in two sites in CA (cooperators Serimian and Pearson), and 4 large screenhouses at USPG full of stocks supporting screening for improved *Criolla* or "egg yolk" style specialty potato with golden flesh (cooperator Douglass from FL), folate (cooperator Goyer from OR), glycoalkaloids (cooperator Navarre from WA), anti-obesity (cooperator Kemin from IA), greening, K-screening, new *Coronita* fruit mutant (extra pistils in place of anthers), Zebra Chip resistance in *bulbocastanum* (cooperator Cooper in WA).


Improved *Criolla* selections

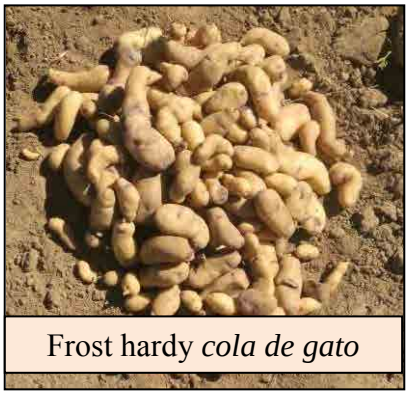
We detected a significant association of tuber pH (very fast, cheap and easy to screen) with glycoalkaloids and folate (much harder to screen) and organized an experiment to test this more systematically.


Coronita male sterile mutant


Zebra Chip resistance in *bulbocastanum*

This year, work with J. Palta (UW), International Potato Center (CIP), and colleagues in the Peruvian national potato program (INIA) progress was made in the frost hardiness breeding project with *S. commersonii*. An elite selection was informally named *"Cola de gato"*. We also initiated a program to re-breed the non-bitter, frost hardy *S. ajanhuiri*, a primitive cultivated species with reputed progenitor *S. megistacrolobum* native to the Puno Altiplano.

Bamberg, Palta, del Rio, Gomez and locals at Potato Park near Cusco, Peru



Frost hardy *cola de gato*

Dr. Jansky's Enhancement:

The germplasm release of clone M6 was published in the Journal of Plant Registrations. M6 is an inbred line derived from seven generations of self-pollination. It is homozygous for the Sli gene that confers self-compatibility, and it is male and female fertile.

Jansky, S.H., Y.S. Chung, and P. Kittipadukal. 2014. M6: A diploid inbred line for use in breeding and genetics research. Journal of Plant Registrations. doi: 10.3198/jpr2013.05.0024crg.

Yong Suk Chung completed his Ph.D. thesis entitled “Bacterial soft rot resistance and calcium enhancement in wild and cultivated potato.” A polymorphism in the *CAX3-like* candidate gene for calcium uptake by roots was found to be associated with tuber calcium levels. An additional 12 SSR markers also co-segregated with calcium in tubers. SSR4743 is located near the *CAX3* homolog on chromosome 7.
Predictivity of taxonomy and biogeography for late blight resistance was completed (Alexander Khiutti, visiting scientist, St. Petersburg, Russia).A collection of 143 accessions representing 34 wild *Solanum* species was screened for foliar late blight resistance using whole plants and for tuber late blight resistance using greenhouse-generated tubers. A manuscript is in preparation.

Recombinant inbred lines are being developed in populations derived from wild species carrying resistance to early blight (*S. raphanifolium*) and common scab (*S. chacoense*). In addition, an F2 population derived from self-pollinating a clone from a cross between DM1-3 and M6 is segregating for a number of agronomic and disease resistance traits. It is being genotyped using the SolCAP SNP array and will be used for trait mapping. RILs are also being developed in this population.

A population derived by crossing US-W4 with M6 has been grown in replicated field trials for three years. Yield comparable to that of cultivars is common among clones in this population. Phenotyping (tuber yield, size set; chip color) and genotyping are underway.

C. Classification

Dr. Spooner is working on monographs that will fully document the taxonomic reduction of the genebank's species to about 100 species.

D. Distribution service

Distribution of germplasm is at the heart of our service. The volume and types of stocks sent to various consignee categories are summarized in the table below. **We filled almost 1/3 more orders in 2013 than 2012**: 230 domestic orders to clients in 39 states of the USA and 19 foreign orders to 10 other countries. About ½ of domestic orders are for breeding and genetics, about ¼ for home gardeners, and the remaining ¼ for pathology, physiology, entomology, taxonomy, and education. In 2013 we maintained the popular offering of 100 cultivars as tubers by devising and implementing an iron-clad disease control and quarantine program for their production (full details available at our website).

	Units of Germplasm Sent[1]								
Category	Seed	TU	TC	IV	DNA	Plants	Herb	Total	PIs
Domestic	2,762	71	2,484	1,181	50	2	0	6,550	4,688
Foreign	480	0	12	80	0	0	0	572	501
Total	3,242	71	2,496	1,261	50	2	0	7,122	5,189

[1] Types of stocks sent/(number of seeds, tubers or plantlets per standard shipping unit): Seed= True Seeds/(50), TU = Tuber families/(12), TC = Tuber Clones/(3), IV = *in vitro* stocks/(3), DNA = dried leaf samples/(1), Plants = rooted cuttings /(1), Herb= herbarium specimens/(1).

E. Outreach

Media coverage, Tours, Teaching, TechTran and Trips with presentations done

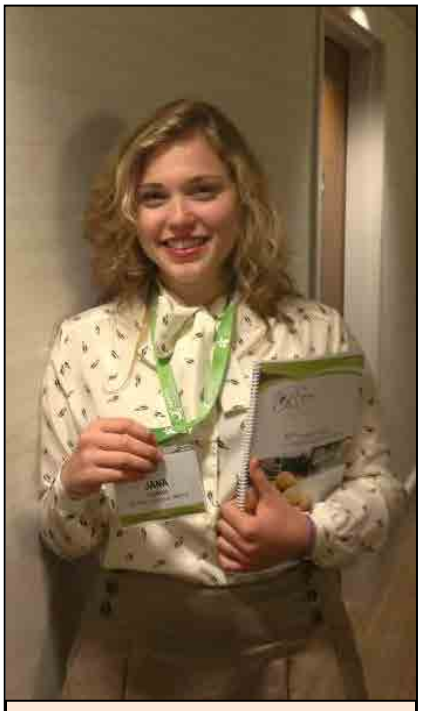
Bamberg served as PhD committee member for Cinthya Zorrilla-C, and Yong Soek Jung.

Summer student interns participated in experiments: Ahna Keilar (seed germ and seedling transplant tech), Abe Keilar (crossing tech for jam and blb), Hannah Haight (prebiotic assay and nutrient microbial bioassays), Jana Suriano (*Matryoshka* floral mutant and tuber greening with publication authorship, attended and made formal presentation at PAA, participated in Arizona collecting).

NCR potato genetics group in Chicago presentations; Potato Association of America meeting in Quebec-- four research presentations/abstracts.

Chinese, Russian, and Japanese potato scientists, UW River Falls Horticulture students, and Southern Door HS Spanish class tour genebank.

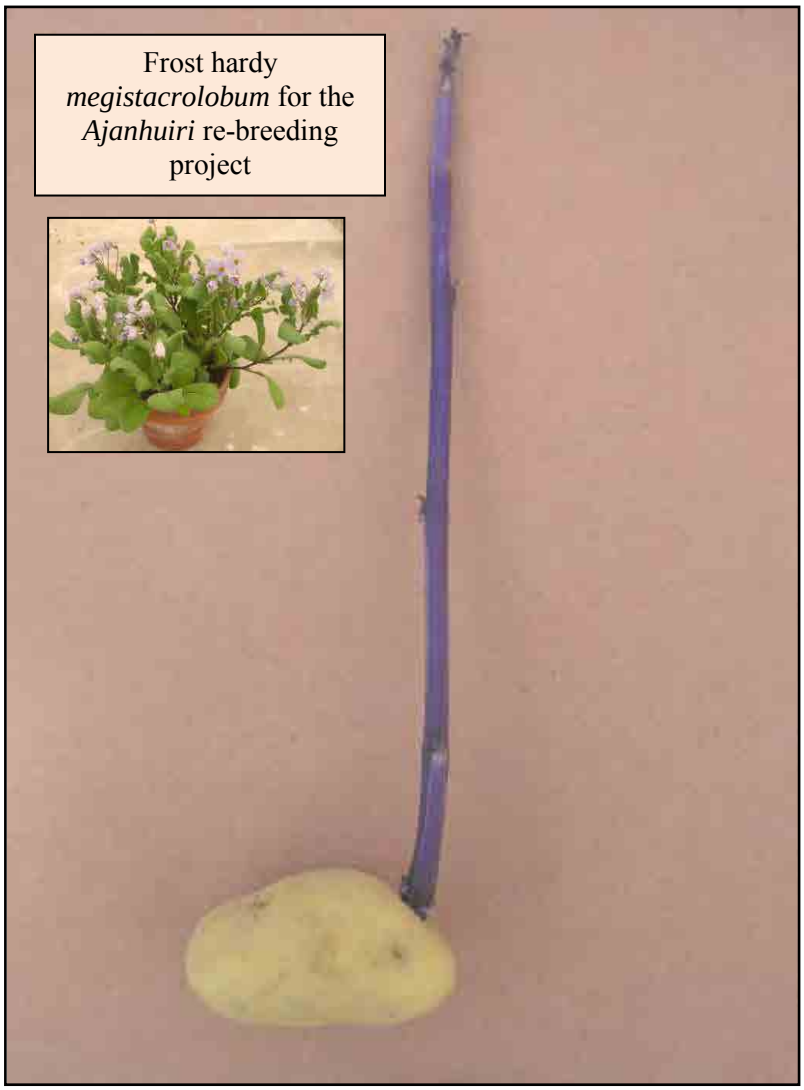
Leadership: Bamberg continued as Editor in Chief for the American Journal of Potato Research, and Chair of the USDA/ARS Potato Crop Germplasm Committee.



Undergrad intern Jana Suriano, presenter at 2013 PAA

Reports & Plans: ARS: PGOC, CGC, CRIS, Annual Performance, Budget. NRSP6: Annual Report, TAC meeting minutes. PAA: AJPR Editor in Chief report, Outstanding Paper. UW-Hort: Annual Performance. PARS: Tour guide & field book.

Management of Grants & Awards: Potato CGC grants, AJPR Outstanding Paper



IMPACT STATEMENT

In 2013, seed increase success was steady, and number of germplasm orders increased substantially, supporting the needs of the nation and world for resources to genetically improve the potato crop.

The payoff in funding the genebank is in discovering and deploying traits that are useful to the public and the industry. We participated in successful selection of better stocks for golden flesh, frost resistance in Peruvian highlands, folate, potassium, resistance to tuber greening, glycoalkaloids, and a natural appetite suppressing protein.

We continued work on improving germplasm management. We again collected germplasm in-country, finding and making available populations at sites never before reported or collected, and developing novel technology to improve the genebank's representation of diversity in the wild.

Salary and travel support plus cash gifts from industry totaled $40K in 2013.

The ability to efficiently evaluate traits is rapidly improving. We are on the brink of a leap forward in breeding through molecular markers and genetic technology. Potato is an increasingly important world food. Climate is changing, and health issues and their economic impact are increasing in our aging population. Because of these factors, there has never been a more important (or exciting) time to be involved in improving potato through mining the rich deposits of traits in the US Potato Genebank.

WORK PLANS / STAFF & FUNDING / ADMINISTRATION

In FY15, we plan to continue the service program to acquire, preserve, classify, and promptly distribute high quality germplasm and data to all requesters. We will endeavor to say "yes" to requests for custom service and advice whenever we are able.

We plan to restore the ½ position of A. del Rio that was cut due to funding shortfalls in recent years, thus rebuilding our program in the area of genetic diversity management research (making use of the new, more powerful DNA markers now available), collecting research (predicting sites likely threatened by climate

change), and benefit sharing collaborations with Andean germplasm donor countries (in particular, the successful frost resistance breeding effort in Puno described above).

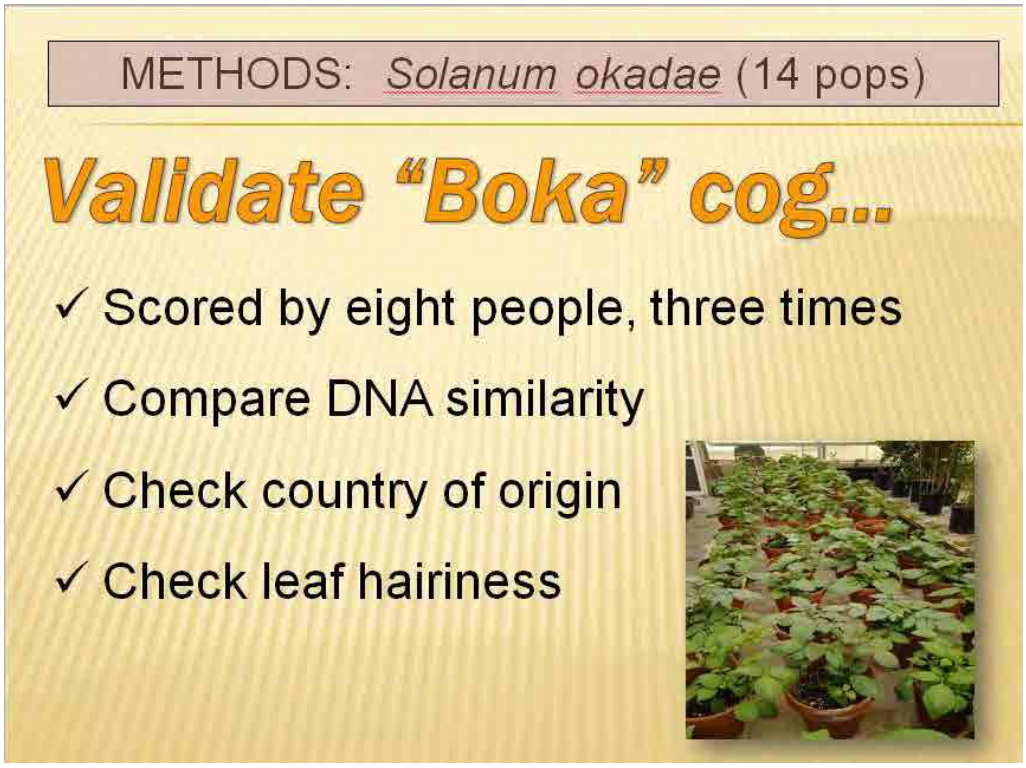
We expect to continue participation in "teaching" activities by hiring summer student interns who learn about potato science and help us explore promising new research and technology ideas (this has resulted in students participating in germplasm collecting, formal presentations at PAA, and authorship on peer reviewed publications). Rapport with potato science and scientists will be maintained by service as editor of American Journal of Potato Research, and participation in the Potato Association of America.

We expect to continue the service to industry partners that has been attracting their strong support, and similarly maintain strong ties with our sister genebanks around the world.

We intend to seek opportunities to evaluate and deploy germplasm in ways that impact the consumer, notably with respect to nutritional traits, thus enhancing the reputation, demand, and positive health and economic impact of the potato crop on society.

We expect to continue and expand approaches to evaluation and technology that multiply information gathering:

1) Multiple data collection schemes for a single grow-out
2) Synergistic cooperation with specialists in various disciplines
3) Testing for links between easily assessed traits and more difficult traits
4) Making use of our *in vitro* facilities and expertise to investigate microbial bioassays and selecting agents.
5) Characterizing visual (cog), genetic, geographic, and trait differences within species as predictors of germplasm application



S. okadae visual "cog" exercise demonstrates method for initial detection of difference within species (slide of presentation at PAA2013)

PUBLICATIONS

NRSP6 and associated USDA/ARS project staff publications

Bamberg del Rio, Martin, Suriano and coauthors: Five journal articles now available online will be documented in this report when in print: AFLP core set of *microdontum*, Zebra chip resistance screening in *bulbocastanum*, New *Matryoshka* floral mutant, Selection for tuber quality in a Superior x Atlantic hybrid population, History and origin of Russet Burbank.
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Publications by others using NRSP6 stocks

Many other scientists are publishing research that directly or indirectly originated from NRSP6 stocks. Publications that mention potato species (both old and new taxonomy) are likely to have such a connection to USPG germplasm and service. The search below produced 153 hits which the reader can regenerate independently, or which can be accessed through our website: http://www.ars-grin.gov/nr6.

The search net below does not catch cultivars, breeding stocks and genetic stocks, which have some 900 particular names to search, or are *tuberosum* and therefore more likely to be of independent origin. Note that even when the publication is of foreign origin, and the researcher probably received materials from another genebank, that foreign genebank may have originally received those materials from USPG. Since potato research and breeding is a slow process, materials published in 2013 could, of course, have been ordered many years previously. Similarly, these articles may only cite previous work with exotic species as related background information published by others, not because they were the materials used in the present experiment.

Digitop > browse by type: Databases > AGRICOLA > (log in) > cut and paste string below into "simple search" box > click "go"

This hits 153 records in Agricola or CAB abstracts for 2013 -- 140 for 2012 and 129 for 2011

Solanum and (abancayense or acaule or achacachense or acroglossum or acroscopicum or aemulans or agrimonifolium or ajanhuiri or alandiae or albicans or albornozii or ambosinum or andreanum or arnezii or astleyi or avilesii or aymaraesense or berthaultii or blanco-galdosii or boliviense or brachistotrichum or brachycarpum or brevicaule or buesii or bukasovii or bulbocastanum or burkartii or cajamarquense or canasense or candolleanum or capsicibaccatum or cardiophyllum or chacoense or chancayense or chilliasense or chillonanum or chiquidenum or chomatophilum or circaeifolium or clarum or coelestipetalum or colombianum or commersonii or contumazaense or curtilobum or demissum or doddsii or dolichocremastrum or edinense or edinense or ehrenbergii or etuberosum or fendleri or fernandezianum or flahaultii or gandarillasii or garcia-barrigae or gourlayi or guerreroense or hintonii or hjertingii or hondelmannii or hoopesii or hougasii or huancabambense or hypacrarthrum or immite or incamayoense or infundibuliforme or iopetalum or irosinum or jamesii or juzepczukii or kurtzianum or laxissimum or leptophyes or leptosepalum or lesteri or lignicaule or limbaniense or lobbianum or longiconicum or macropilosum or maglia or malmeanum or marinasense or matehualae or medians or megistacrolobum or michoacanum or microdontum or minutifoliolum or mochiquense or morelliforme or moscopanum or multidissectum or multiinterruptum or nayaritense or neocardenasii or neorossii or neovalenzuelae or okadae or oplocense or orocense or orophilum or otites or oxycarpum or palustre or pampasense or papita or paramoense or pascoense or paucijugum or paucissectum or phureja or pinnatisectum or piurae or polyadenium or polytrichon or raphanifolium or rechei or sambucinum or sanctae-rosae or sandemanii or santolallae or scabrifolium or schenckii or soestii or sogarandinum or solisii or sparsipilum or spegazzinii or stenophyllidium or stoloniferum or subpanduratum or sucrense or sucubunense or tarijense or tarnii or trifidum or tundalomense or tuquerrense or ugentii or velardei or venturii or vernei or verrucosum or violaceimarmoratum or weberbaueri or yungasense or goniocalyx or stenotomum or andigenum or andigena or (USDA and "Solanum tuberosum")) (doc-type:Articles or doc-type:Books) pub-year:2013

Budget Situation

Expected NRSP6 spending in FY14 (similar outlook for FY15)

104	Martin (80%) & del Rio (50%)
27	Part time techs
17	Supplies
2	Travel
150	

New USDA money plan

After restoring del Rio to 100%, about $45K remain for increasing:

1. Evaluation for traits and tuber components.
2. DNA-based tests for assessing genetic diversity with respect to collecting and preservation techniques, climate change, etc.
3. Latin American projects for benefit sharing.
4. Student intern training

Executive 3-year summary for NRSP6 Midterm Review, CY2010-2012

A. Acquisition. A total of 74 new germplasm stocks were collected in the wild and 33 more imported from cooperators.

B. Preservation schedule was maintained and **Evaluation** was successful for many useful traits: Seed populations multiplied = 660, germination tests = 4014, virus tests = 2110. Over 3000 field plots were grown for evaluation and taxonomy. We worked with numerous cooperators, providing germplasm handling technology, custom samples and hybrids resulting in identification of elite new materials for antioxidants, anti-appetite proteins, orange flesh, folate, thiamine, starch balance, low acrylamide, anti-cancer, resistance to greening, frost tolerance and calcium use efficiency. We discovered a new floral mutant. We demonstrated that hotspots of genetic diversity can be identified in the wild for collecting, and that an AFLP-based core collection of model species will capture all of the known useful traits. We showed that pesticide overspray of wild populations near farmers' fields in Peru may reduce fecundity, but probably not gentic diversity of the wild populations.

C. Classification reduced the number of species to about 100, for a more stable and predictive taxonomy.

D. Distribution totals were strong showing continued interest and value in our germplasm:

Category	Seed	TU	TC	IV	DNA	Plants	Herb	Total	Populations
Domestic	6,709	13	7,681	4,435	123	586	11	19,558	13,236
Foreign	2,537	0	0	1,578	3	0	0	4,118	2,460
Total	9,246	13	7,681	6,013	126	586	11	23,676	15,696

[1] Types of stocks sent/(number of seeds, tubers or plantlets per standard shipping unit): Seed= True Seeds/(50), TU = Tuber families/(12), TC = Tuber Clones/(3), IV = *in vitro* stocks/(3), DNA = dried leaf samples/(1), Plants = rooted cuttings /(1), Herb= herbarium specimens/(1).

E. Outreach. A robust website including access to all NRSP6 stock data, ordering information, technology tips, mapping features, publications, and complete reference to administrative reports was maintained. We hosted numerous visiting scientists, were featured in two documentary films and a syndicated article by the Milwaukee Journal Sentinel, gave invited keynote lectures at the US Botanic Gardens (DC), and Latin American Potato Association (Cuzco); served as Editor in Chief for American Journal of Potato Research and chairman of the Potato Crop Germplasm Committee. We returned benefits to Peru by cooperatively selecting and testing productive frost hardy and calcium responsive lines in the highlands. We trained two summer interns attending UW-Madison and Princeton.

F. Impact. Ten cultivar releases were published, each having at least one of nine different exotic potato species in their pedigrees. No other crop matches potato in use of exotics in practical breeding. Staff published 55 scholarly research papers, and nearly 400 more were cited by others using NRSP6 species.

Work Plans / Staff & Funding / administration / Integration

Acquire wild germplasm in southwest USA and valuable germplasm from other genebanks and/or scientists
Preserve/multiply 200 populations per year, with associated maintenance of purity, germination, and health
Classify in a way that maximizes the groupings of germplasm by genetic value
Distribute germplasm and info rapidly to clients in a way that maximizes their research and breeding success
Evaluate traits already under study and engage new traits, especially nutritional ones (like anti-diabetes)
Publish results of evaluation and technical research (see above)
Lead Crop Germplasm Committee and American Journal of Potato Research
Maintain integration with UW-Madison as full professor in Dept of Horticulture
Maintain >$45K level of 2012 industry support and $150K maintenance level of Multistate Research Funds