APPENDIX CONTENTS

NRSP-6 TAC17 MEETING MINUTES

Agenda

Teleconference based at Plye Center, Madison, WI
http://conferencing.uwex.edu/about/pyle-center/
Tuesday, June 13, 2017
9-12 AM CT

W. DeJong = Chair
C. Yencho = Vice Chair
J. Parsons = Secretary (for G. Gusmini)

Meeting sections – DISCUSSION LEADER

Preliminaries – DE JONG
1. Welcome, introductions, announcements (resolutions committee to be appointed in advance)
2. Review and approve 2016 minutes

Reports
3. NPGS – BRETTING
4. NRSP6 update on admin, service, funds, tech, CGC -- BAMBERG
5. PARS status, NRSP6 budget, AA regional admin status and concerns -- BARKER
6. USA-regional & Canada use of NRSP6 germplasm and tech rep advice for the genebank – DE JONG

Comments from other cooperators
7. Industry – PARSONS
8. NIFA – LIN & KALEIKAU
9. USDA/ARS – SIMON
10. APHIS/Quarantine -- FRENCH

Resolutions, Venue & Officers for next year can be settled later by email if time is short.

Present at Pyle Center:
John Bamberg – USPG Project Leader, Sturgeon Bay
Laura Shannon – new potato breeder at University of Minnesota
Dave Spooner – USPG taxonomist, Madison
Shelley Jansky – USPG germplasm enhancement, Madison
Chris Hamilton – NCRA, Madison
Josh Parsons – Frito-Lay, Rhinelander
Bill Barker – CALS, Madison
Jeff Endleman – UW potato breeder, Madison
Max Martin – USPG Project Assistant, Sturgeon Bay

Participating by remote access:
Walter DeJong – NE Tech Rep, Cornell
Peter Bretting – NPGS NPL, Beltsville
Dave Douches – NC Tech Rep, MSU
Craig Yencho – S Tech Rep, NCSU
Dave Holm – W Tech Rep, CSU
Ed Kaleikau – NPL NIFA, Beltsville
Liang-Shiou Lin – NPL NIFA, Beltsville
Rich Novy – USDA/ARS Tech Rep, Aberdeen, ID
USPG Sturgeon Bay staff and Curzio Caravati of Kenosha Potato Project
Ron French -- APHIS/Quarantine, Beltsville
JL Willet – USDA, Peoria

Meeting Minutes

9:02

Welcome by **technical support**, roll call. There were some technical difficulties with the video conferencing. All participants could at least participate by phone, some had trouble with the video.

9:08

John Bamberg - opening remarks about meeting venue. Met at the Pyle Center to conserve travel funds and time so as to promote more participation by having video conferencing instead of in person meeting.

9:12

Walter DeJong (chair) - Opening remarks

Richard Novy and Benoit Bitzimungu are a resolution committee to make resolutions from the meeting.

Meeting minutes from last year - June 24 changed to June 14 and then approved (all in favor)
John Bamberg noted meeting minutes need to be posted within 60 days of the meeting so while it is a good idea to approve the minutes, they need to be posted sooner than the next meeting.

Peter Bretting - "The National Plant Germplasm System - 2017 status, prospects, and challenges"
-NPGS has most campuses on land grant universities - great partnership and thank you to university cooperators.
-NPGS is over major accumulation phase across the system. Less than 1% growth per year based on targeted accessions vs. large increases.
-Web site access relatively stable over years. In 2016 there was a change in system which is why the number of accesses looks lower - not tracked the same anymore.
-Each year around 250,000 accessions are distributed. 2/3-3/4 distributed in the US and the majority to the public sector.
-Fiscal year 2017 essentially the same as 2016. Fiscal year 2018 if approved in current form, would cut about 13.5%. Congress and reconciliation budget still not released.
-Budget has remained stable, but when adjusted for inflation then the value of those dollars decreases.
-Expanding demand for data and germplasm and decreasing actual dollars to meet demand
-Interest in cryopreservation or in vitro conservation for clonal germplasm due to extremely virulent diseases. Some crops only maintained in the field and this would prevent loss of those accessions.
-Patents and PVP of GMO crops are expiring and the first crops are entering the NPGS system. Need BMPs to manage them separately and make sure there is no Adventitious Presence in the remaining material.
-Maintenance is highest priority.
-Acquisition of endangered crops or in endangered areas is high priority as well.
-Several personnel changes - see slides
-2016 NP 301 Retrospective Review
-Dr David Bubeck chair, 8 other anonymous reviewers
-Shelley Jansky helped highlight Sturgeon Bay's contribution to potato breeding and the potato part of the program/review was called out as a highlight.
-FAO international treaty and the Convention on Biological Diversity
190 nations part of CBD - US has signed (1993) but has NOT yet been ratified by the Senate
-143 nations part of IT - US Senate ratified the treaty in 2016 (Bush signed in 2002. The senate didn't look at it until the SMTA was finalized in 2006-2007. There were committee hearings in 2010 and

approved by committee but not taken to vote to whole senate. Then it didn't come up to a vote until 2016. Approved by at least 66 senators - 2/3 supermajority needed. Don't know the actual count)
-Treaties are not retroactive. Going forward, global germplasm collection terms determined by bilateral agreements between the collector and host countries. Since CBD, access to germplasm has been hindered.
-Under IT, there is a standard way to acquire materials - use a Standard MTA.
-Now that US is part of IT, the US now has a seat at the table and can get help (potentially) and work issues with statements in the SMTA at higher levels.
-For NPGS, there are a few additional reporting requirements but otherwise not overburdened. Outside of US, GRIN shipments will be sent with SMTA.
*ARS scientists are permitted to use PGRFA accompanied by the SMTA in research but **NOT** in breeding. Some of the SMTA obligations are not acceptable to the private sector so the ARS scientists are not allowed to use the material in breeding. US might try and change these unfavorable aspects of the SMTA.
*Problematic clauses in SMTA - Lacks a termination clause - the obligations you enter into are perpetual. Most companies are not interested in signing or accepting non-ending legally binding contracts.

9:58
John Bamberg- Thank you to **Simplot** for hosting the meeting and thanks for **Max Martin** for finding Pyle center and getting that set up.

-John then browsed through the website to show the resources on there.
-Searching "NRSP 6" shows the genebank correctly at the top of the search results.
-Genebank Holdings takes you to the accessions Sturgeon Bay has - takes you to the GRIN site
-Evaluation data also takes you to GRIN
-There are "Genetic stocks" and "Breeding stocks" and there is not a very clear distinction. Breeding stocks might be a bit further down the road in development, but it is a judgment call when the material is entered.
4 partners - Sturgeon Bay, UW, industry, federal
Shelley Jansky - Germplasm enhancement - she is bridge between GRIN and breeders by working on parental lines specifically for diseases resistance. M clones - M is for Madison.
David Spooner - 14 years in a row he spent 2.5 months a year collecting. Up until 2000. 10 years ago David also started working on carrots as well. Works on documenting the potato diversity.
Germplasm handling tips - *John would like to do a better job of making resources available to people who need them - how to guides on the website.
Max Martin - Things are going well at the station.
~5,000 populations of botanical seeds
Intergenebank database - shows which genebanks globally have similar/same accessions
Administrative reports - meetings and documents. Meeting minutes are at the top, meeting documents are at the bottom of the page.
Walk through administrative reports
Acquisitions - Collection trips to Arizona that are not just collections, but data gathering about location and population observations.
Genebank does basic maintenance as well as research - #4 on annual report highlights a few of the projects
Support a lot of work that requires screening a large amount of genetic variability.
The material is being used - 6 of last 8 potato releases by UW had NRSP6 lines in pedigree
Impact statement is on the last page

Maintaining the clonal collection - how do we decide what to continue to maintain. They routinely send out e-mails to the group asking if there is interest. Crop germplasm committee and this advisory group should probably weigh in on reviewing the clonal in-vitro repository. The objective of the NRSP6 is to preserve genes and not genotypes

10:41

William Barker- The story in WI is repeated at many land grant institutions - there is a decline in state support. Ag research budget greatly reduced. There is value from the genebank to Hancock and Rhinelander breeding stations. Within the genebank are the solutions to some of society's current problems. Bill is working with some private sectors to support genebank functions. The Genebank will have to diversify funding if possible. Bill asks everyone in the potato community to promote the genebank and the value of the genebank whenever the opportunity arises. If all AA's can come to the midterm meeting next year with information on the value of the NRSP6 site, that will help tremendously.

Chris Hamilton- Next year NRSP6 will be up for midterm review. Conducted by 4 regional advisors. The review from this year recommended Sturgeon bay move away from NRSP6 funding. It is $150,000 and they are asking to remove that funding from Sturgeon Bay. NRSP is supposed to be a temporary funding model and NRSP6 has been funded for a while now so there is pressure to remove the funding.
NRSP - National Research Support Project - fund designed to get research projects going, not ongoing.

Question about funding for NRSP6 in grants that utilize its resources? No one knew if that is allowable. There was a recommendation to make a "shipping and handling" charge for outgoing accessions from Sturgeon Bay.

Bamberg responded to the above challenges and recommendations by noting that there is much history about NRSP6 funding considerations that we are not able to discuss at this meeting, but we would be wise to understand. We should have thorough research, documentation, and communication before the 2018 regional spring meetings or midterm TAC regarding the contentions: a) NRSP6 needs more industry support, b) NRSP6 can or should charge for germplasm, c) NRSP6 is funded awkwardly, d) NRSPs are necessarily short term and therefore not appropriate for NRSP6, e) NRSP6 depends more on state vs federal support than other genebanks, f) a regional (North Central) multistate project would be more appropriate for the USPG that Off-the-Top.

11:03 - break until 11:13

Reports are or will be available online.
Dave Holm - Recommendation to bring in European clones. Max said the USDA can bring in 30 clones per year. Especially useful because of the disease resistances in many of their material.
Dave Douches - Working hard on diploids, extracting and evaluating haploids. Introgressing self-compatibility from M6 and backcrossing to tuberosum dihaploids. Self-compatibility is not as easily inherited as you would like it to be. Alca Tarna source of Potato Leaf Roll Virus resistance. Bacterial wilt resistant material from John Bamberg
Jeff Endelman - Successfully induced some dihaploids with IVP 101 and working on chloroplast counting and genotyping. Also got some European germplasm.
Not present but Susie Thompson is also doing dihaploid extraction.
Rich Novy - Several requests made for Zebra chip or psyllid resistance

Craig Yencho - Southern Region - not primarily strong supporter of genebank efforts. Usually not very big potato programs. Creighton Miller is doing a big screening for psyllid/ZC resistance. PVY resistance is a much larger interest as well.

Walter - Half of accessions to NE region went to company trying to mine the microbiome.

Josh Parsons - Thank you to the genebank for ongoing support for PepsiCo's initiatives. We have made use of the genebank, and given back genotypic information whenever we can to support the ongoing research.

Ed Kaleikau and **Liang-Shiou Lin** - USDA/ARS update - National Program leaders - AFRI plant breeding for agricultural production. Focus on pre-breeding and germplasm enhancements. Commodity boards and NIFA make grants available for a 1:1 match at times. It might be an option to get potato industry interested and then have NIFA match the grant.
Li Yang

NIFA website - search for "commodity board" and that gives information on how they can participate. Procedurally, commodity board submits topic and puts funds in escrow. Then researchers applying for grants need to get a letter of support from the commodity board.

Ronald French - APHIS - 2nd day on the job - Lead plant pathologist for potato, sweet potato, and cassava. The connection with Ron was lost so we will need an e-mailed report

USDA/ARS - No update

Wrap-up Discussion
Walter DeJong volunteered to host the meeting next year if it was a week later. John mentioned we could meet in Sturgeon Bay in connection with the National Plant Germplasm Coordinating Committee meeting at Sturgeon Bay on May 29-30. Meeting will officially be decided via e-mail.

Dave Douches volunteered to be the incoming secretary with **Craig Yencho** becoming the chair and **Joshua Parsons** becoming the Vice Chair.

Thank you to John, Max, Jesse, Simplot (for funding), thank conference group for hard work trying to get the systems up and running.

Meeting adjourned at 12:08pm.

Action items mentioned during the meeting:
*Discuss about merging "genetic stocks" and "breeding stocks" to one heading since the distinction is not very clear.
*Have a meeting at PAA (or potentially other time) with industry supporters to explain the situation of the funding that is going away and try and gain industry support.

Resolutions:

NRSP-6 TAC 2017 Resolutions

Whereas John Bamberg, Max Martin, Jesse Schartner and other NRSP-6 staff have efficiently organized an excellent Technical Advisory Committee (TAC) meeting, and have provided a detailed and thorough summary of their outstanding work in the maintenance, characterization, and dissemination of potato germplasm resources for the benefit of scientists in the USA, Canada, and around the world, let it be resolved that the genebank staff be commended in the highest possible terms for their efficiency, hospitality, and scientific contributions to the potato community.

Whereas the 2017 NRSP-7 TAC meeting was held as a video conference to facilitate participation, we acknowledge the efficient and coordinated efforts of John Ibis and his staff at Instructional Communications Systems, University of Wisconsin-Extension in providing their expertise in electronic meeting resources for the benefit of all TAC participants.

We also wish to acknowledge and thank the J.R. Simplot Company for providing $2,785 to sponsor the TAC17 video conference at the Pyle Center on the University of Wisconsin-Madison campus.

Western Region Report - NRSP-6 Technical Committee Meeting 2017
David G. Holm

During 2016, NRSP-6 supplied stocks to the following Western states: Alaska, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah and Washington (Table 1). Western Region USDA/ARS requests are not included in this report.

Thirty-six entities via 49 requests ordered 2,284 units. Potato materials were requested by universities, research institutes and many private companies and farms (Table 1).

Table 1. NRSP-6 Distribution in the Western Region - 2016.

Name	Organization	City	State	Reported
Milton Agader	Twin Bridge Farms	Waialua	HI	
Andrew Barney	Colorado State Unversity	Loveland	CO	
Marlys Bedlington	Pure Potato, LLC	Lynden	WA	
Bill Cambell		Palmer	AL	
Michael Conley	Arctic Strawberry	North Pole	AL	
Jenny Durrin	University of Idaho	Moscow	ID	
Fahrettin Goktepe	Potato Seed Solutions/SunRain	Idaho Falls	ID	
Aymeric Goyer	Oregon State University	Hermiston	OR	
Biao Gu	Oregon State University	Corvallis	OR	
Charlie Higgins		Farmington	NM	
Russell Hoge		Salem	OR	
David Holm	Colorado State University	Center	CO	✓
Christopher Homanics		Eugene	OR	
Sastry Jayanty	Colorado State University	Center	CO	
Dylan Kosma	University of Nevada	Reno	NV	
Joseph Kuhl	University of Idaho	Moscow	ID	
Kevin Lombard	New Mexico State University	Farmington	NM	
Lisbeth Louderback	Natural History Museum of Utah	Salt Lake City	UT	
Andrew McGinnis	University of Idaho	Moscow	ID	
Walter Messier	Evolutionary Genomics	Longmont	CO	
Livingstone Nganga	Genome Biomedical Science Facility	Davis	CA	✓
Satyendra Rajguru	Cibus US LLC	San Diego	CA	
Craig Richael	J. R. Simplot Co.	Boise	ID	
Rocio Rivas	Montana State University	Bozeman	MT	
Caius Rommens	Nightshade LLC	Colville	WA	
Vidyasagar Sathuvalli	Oregon State University	Hermiston	OR	✓
Lur Schroeder	University of Idaho Extension	Aberdeen	ID	
Joseph Simcox	The Rare Vegetable Seed Consortium	Belen	NM	
Barbara Smith	Black Thread	Las Vegas	NV	
Han Tan	University of California	Davis	CA	
Kaylene Tate		Rainier	WA	
Terry Tolbert	Escalante Interagency Office	Escalante	UT	
Brent Towell	Middle Valley Permaculture	Boise	ID	
Kim Van Meier		Red Bluff	CA	
Thomas Wagner		Everett	WA	✓
Bill Whitson	Cultivariable Seeds	Moclips	WA	✓

Summary

The consensus is that seeds and in vitro plantlets were received in excellent condition and in a timely manner. The Genebank staff was very helpful in providing advice about maintaining, growing and manipulating the potatoes for the purpose of research.

- The materials received will be used in an NSF-Funded projects to study the mechanism of haploid induction in potato, and how to potentially manipulate haploid induction for rapid introgression of traits of interest. Several posters related to the project were presented in the SolGenomics Conference held at UC Davis in September 2016.
- The only recommendation to the Genebank is that it would be very helpful to import some of the potato varieties held in the European databases. It was noticed that the US Genebank holds primarily American varieties whereas the European databases hold primarily European varieties. There is interest in some old European varieties that were better suited for some studies. Overall, participants were very grateful for all the hard work that the Genebank has put in curating and maintaining varieties.
- I use germplasm to use in breeding work as I have for many years. One of the results from obtaining germplasm in the past was in creating the variety Skagit Valley Gold which is now being used for breeding with the Colorado breeding program. Other clones are being cleaned up for the Sturgeon Bay potato center such as the one mentioned and Skagit Ayni.
- The Oregon State University Potato Breeding Program is screening wild potato accessions for resistance to Columbia root-knot nematode (*Meloidogyne chitwoodi*) and Verticillium dahliae, both major soil-borne pathogens of potatoes in the Pacific Northwest. We Screened 45 accessions for their response to Columbia root-knot nematode and 23 accessions for *Verticillium* wilt. At this point, it appears that many accessions from *S. hougasii* confer strong resistance to *M. chitwoodi*, roza pathotype including PI161726, PI239423, PI239424, PI283107, PI558402, and PI558422. In addition, select clones from *S. stenophyllidium* accession PI545815 and *S. bulbocastanum* accession 255518 may confer additional sources of untapped resistance to *M. chitwoodi*. For *V. dahliae*, strong resistance was more difficult to observe; the majority of the wild potato clones we tested appeared to be much more susceptible than the elite potato controls (Ranger Russet) used. However, some accessions, including a clone from *S. andreanum* (PI498148), may have moderate resistance genes that could be beneficial if introgressed into elite potato germplasm. The next step will be to begin to introgress sources of resistance to these two pathogens into elite potato germplasm. These crosses will give us a better understanding of each resistance source, and put us one step closer to deploying these resistance sources in potato production.
- The Colorado Potato Breeding and Selection Program has several initiatives underway to enhance the carotenoid content of potato cultivars. One initiative was began in 2007 by hybridizing two high carotenoid selections obtained from Dr. Chuck Brown. The first product to come from this work is selection CO07131-1W/Y (PA4X137-12 x 4X91E22). The parents were derived from *S. phureja* and *S. stenotomum* ancestry. This selection produces small tubers with very dark yellow flesh with about a five-fold increase in tuber carotenoids compared to Yukon Gold. It currently is undergoing grower trials. Another initiative is based on a diploid hybrid population of *S. phureja* x *S. stenotomum* adapted to long-day growing conditions from Dr. Kathy Haynes. Currently ten selections remain from this material and are being hybridized with tetraploid yellows. This parental material has a six- to ten-fold increase in carotenoids. We also recently received three TPS populations of Colombian sources of *S. phureja* and the parental clones from NRSP-6. Seedling tubers from the TPS families have been produced and are now planted in the field for selection this fall.

As we receive more reports this summary will be updated and submitted to NRSP-6 for posting on their website.

2017 NRSP-6 Germplasm Utilization Report - Southern Region

Compiled and Submitted by Craig Yencho, Southern Region Representative

Potato Research Programs and Use of NRSP-6 Stocks in the Southern Region

There are four land grant Universities in the Southern Region with on-going active potato improvement and/or research programs utilizing NRSP-6 stock: Florida, North Carolina, Texas and Virginia (see reports below). Several other universities in the southern states periodically conduct potato research utilizing NRSP-6 stock, and a wide variety of home gardeners and nurseries also request stocks. During 2016, the potato genebank received requests for 464 NRSP-6 potato stocks from 22 individuals and/or entities in 10 states (AL, FL, KY, LA, NC, OK, SC, TN, TX, VA). The requests came from a wide range of stakeholders from home gardeners and nurseries to university scientists and private companies.

University Reports

North Carolina State University - Craig Yencho and Mark Clough

The goal of the North Carolina breeding program is to develop potato cultivars that are adapted to North Carolina, and the mid-Atlantic and southeastern US. We are a member of the NE1231 (formerly NE1031) Regional Potato Variety Development Project, and we collaborate with the USDA-ARS, Univ. of Maine (ME) and Cornell University (NY) potato breeding programs in the east, as well as other potato breeding programs in the US and Canada.

Breeding and Variety Development - The bulk of our breeding work is conducted at the Tidewater Research Station (NCDA&CS)/Vernon G. James Research and Extension Center (NCSU) in Plymouth, NC. We also conduct 4-5 on-farm trials each year as part of our variety development efforts. Crossing work is done at our greenhouses in Plymouth, and we grow and share mini-tubers with Dr. Kathy Haynes at the USDA-ARS yearly.

Germplasm Development - To address the internal heat necrosis (IHN) problems common to the mid-Atlantic and southeastern states, we have been working on a long-term project with Dr. Kathleen Haynes, USDA-ARS. The materials for this study were derived from 4x-2x *S. tuberosum* x (*S. phureja* X *S. stenotomun* (phu-stn)) hybrids developed by Dr. Haynes. We have also developed a mapping population, B2721, a cross between B1829-5 and Atlantic. B2721 was genotyped with the Infinium® 8303 SNP array developed by the USDA-NIFA SolCAP project and quantitative trait loci (QTL) were detected for IHN on chromosomes 1, 5, 9, and 12. Genetic effect models of the QTL explained roughly 28 and 25% of the variation for incidence and severity, respectively. The B2721 population has also been phenotyped for chip color, specific gravity, and reaction to scab.

Our Colorado potato beetle (CPB) germplasm enhancement project seeks to introgress CPB resistance derived from *Solanum berthaultii* and *S. chacoense* into cultivated potato. The project began in 1998 using materials obtained from the USDA-ARS Potato Genebank, the USDA-ARS BARC, and Cornell University. We screen lines for resistance and adaptation using a rapid advance strategy that consists of simultaneous selection for CPB resistance and adaptation using separate plots planted the same year.

Much of the germplasm requested by our program from the NRSP6 project this year were

materials that possessed PVY resistance derived from *S. andigena* and *S. stoloniferum*, or were high in anthocyanin content. These are two additional traits that we intend to incorporate into our program in the coming years.

Peer-reviewed manuscripts – 2016

1. Oluwatosin, E.A., S.D. Johanningsmeier, V-D. Truong, and G. C. Yencho. 2016. Development and validation of a near-infrared spectroscopy method for the prediction of acrylamide content in french-fried potato. J. Agric. Food Chem. 64:1850−1860.
2. Ceballos, H., R.S. Kawuki, V.E. Gracen, G.C. Yencho, and C.H. Hershey. 2015. Conventional breeding, marker-assisted selection, genomic selection and inbreeding in clonally propagated crops: a case study for cassava. Theor. Appl. Gen. 171: 1647-1667.

Texas A&M University – Isabel Vales, J. Creighton Miller, Jr.

Texas – Isabel Vales, J. Creighton Miller, Jr., Douglas C. Scheuring, Jeffrey W. Koym, Julien G. Levy, and Cecilia Tamborindeguy

Dr. Isabel Vales, was recruited to lead the TAMU breeding program in Fall 2016 and she will be overlapping with Dr. Miller during 2017. In 2016, the Texas Potato Breeding and Variety Development Program requested the Mini-Core collection from the US Potato Gene Bank, Sturgeon Bay, WI for evaluation of potato psyllid (*Bactericera cockerelli*) and/or *Candidatus* Liberibacter solanacearum (Lso) resistance. Seed of the 80 accession Mini-Core collection were planted February 16, 2016 in College Station, TX. Seedlings were transplanted March 11 to one-gallon pots and 9cm paper pots. Four one-gallon treatment pots were placed in one greenhouse and two one-gallon control pots were placed in another greenhouse. On April 21, one male and one female psyllid were caged on a leaf in the upper third of the canopy and allowed to feed for one week, at which time they were removed. Live and dead insects and presence of eggs were noted. Five weeks after infection, leaf samples from each plant were collected for PCR verification of infection at a later time. Plant Lso symptoms were noted on treatment plants and compared to the controls.

On April 8, the 9cm paper pots were transplanted into insect proof cage structures in the field near Springlake, TX. Four plants of each clone were planted together in a treatment cage and two in a control cage. Based on preliminary greenhouse data, 11 clones were selected for re-evaluation in the field. Again, male and female insects were caged on each selected treatment plant on May 24. One week later, June 1, insects were removed and live, dead, and eggs were noted. Five weeks after infection, leaf samples from each plant were collected for later PCR verification of infection. Plant Lso symptoms were noted on treatment plants and compared to the controls.

Tubers of 30 clones were also obtained from Sturgeon Bay. These were tubers from the grow-out of PI material that the US Potato Gene Bank conducts annually. This material was planted in one-gallon pots in the greenhouse and as tubers in the field. The same protocol as above was followed. Since the trial was planted about two weeks later, preliminary greenhouse data was not obtained in time to decrease the number of field retest. All of the treatment plants in both the greenhouse and field were treated with insects. Final results are not available at this time as the study is still in progress.

Peer-reviewed Manuscripts

S. H. Jansky,* A. O. Charkowski, D. S. Douches, G. Gusmini, C. Richael, P. C. Bethke, D. M. Spooner, R. G Novy, H. De Jong, W. S. De Jong, J. B. Bamberg, A. L. Thompson, B. Bizimungu, D. G. Holm, C. R. Brown, K. G. Haynes, V. R. Sathuvalli, R. E. Veilleux, J. C. Miller, Jr., J. M. Bradeen, and J. M. Jiang. 2016 Reinventing potato as a diploid inbred line-based crop. Crop Sci. 56: 1-11.

Virginia Tech – Richard Veilleux
In 2016, Dr. Veilleux entered phased-retirement and is currently serving as the interim Department Head of Horticultural Science.

University of Florida - Lincoln Zotarelli
The UF is not engaged in breeding activities but we did request a large amount of germplasm from the NRSP-6 program for germplasm screening activities regarding nitrogen utilization.

Peer-reviewed Scientific Journals

Raymundo, R., S. Asseng, R. Prassad, U. Kleinwechter, J. Concha, B. Condori, W. Bowen, J. Wolf, J.E. Olesen, Q. Dong, **L. Zotarelli**, M. Gastelo, A. Alva, M. Travasso, R. Quiroz, V. Arora, W. Graham, C. Porter. 2016. Performance of the SUBSTOR-potato model across contrasting growing conditions. Field Crops Research. doi:10.1016/j.fcr.2016.04.012.

Reyes-Cabrera, J., **L. Zotarelli**, M.D. Dukes, D.L. Rowland., S.A. Sargent. 2016. Soil moisture distribution under drip irrigation and seepage for potato production. Agricultural Water Management. 169: 183-192.

Rens, L.R., **L. Zotarelli**, A. Alva, D.L. Rowland, G. Liu, K.T. Morgan. 2016. Fertilizer nitrogen uptake efficiencies for potato as influenced by application timing. Nutrient Cycling in Agroecosystems. 104: 175-185.

Liao, X., Z. Su, G. Liu, **L. Zotarelli**, C. Snodgrass. 2016. Impact of soil moisture and temperature on potato production using seepage and center pivot irrigation. Agricultural Water Management. 165: 230-236.

Rens, L.R., **L. Zotarelli**, D.J. Cantliffe, P. Stoffella, D. Gergela, D. Fourman. 2016. Commercial evaluation of seasonal distribution of nitrogen fertilizer for potato. Potato Research. 59: 1-20.

Report to NRSP-6 Technical Committee, June 2017

Northeast Region Representative: Walter De Jong

The Northeast region received 407 units of germplasm, spread across 12 requests, in 2016.

Over half of these went to a startup company (Indigo Agriculture, formerly Symbiota) that focuses on harnessing the plant microbiome to make crops more resistant to drought and disease.

Eight accessions were sent to two researchers at land grant universities while ten units were sent to an anthropologist at SUNY Brockport. Fifty-five accessions were sent to the Scatterseed Project (www.gardeningplaces.com/scatterseed.htm), an independent program that seeks to preserve genetic diversity for future generations. The remaining accessions were distributed to five individuals interested in one or more specific varieties for home gardening, small scale commercial production, or for hobby breeding.

Tech Rep Observations:

1. I'm intrigued by the idea that the potato genebank could be used to look for useful microbes (Indigo Agriculture, above). I doubt that most germplasm collectors (for any crop) were thinking about preserving microbes when they went on sampling expeditions.

2. A traditional use of crop genebanks has been to screen a large number of accessions for resistance to an important pathogen, where resistant accessions are then used as parents in breeding. As understanding of pathogen-plant interactions deepens, screening methodologies can change. An interesting approach I've been watching for a few years - overseen by nematologist Xiaohong Wang at the USDA/ARS in Ithaca, NY - involves germinating wild potato seeds on media containing a CLE peptide (hormone mimic) effector from *Globodera rostochiensis* (golden cyst nematode). The roots of most accessions are stunted in the presence of this peptide, presumably because they have receptors in or near their root meristems that recognize it. The roots of some accessions, however, are not affected – and these may contain novel resistance genes in the form of variant receptors that don't recognize the effector.

USDA/ARS Report on use of NRSP-6 Germplasm in 2016
Rich Novy, June 13, 2017

In 2016, there were 1269 units shipped in 58 orders to twelve USDA/ARS cooperators in six states. Nine of 12 recipients responded to my request for information regarding the use of requested germplasm with their summaries provided below.

John Bamberg, Sturgeon Bay, WI: As Lead Scientist for the US Potato Genebank, I and my team try to be involved in many basic studies on genebank techniques, diversity management, collecting, and all disciplines to which the germplasm might apply. So, in 2016 we ordered USPG stocks for numerous studies in pursuit of improving core collections, crossability, disease, pests and stress resistances; nutritional components. Details in genebank annual report 2016 accessible through USPG website.

Rodney Cooper, Wapato, WA: Accessions of *Solanum* spp. were screened for genetic resistance to zebra chip disease and potato psyllid. Although accessions varied in susceptibility to psyllids, none were resistant to the zebra chip pathogen. We also obtained seeds of several weedy Solanaceae to screen for susceptibility to potato psyllid and the zebra chip pathogen. These assays are ongoing.

Dennis Halterman, Madison, WI: We have used the germplasm from the genebank for various experiments looking for disease resistance phenotypes. Most recently, we have screened accessions for resistance/susceptibility to the foliar bacterial pathogen *Pseudomonas syringae*. This bacteria is a major problem for tomato, but not in cultivated potato. Surprisingly, we found that many wild species relatives are susceptible while cultivars are immune. We have also used many accessions to screen for responses to specific proteins made by the late blight pathogen, *Phytophthora infestans*. We are not using the germplasm for crosses, but rather identification of interesting genotypes that we can use to identify specific genes involved in disease resistance.

Shelley Jansky, Madison, WI: A set of accessions previously identified as resistant to Verticillium wilt was evaluated for Race 2 of *Verticillium dahliae*. We planted a set of taxonomically diverse species in the field for an evaluation of variation in leaf composition based on hyperspectral analysis. The set of *Phureja* haploid inducers was obtained for a project aimed at improving haploid induction ability. Finally, we are evaluating three *S. chacoense* accessions that are potential sources of the Sli gene.

Kent McCue, Albany, CA: Stock cultures were received from NSRP to revive tissue culture lines that are maintained for genetic transformation experiments. These cultures provide critical continuity for our research as their replacement every few years is required to maintain healthy consistent results and/or recover from biotic interference. In the past year these replacements were required due to the decimation caused by an insect infestation that spread fungal contamination. New cultures are regularly required to replace the lines used for our ongoing research on development of molecular engineering components and their use in proof of principal of studies on disease resistance and crop improvement.

Dimitre Mollov, Beltsville, MD: A population was identified by NRSP-6 personnel as having some individuals with stunted growth. NRSP-6 personnel sent me seeds from the same cross (full-sibs) parents: PI320376xCCC1371. I planted 184 seeds and took phenotypic data. About half germinated (96) and 11-15 were showing the phenotype we were interested. I have DNA and can follow if Jorge Abad's successor is interested in continuing this project.

Rich Novy, Aberdeen, ID: Three BR clones as described by Meijer, Jansky, and Halterman as having early blight and late blight resistances from *S. palustre* and *S. bulbocastanum*, respectively were requested and successfully used as parental clones in hybridizations to russet-skinned clones in 2016.

Chris Wallis, Parlier, CA: The NRSP-6 material was utilized in research exploring the mechanisms by which potatoes breeding lines could resist infections by Ca. Liberibacter solanacearum, the causal agent of potato zebra chip disease. It was determined that resistant breeding lines undergo host responses to a far fewer extent than susceptible varieties, resulting in the lack of zebra chip disease even when infected by the bacterial pathogen. In addition, potato resistance to potato psyllids, the vectors of Ca. Liberibacter solanacearum, was examined, and increased concentrations of terpenoid compounds in foliage may be associated with reduced psyllid reproduction.

Xiaohong Wang, Ithaca, NY: We have tested many accessions of wild potato species received from NRSP-6 for resistance against the three species of potato cyst nematodes (*Globodera pallida, G. rostochiensis, and G. ellingtonae*) with a goal to identify potato germplasm that confer broad-spectrum resistance to PCNs. In addition, we have utilized wild potato species in our study to investigate the molecular mechanisms of PCN infection of potato plants.

Recent Publications Provided by NRSP-6 Germplasm Recipients Relating to the Use of the Germplasm:

Bamberg, JB, A. H. del Rio, D. Kinder, L. Louderback, B.Pavlik, and C.Fernandez. 2016. Core Collections of potato (Solanum) species native to the USA. American Journal of Potato Research 93:564-571.

Bamberg, JB and A. H. del Rio. 2016. Accumulation of genetic diversity in the US Potato Genebank. *American Journal of Potato Research* 93:430-435.

Bamberg, J.B., Martin, M.W., Abad, J., Jenderek, M.M., Tanner, J., Donnelly, D.J., Nassar, AM.K., Veilleux, R.E., Novy, R.G. 2016. *In vitro* technology at the US Potato Genebank. In Vitro Cellular and Developmental Biology – Plants 52:213-225.

Bamberg, JB, AH del Rio and RA Navarre. 2016. Intuitive Visual Impressions (Cogs) for Identifying Clusters of Diversity within Potato Species. *American Journal of Potato Research* 93:350-359.

Chung, Y.S., C. Kim, and S.H. Jansky. 2017. New source of bacterial soft rot resistance in wild potato (*Solanum chacoense*) tubers. Genetic Resources and Crop Evolution. DOI 10.1007/s10722-017-0487-3.

Chung, Y.S., Palta, J., Bamberg, J., Jansky, S. 2016. Potential molecular markers associated with tuber calcium content in wild potato germplasm. Crop Science. 56(2):576-584.

Cooper, R., and JB Bamberg. 2016. Variation in susceptibility to potato psyllid, Bactericera cockerelli (Hemiptera: Triozidae), among *Solanum verrucosum* germplasm accessions. *American Journal of Potato Research* 93:386-391.

Jansky, S.H., Charkowski, A.O., Douches, D.S., Gusmini, G., Richael, C., Bethke, P.C., Spooner, D.M., Novy, R.G., De Jong, H., De Jong, W.S., Bamberg, J.B., Thompson, A.L., Bizimungu, B., Holm, D.G, Brown, C.R., Haynes, K.G., Sathuvalli, V.R. et al. 2016. Reinventing potato as a diploid inbred line-based crop. Crop Science 56:1-11.

Jansky, S. H., J. Roble, and D. M. Spooner. 2016. *Solanum clarum* and *S. morelliforme* as novel model species for studies of epiphytism. Frontiers in Plant Science 7.

Kuhl, J.C., R.G. Novy, J. L. Whitworth, M.S. Dibble, B. Schneider, and D. Hall. 2016. Development of molecular markers closely linked to the potato leafroll virus resistance gene, Rlr_{etb}, for use in marker-assisted selection. *American Journal of Potato Research* 93:203-212.

2017 North Central Utilization of Germplasm Resources from NRSP-6

North Dakota State University
Susie Thompson

The NRSP-6 Potato Genebank and Potato Introduction Project continues to provide invaluable service to the potato breeding and improvement efforts at NDSU and to US potato breeding and genetics research efforts. In 2016/2017 we accessed three *Solanum tuberosum* subsp. andigenum accessions for use in extracting haploids from our superior cultivars and parental genotypes. These included: PI584993 (IVP 48), PI584994 (IVP 101), ad PI611098 (Phu 460). All have the embryo spot marker.

University of Wisconsin
Jeff Endelman

1. We used IVP101 to pollinate our entire crossing block and generated just over 100 seeds without a purple embryo spot. Seeds were germinated in vitro, and we have begun potting them up for chloroplast counts. Initial results indicate less than half are diploid, which will be checked using the SNP array.

2. We obtained the European clone Sarpo Mira and will be using it for crossing as a donor for the R8 late blight resistance gene.

University of Minnesota
Tom Michaels

Tom Michaels has taken the interim leadership in the potato breeding efforts at the University of Minnesota since the loss of Christian Thill. Dr. Laura Shannon has been hired to lead the potato breeding and genetics project at the University of Minnesota.

Michigan State University
David Douches

We are refocusing our diploid breeding effort to incorporate the dominant Sli gene, which imparts self-compatibility (SC), into our diploid germplasm base. The major source of the gene is *S. chacoense* M6 from Shelley Jansky's program. Have established an accelerated recurrent selection program that has a one year cycle. We have completed five rounds of crossing and four rounds of selection for tuber shape, size, photoperiod adaptation and SC. The germplasm in this population is a combination of *S. phureja, S. berthaultii, S. tarijense, S. chacoense, S. microdontum* and *S. tuberosum.* 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. Each cycle we are SNP genotyping the SC selections from the population to monitor the genetic diversity and population structure. 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 SC phenotype is not simply introgressed into the self-incompatible germplasm. In 2016 we selected within S1 progenies from cycle 2 parental material. Those lines will be further evaluated in 2017.

To complement the recurrent selection population germplasm we are extracting dihaploids from *S. tuberosum* varieties and advanced breeding lines to develop chip-processing germplasm for diploid breeding. We have confirmed dihaploids from Atlantic, Superior, NY148, Kalkaska, MSR127-2, MSS576-5SPL, MSQ131-A, MSJ147-1, MSZ219-14 and Jacqueline Lee. We use chloroplast counts and SNP genotyping to determine ploidy of the dihaploid candidates. We have also have hybridized M6 to some of the dihaploids to introgress SC and currently have selected some BC1 progeny that are SC. Our observation is that SC is quickly lost in backcrossing to the *S. tuberosum* dihaploids.

We have crossed a set of *S. berthaultii* PIs that have high densities of leaf trichomes to M6, the SC source. F1s were selfed and we are currently generating F5 progeny with the goal of creating a RIL population segregating for glandular trichomes. The population size is currently over SC150 progeny. We are also crossed USDA8380-1 to M6 to generate a RIL population to study leptine based insect resistance to Colorado potato beetle. The F4 progeny are currently being generated with about SC 120 progeny. The F2 population of this material is being screened in a Colorado potato beetle nursery at the Montcalm Research Center. We also crossed the CEC and *S. commersonii* clones from NRSP-6 with M6 to introduce SC. These F1 progeny were selfed and populations will be selected to study bacterial wilt resistance.

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 was in the field for field late blight data collection to complement the detached leaf bioassay data collected in 2015. Right now we have a major late blight QTL on Chr. 10. Tuber dormancy is preliminarily mapped to Chr. 4, 5 and 7.

We have used Alca Tarma as a source of PLRV resistance. Through marker-assisted selection we have a population that contains over 90 progeny that have both markers for PVYadg (RYSC 3) and PLVR resistance. BC2 populations have been generated for selection of more adapted progeny that combine both virus resistances. Virus bioassays have been conducted but it has been difficult to transfer PLRV infection with aphids in the greenhouse to this point.

Ph.D. student Michael Hardigan is continuing to study domestication of potato with Robin Buell. He has resequenced a diversity panel of 20 wild diploid potato species, 20 South American landrace accessions and 23 North American potato cultivars. Thus far sequence diversity in both wild and cultivated potatoes exceeds levels found in previous crop resequencing studies, and has begun to identify selected genes targeted during the domestication of potato. Results indicated a substantial portion of wild alleles are already present in cultivated potato due to historic introgressions, though likely at low frequencies. A publication was submitted to PNAS.

Report to the NRSP-6 Technical Committee

Pyle (Teleconference) Center, Madison, WI, June 13, 2017

B. Bizimungu, Agriculture and Agri-Food Canada, Fredericton Research and Development Centre

I) Recent introductions from NRSP-6 Project

- 2015 orders: 3 orders (85 units)
- Material supplied to private breeders and Agriculture and Agri-Food Canada.

II) Research initiatives founded on NRSP-6 genebank stocks

Dr. Chandra Moffat (entomologist, Agriculture and Agri-Food Canada, Fredericton Research and Development Centre): Behavioural responses- Impacts on life history traits

Research using breeding clones [15951-06 (*S. oplocense*), 15953-12 (*S. oplocense*), F12103 (*S. chacoense*), F12110 (*S. chacoense*), GBB1-100 (*S. pinnatisectum*), GBB3-21(*S. pinnatisectum*)] showing low (10-40%) CPB defoliation relative to susceptible varieties.

- To evaluate behavioural, life history and population dynamic responses of CPB reared on each selection over multiple generations.
- To elucidate the mechanism of resistance in each selection and to better understand how CPB populations may interact with resistant selections over time.

Dr. Xianzhou Nie (virologist, Agriculture and Agri-Food Canada, Fredericton Research and Development centre)

- Material currently being assessed for their responses to PVX and different strains of PVY and will be used to develop high resolution DNA melting (HRM) analysis for high throughput HRM marker-assisted selection.

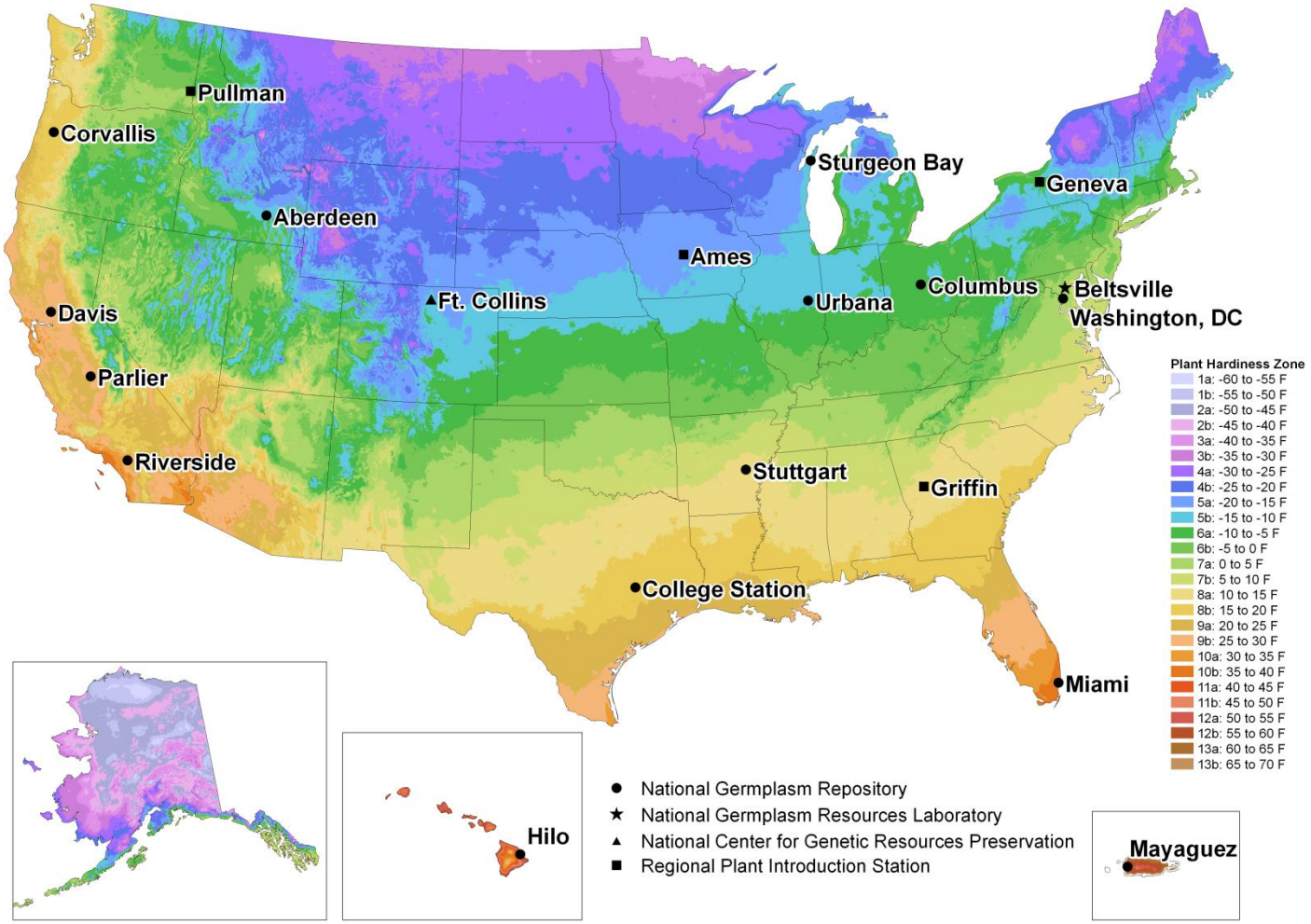
II) Cultivar development- Agriculture and Agri-Food Accelerated Release program (information is available on-line at: www.agr.gc.ca/potato-cultivars)- new cultivars founded on NRSP-6 genebank stocks:

- Advanced selections under commercial testing:
  - 2nd year non-exclusive testing: 2 selections (AR2016-04 and AR2016-08) derived from *S. oplocense* NRSP-6 genebank stock - featuring low (10-40%) CPB defoliation relative to susceptible varieties and cold-sweetening resistance
  - 1st year non-exclusive testing: 2 selections (AR2017-14 and AR2017-15) derived from *S. chacoense* NRSP-6 genebank stock featuring low (10-40%) CPB defoliation relative to susceptible varieties and moderate resistance to foliar late blight.

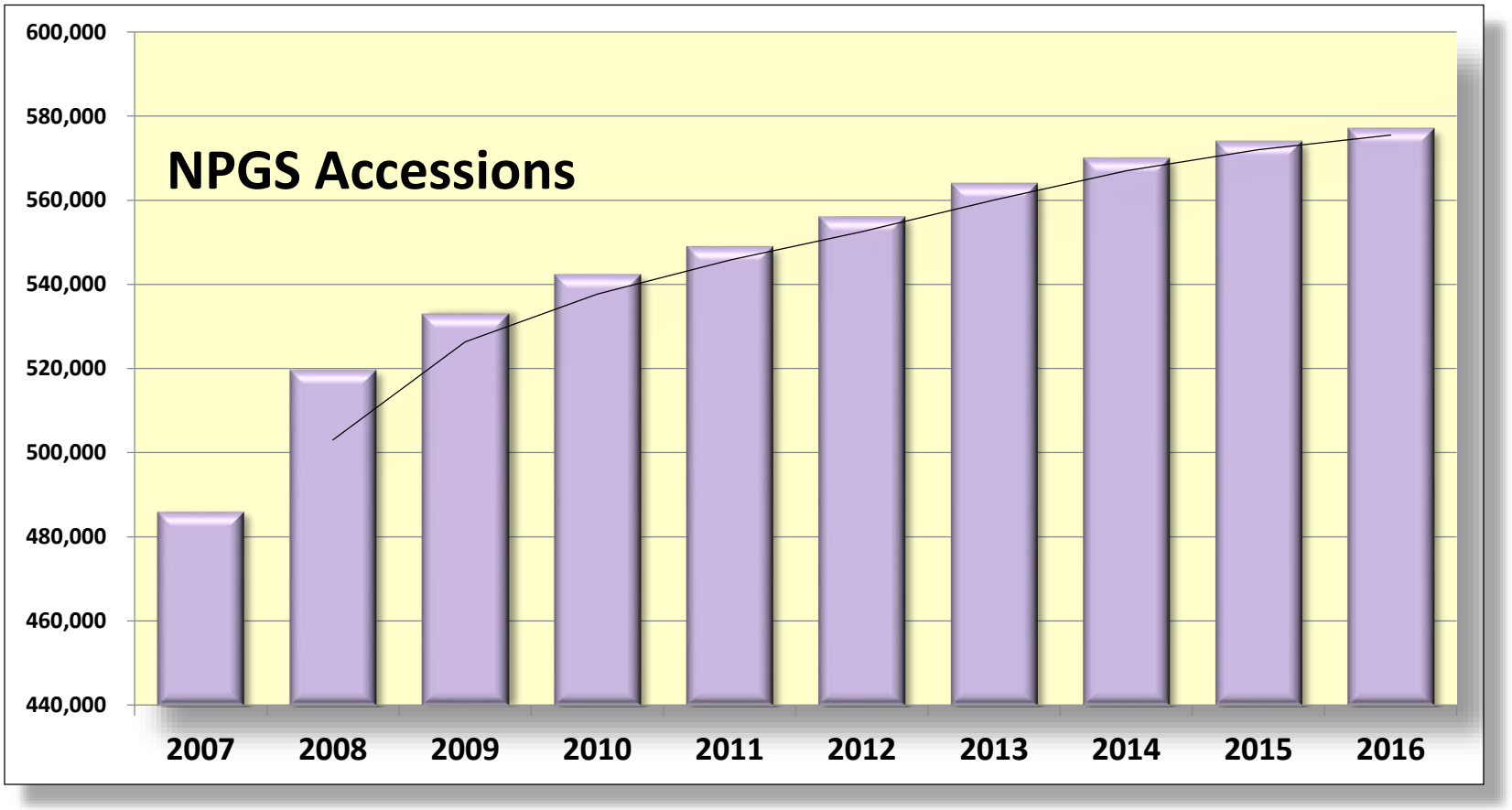
The National Plant Germplasm System: 2017 Status, Prospects, and Challenges

Peter Bretting
USDA/ARS Office of National Programs
Peter.bretting@ars.usda.gov
1.301.504.5541

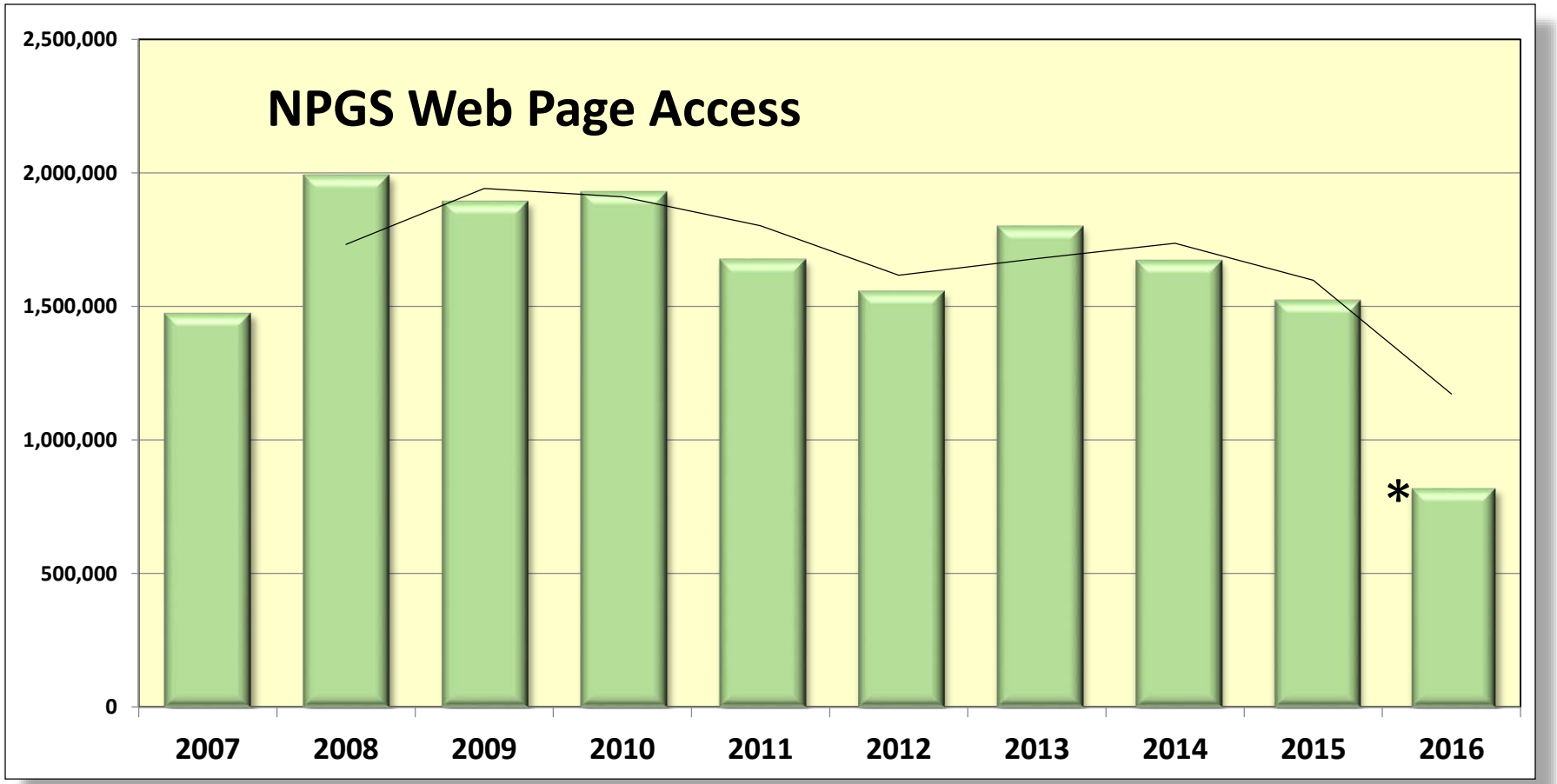
USDA National Plant Germplasm System (NPGS)



NUMBER OF NPGS ACCESSIONS 2007-2016

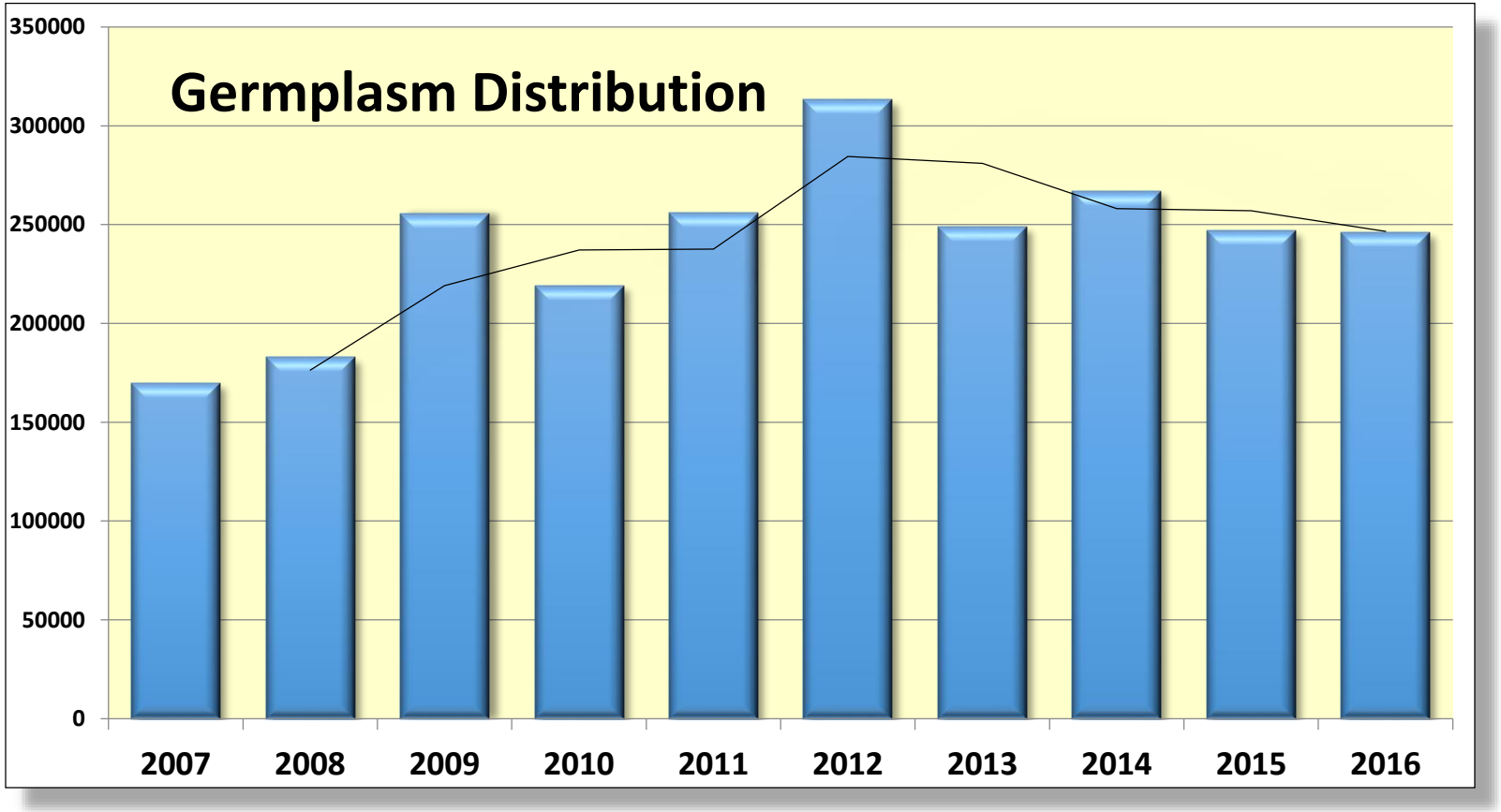


DEMAND FOR NPGS INFORMATION 2007-2016



* New GRIN-Global measuring method instituted

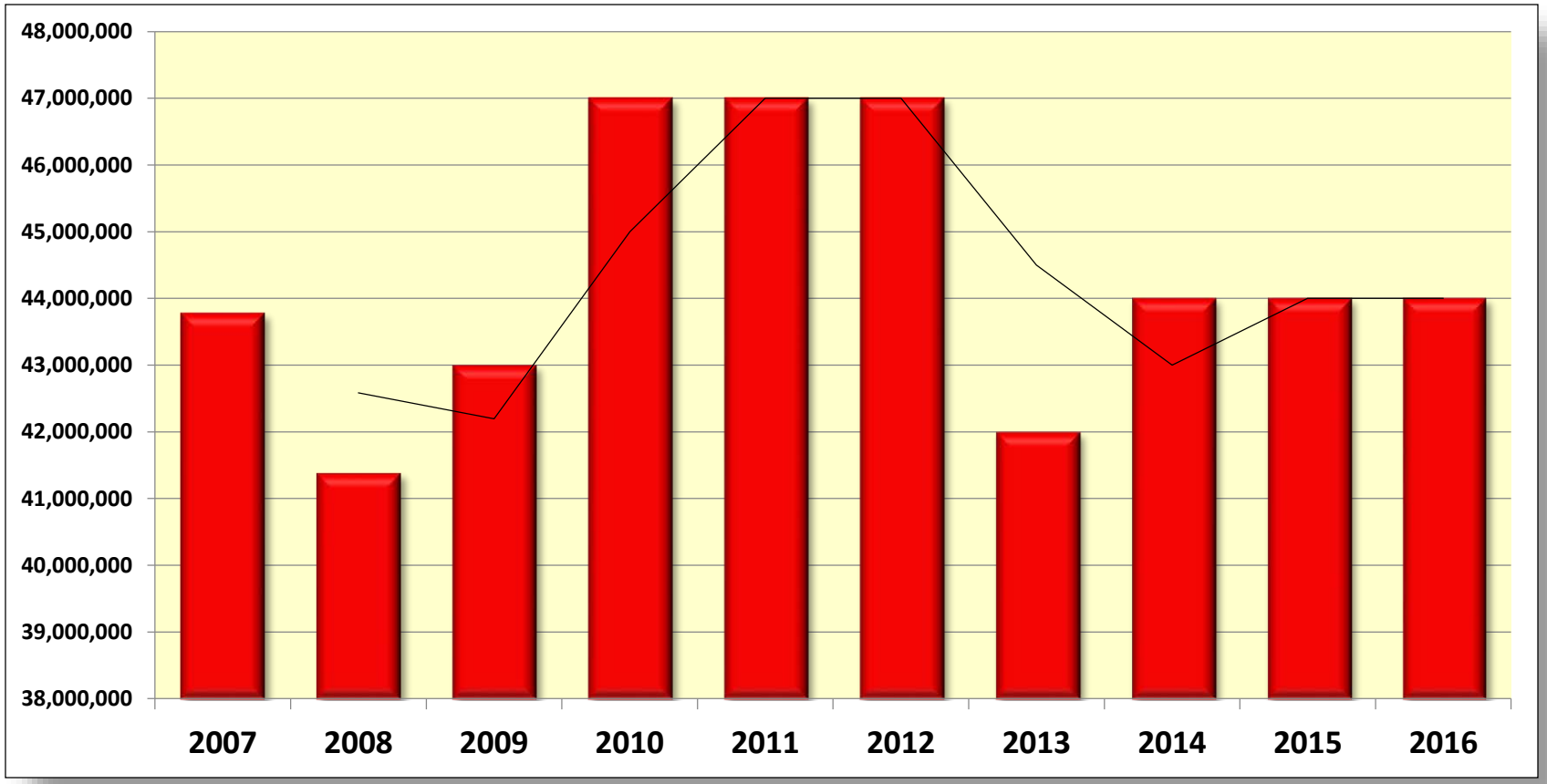
DEMAND FOR NPGS GERMPLASM 2007-2016



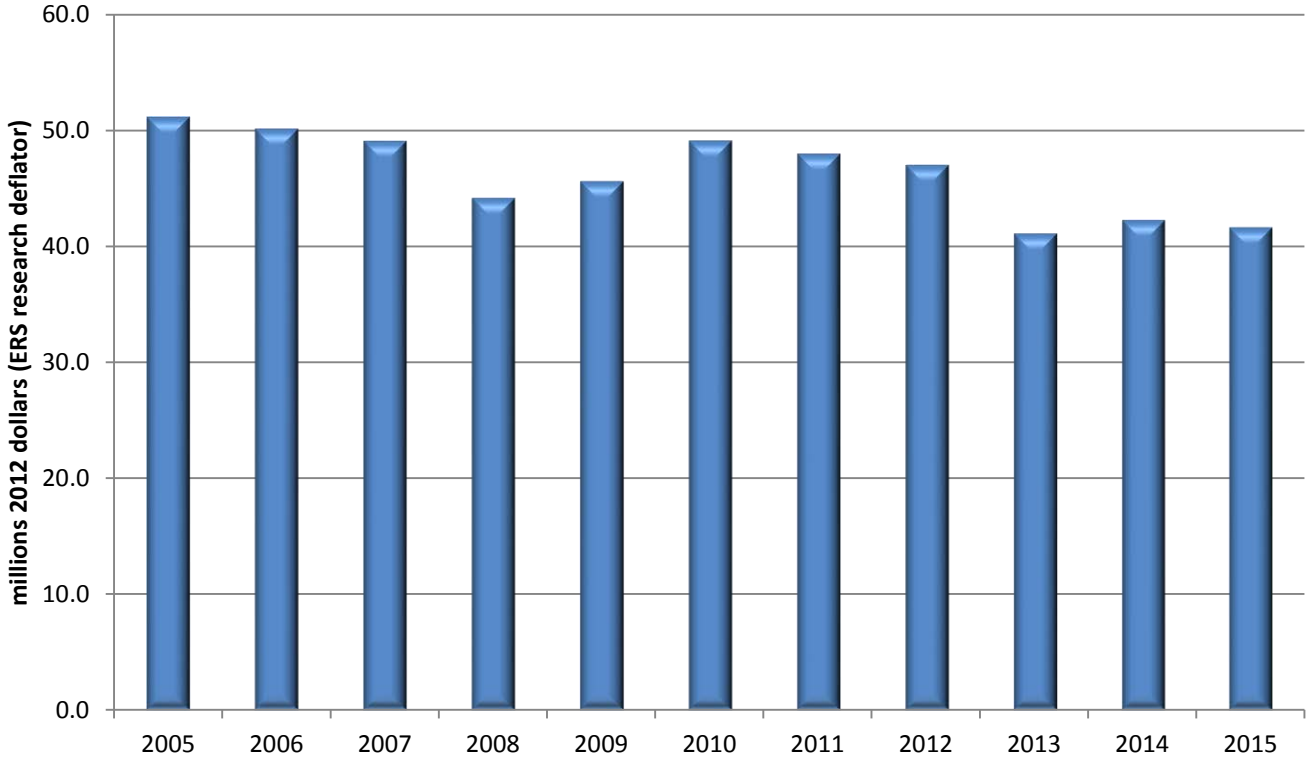
ARS National Plant Germplasm System

BUDGET

2007-2016



Real ARS National Plant Germplasm System Budget, 2005-2015, converted to 2012 dollars with ERS research deflator



Note: Deflator for 2015 is preliminary

Some key challenges for the NPGS

- **Managing and expanding the NPGS operational capacity and infrastructure to meet the increased demand for germplasm and associated information.**
- **Recent and upcoming NPGS personnel retirements.**
- **Developing and applying cryopreservation and/or in vitro conservation methods for clonal germplasm.**
- **BMPs and procedures for managing accessions (and breeding stocks) with GE traits and the occurrence of adventitious presence (AP).**
- **Acquiring and conserving additional germplasm, especially of crop wild relatives.**

Genetic Resource Management Priorities

- Acquisition
- Maintenance
- Regeneration
- Documentation and Data Management
- Distribution

- Characterization
- Evaluation
- Enhancement
- Research in support of the preceding priorities

Personnel Changes

- **Farewell and best wishes to RLs Richard Percy (ARS-College Station), Randy Nelson (ARS-Urbana) and Gary Pederson (ARS-SRPIS, Griffin) for their retirements.**
- **Farewell and best wishes to Charlie Block, Plant Pathologist at ARS-NCRPIS, Ames who retired to take a position at the Iowa State University Seed Science Center.**
- **Best wishes to Tomás Ayala Silva, who transferred from the ARS-SHRS, Miami to ARS-TARS, Mayagüez to assume the curator position there.**
- **Welcome and best wishes to Peter Boches, new tropical crop curator at PBARC, Hilo, and Melanie Schori, new plant taxonomist for GRIN Taxonomy at NGRL, Beltsville.**

2016 Retrospective Review of NP 301 Plant Genetic Resources, Genomics and Genetic Improvement

- Largest USDA/ARS National Program:
  - 155 individual research projects.
  - Conducted at more than 50 sites in the U. S.
  - More than 300 crop researchers, breeders, and curators.
- Includes all of USDA/ARS's plant breeding, plant genetics/genomics, information management, bioinformatics, plant genetic resources, plant biology, and plant biotechnology risk assessment research and service activities.
- Covers all major and most specialty crops

2016 NP 301 Retrospective Review Process

- **Composition of the Review Panel:**
  - **Chair: Dr. David Bubeck, Research Director, DuPont Pioneer, Inc.**
  - **Eight panel members: two from AAFC Canada, six from US Land-Grant Universities.**
- **Review Criteria:**
  - **Assess the quality and impact of NP 301's accomplishments during 2011-2015 relative to the NP 301 Action Plan.**
  - **Assess whether NP 301 collaborated effectively with public and private sector partners.**
- **Panel Report was delivered via seminar/webinar on 28 June 2016.**

Summary of NP 301
2011-2015 Accomplishments

- **Advanced crop genetics, molecular biology and physiology.**
- **Underpinned global crop breeding and research.**
- **Integrated global crop breeding and research.**
- **Reduced global crop genetic vulnerability.**
- **Increased global crop yield and product value.**
- **Accomplishments resulted from collaborations, and complemented private-sector efforts.**

NP 301 Retrospective Review Panel – Fundamental Observation

- **"As a collective effort, NP 301 is leading the world to exceptional innovation in Plant Genetic Resources, Genomics and Genetic Improvement. Without this program, the risk and vulnerability to U.S. and world agriculture would be substantial."**

ANNUAL REPORT
FY 2016

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	Vice Chair (2017)	C. Yencho
Western Region		D. Holm
North Central Region		D. Douches
Northeastern Region	Chair (2017)	W. De Jong
Administrative Advisors		
Southern Region		C. Nessler
Western Region		J. Loper
North Central Region	Lead AA	B. Barker
Northeastern Region		E. Ashworth

United States Department of Agriculture

ARS		
Technical Representative		R. Novy
National Program Staff		P. Bretting
		G. Wisler
Midwest Area		R. Matteri & P. Simon
NIFA		E. Kaleikau & L-S Lin
APHIS		R. French
NRSP-6 Project Leader		J. Bamberg
Agriculture & Agrifood Canada		B. Bizimungu
Industry	Secretary (2017)	J. Parsons

PROGRESS AND PRINCIPAL ACCOMPLISHMENTS

A. Acquisitions and associated work

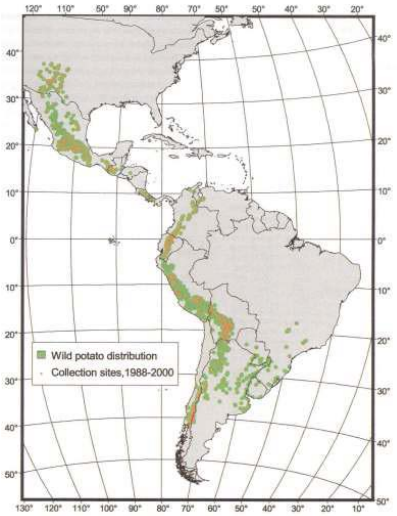
In 2016, we collected 26 germplasm accessions from Arizona, with the support of K. Williams of the USDA Plant Exploration office at Beltsville. We found robust populations in places never previously reported. A detailed trip report is available on GRIN. We also sought and received many new breeding stocks from H. DeJong. We began the process of acquiring clones for which PVP has expired.

(L-R) Alfonso del Rio, Ingrid Bamberg and Charles Fernandez collecting at a new site near Woods Canyon Lake.

Two manuscripts were published on the dynamics of germplasm acquisition in the genebank. One reported on a mega-population of *jamesii* that captures over 80% of the known diversity for that species. This would be a one-stop-shopping site for *in situ* collecting and study. Another manuscript was published that used model species to show the pattern of expected accumulation of diversity in the collection indicates that 100 populations essentially maximized diversity and unique alleles.

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 2016, 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.

B. Classification



Dr. Spooner's monograph on the species of southern South America is now available and another on the species of northern South America is coming soon. Arrangements have been made to move and incorporate PTIS into the University of Wisconsin herbarium. We began making high quality digital scans of plants of all stocks to accompany the accession records in GRIN.

C. Preservation and Evaluation. About 3,500 individual field plots, greenhouse and screenhouse growouts were done locally and at the HARS research farm at Hancock, WI.

1. Propagation: In 2016, 143 seed increases and 3090 clonally (based on 1030 in vitro clones being transferred 3 times/year).

2. Germplasm health monitoring: We tested 698 accessions for PSTV and 310 clones for the six common potato viruses..

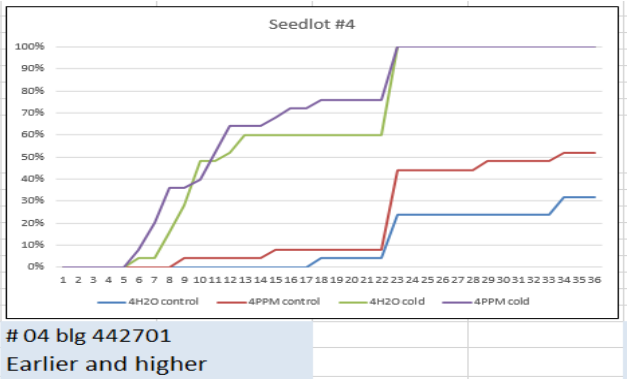
3. Characterization: We did 1509 germination tests, 34 ploidy evaluations and 31 tetrazolium seed viability assays. We demonstrated that some seedlots that have very low germination by conventional methods are actually highly viable if germination is nursed *in vitro.*

4. Evaluation and Technology:

Peru connection: With Peru cooperator J. Arcos and J. Palta of UW, we continued to make crosses of various elites for wart, drought, frost, late blight, tuber calcium for Puno, a major center of potato production and breeding in Peru. One of our hybrids is being tested for cultivar release.

Egg-yolk specialty potatoes: We continued evaluation of the best selections, and recurrent breeding. With cooperators at University of Minnesota, we began the process of creating an inbred diploid form of *Criolla* with exellent color, taste and tuber dormancy.

Genotyping genebank holdings: We received data from Frito genotyping of ~700 cultivars and breeding stocks and began analysis. This promises to be a tremendous tool to show us hot-spots of genetic diversity (core collections), which should lead to more efficient collecting, preservation, and evaluation of germplasm and mining of particular traits.



Seed germination. Diurnal temperature fluctuation effects on germination of recalcitrant seedlots was tested. Some "trickle-germinating" seedlots showed a beneficial burst of germination and increased final germ when exposed to cold nights.

Core collections and other intra-specific groupings: We made high quality digital scans of all ~225 members of *boliviense* and assessed ability to visually sub-group them.

Remote grow-outs: With U New Mexico cooperator at Farmington, we conducted remote field tuber grow-outs of all *jamesii* providing tissue for multiple analyses.

Tuber freezing resistance: Confirmed first reported significant tuber freezing survival. If we can dissect the physiology and apply it to other germplasm, it might lead to an efficient long-term germplasm storage tool.

Field tuber adaptation: We continued pursuit of large field tuber lines of *jamesii* and confirmed hybridity of other related species which are very rich in desirable traits but very difficult to cross with cultivated forms.

Potato beer. We continued to explore best approach to high quality product, and grew ~600 evaluation plots to identify high potassium materials. We shared samples with cooperators in Peru pursuant to a Peruvian potato beer that would benefit from Peru's reputation as native home of potato.

D. Distribution

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. In 2016, distributions were typical: 221 domestic orders to 115 clients in 37 states and 16 foreign orders to 8 other countries. About 1/3 of the domestic orders are for breeding and genetics, 1/3 for home gardeners, and remainder 1/3 for pathology, physiology, entomology, taxonomy and education.

In 2016 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). We now only offer tubers of wild species by special order.

	Units of Germplasm Sent[1]							
Category	Seed	TU	IV	DNA	Plants	Herb	Total	PIs
Domestic	7739	2271	2277	1043	945	0	14275	6099
Foreign	4203	0	695	0	0	0	4898	4409
Total	11942	2271	2972	1043	945	0	19173	10508

[1]Types of stocks sent/(number of seeds, tubers or plantlets per standard shipping unit): Seed = True Seeds/(50), TU = Tuber Clones/(3), IV = *in vitro*/(3), DNA = dried leaf or tuber samples/(1), Plants = Rooted Cuttings/(1), Herb = Herbarium Specimens/(1).

E. Outreach

Trip to Peru in March solidified program for cooperative activities in Puno.

Chaired Potato CGC and AJPR Editorial Board meetings.

Volunteered presentations with published abstracts: Four at PAA in Grand Rapids, MI, Invited presentation at CSSA meeting in PHX.

Provided Master Gardeners' training and engagement in potato science with germination testing work days.

Hired and managed an undergrad student as summer interns with research projects.

Hosted international visitors from Peru, Chile, Japan

All germplasm documentation, and details about technology, outreach, and staff publications is available at our website: http://www.ars-grin.gov/nr6/.

IMPACT STATEMENT See attached appendix

WORK PLANS / STAFF & FUNDING / ADMINISTRATION

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.

Continue study of status and dynamics of genetic diversity: Core collection, cogs, how best to collect from the wild.

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.

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

Continue developing germplasm-use technology like big-tuber mutants, double pollination.

Continue looking for more efficient ways to evaluate germplasm, like specialized tuber-generating growth chambers.

Continue screening for traits of high priority to both producer and consumer.

Continue administrative leadership services on national germplasm committees and editorial service to *American Journal of Potato Research*.

PUBLICATIONS

Many other scientists are publishing research that directly or indirectly originated from NRSP6 stocks. The search below produced hits which the reader can regenerate independently, or which can be accessed through our website: http://www.ars-grin.gov/nr6. Staff publications (for 2016 and previous) which give details on the initiatives summarized above can be readily accessed through the personnel links for Bamberg, Spooner, and Jansky at the genebank website.

The search 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 2016 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. Because of reporting lag, the result for 2015 is most representative = **161 papers**.

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

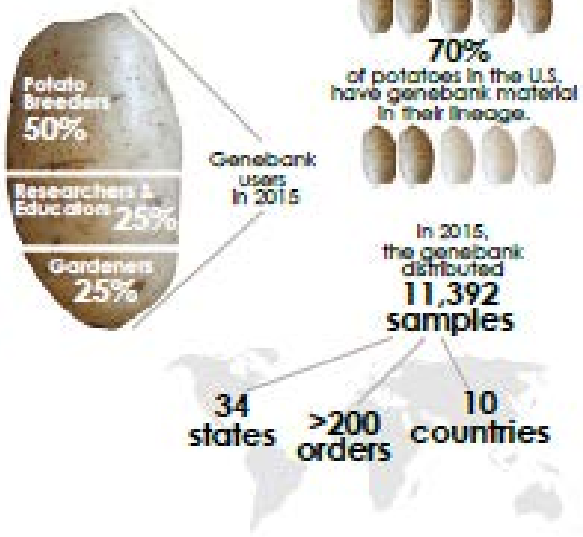
Solanum and (abancayense or acaule or achacachense or acroglossum or acroscopicum or aemulans or agrimonifolium or ajanhuiri or alandiae or albicans or albornozii or ambosinum or andreanum or arnezii or astleyi or avilesii or aymaraesense or berthaultii or blanco-galdosii or boliviense or brachistotrichum 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 stipuloideum 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:2015.

Impact Appendix

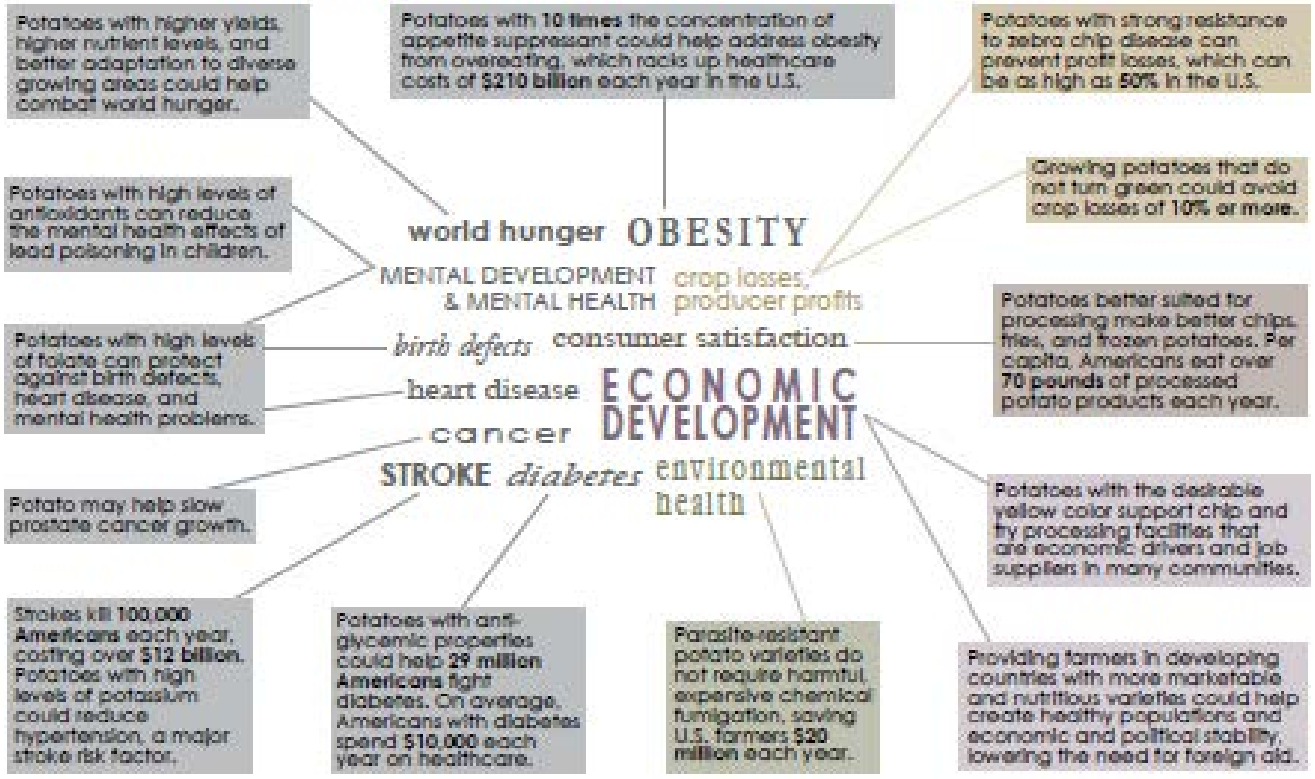
BREEDING BETTER POTATOES

As the most widely grown and consumed vegetable in the U.S., potatoes can have a huge impact on the economy, the environment, and human health. Potatoes are a popular food choice because they are filling, palatable, nutrient-dense, and affordable, and the international market for frozen potatoes, French fries, and potato chips is booming. The value of potato production in the U.S. totals over $4.3 billion each year, with over $1 billion in exports.

Improving potato varieties is key to sustaining this important crop. Since 1947, researchers, breeders, and farmers have used seeds and data from the U.S. Potato Genebank to conduct potato research and cultivate new, desirable potato varieties. A group of researchers coordinates the genebank and supports its efforts by improving techniques and tools for collecting, analyzing, and preserving potato specimens from around the world. A diverse genebank means that researchers, breeders, and farmers will have the resources they need to overcome potato production challenges and sustain the crop for future generations.



Benefits of Genebank Research & Potato Varieties



Want to know more?

National Research Support Project NRSP-6 is supported, in part, through USDA's National Institute of Food and Agriculture by the Multistate Research Fund established in by the Agricultural Research, Extension, and Education Reform Act, which encourages and enhances multistate, multidisciplinary research on critical national or regional issues. Additional funds have been provided by USDA's Agricultural Research Service, private industry sponsors, and the University of Wisconsin. NRSP-6 has been renewed through 2020. For more information on the project, visit http://www.ars-grin.gov/nr6/. For more information on the Multistate Research Program or the Impact Writing Initiative that produced this document, visit http://www.multistateresearchimpacts.org/.