ANNUAL REPORT
FY 2017

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		F. Servello

United States Department of Agriculture

ARS		
Technical Representative		R. Novy
National Program Staff		P. Bretting
		J. Munyaneza
Midwest Area		JL. Willett & 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 2017, we collected 17 germplasm accessions from an expedition to Colorado and New Mexico with the support of K. Williams of the USDA Plant Exploration office at Beltsville. We found potatoes in new places at the northeast extreme of the range. Some were extremely robust populations (below left) but some places (below right) were extremely stressed (although these small dead plants often had one mature tuber and fruit). A detailed trip report is available on GRIN, attached to every new accession record. We also sought and received 19 new clonal breeding stocks and cultivars from various donors. We continued the process of acquiring clones for which PVP has expired.

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 2017, 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 continued work on a monograph of species of northern South America. The PTIS herbarium was moved to the University of Wisconsin (see... https://news.wisc.edu/valuable-potato-specimens-transferred-to-wisconsin-state-herbarium/). We continued making high quality digital images of plants, including tubers, of the species *microdontum* and *boliviense* to attach to accession records in GRIN. We continued research on crafting core collections within species *stoloniferum* and *bolviense*.

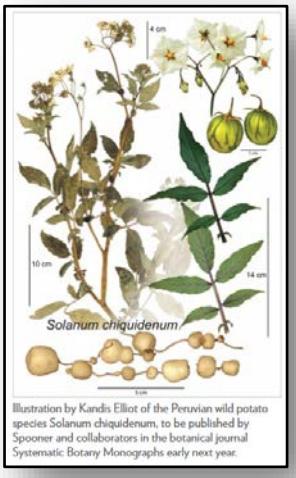
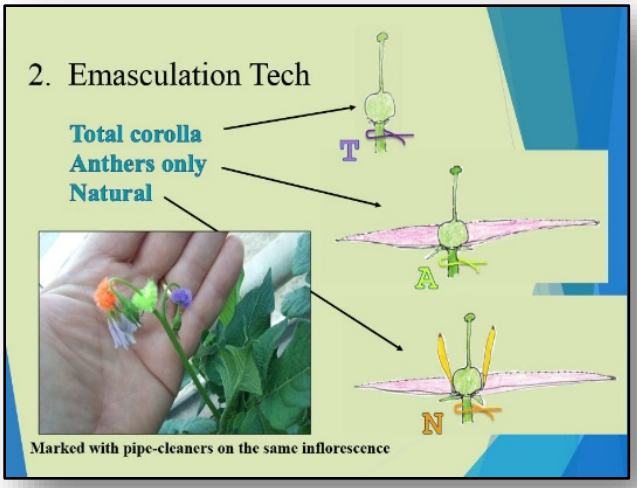


Illustration by Kandis Elliot of the Peruvian wild potato species Solanum chiquidenum, to be published by Spooner and collaborators in the botanical journal Systematic Botany Monographs early next year.

C. Preservation and Evaluation. Nearly two acres of individual field plots for numerous evaluation experiments were grown at the UW Ag Research



Station at Hancock, Wisconsin. Four large screenhouses at Sturgeon Bay were used for other such experiments grown in pots.

1. Propagation: In 2017, we hand-pollinated 167 families of 20 plants each in the greenhouse for seed increase and performed 3,150 *in vitro* transfers to maintain fresh propagules of clonal stocks. Alternate methods of emasculation were systematically tested (at left).

2. Germplasm health monitoring: We did 589 tests for PSTV and 217 more for the six common potato viruses.

3. Characterization: We did 1,567 replicated germination tests, 25 ploidy evaluations and 21 tetrazolium seed viability assays. These statistics do not include the hundreds of assays performed researching ways to improve the efficiency of seed germination and ploidy determinations.

4. Evaluation and Technology:

<u>Peru connection</u>: With Peru cooperators and J. Palta of University of Wisconsin, we continue research and breeding for wart, drought, frost, late blight, tuber calcium. L. Palomino, INIA breeder (at right), holds one of our named selections being released in the Cusco region. We also continued strong collaboration on projects with colleagues in the NGO CITE-papa, and our sister genebank, CIP, in Lima.

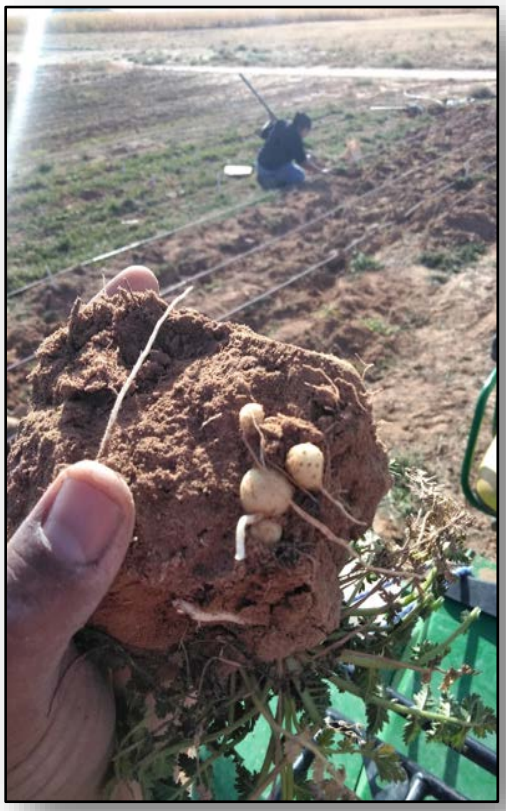
<u>Egg-yolk specialty potatoes</u>: We continued evaluation of the best selections, and recurrent breeding. With cooperators at University of Minnesota, we began the process of creating an inbred diploid form of *Criolla* with excellent color, taste and tuber dormancy.

<u>Genotyping genebank holdings</u>: We cooperated with CIP colleagues to GBS genotype multiple individuals from ten populations to assess heterogeneity and effects of seed increase. Similar markers are being generated on 50 individuals of *microdontum* with PepsiCo-FritoLay to look for markers associated with *Dickeya* resistance and other traits. With Oregon cooperators, we identified SolCap SNPs associated with high folate.

<u>Somaclonal and other variants</u>: We produced 14 somaclonal variants to see if this technique, which uses tissue culture technology and expertise already established at the genebank, can improve elite selections for various traits. Finding and using novel diversity is our primary mission. The unique extreme fasciation in the *jamesii* accession found in 2017 are the kind of opportunities we look for.

Remote grow-outs: With New Mexico State University cooperators at Farmington, we again conducted remote field tuber grow-outs providing tissue for multiple analyses (below right).

Tuber freezing: We are wrapping up data collection on the first reported significant tuber freezing tolerance in potato. If we can dissect the physiology and apply it to other germplasm, it might lead to an efficient long-term germplasm storage tool, or other uses in the industry. We reported this finding at the annual meeting of the Potato Association of America.



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 2017, total distributions were up about 25% over historic aveages: 229 domestic orders to clients in 35 states and 17 foreign orders to 9 other countries. About 1/3 of the domestic orders are for public breeders and geneticists, 1/3 for pathology, physiology, entomology, taxonomy and education, and the remaining 1/3 for private germplasm users.

In 2017 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	4,200	2,993	1,597	920	1,173	0	10,883	7,194
Foreign	933	0	285	0	0	0	1,218	721
Total	5,133	2,993	1,882	920	1,173	0	12,101	7,915

[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).

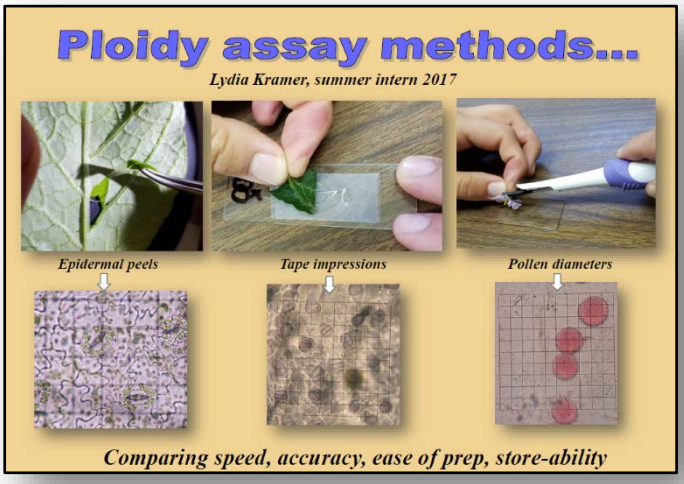
E. Outreach

Staff member T. Kazmierczak demonstrates pollination to visiting agricultural students from Ukraine, Brazil, and Uganda

We made a trip to Peru in November to solidify our cooperative programs in Puno, Cusco, and Lima. Bamberg chaired the Potato CGC and served as Editor in Chief of AJPR. We hosted visitors from Kenya, Ukraine, Brazil, Uganda, Peru, and University of Minnesota. Staff member A. del Rio was invited to be on the organizing committee of the Latin American Potato Association Meeting in Cusco, Peru in May, 2018. We have been asked to host the National Plant Germplasm Coordinating Committee meeting in May 2018. We volunteered presentations with published abstracts: Two at PAA in Fargo, invited presentation at CSSA meeting in Phoenix and were invited to write a book chapter on nutritional opportunities in new potato outlets.

We hired and managed two undergrad students as summer interns with research projects. One of these projects (systematic assessment of ploidy estimation techniques) has already been presented at a national germplasm meeting.

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



IMPACT STATEMENT In the past couple of years breeders have engaged in the revolutionary remaking of potato as a diploid inbred crop. This is only possible because haploidizing technology and selfing mutants were both discovered in NRSP6 germplasm--by NRSP6 staff. And NRSP6 further supported the effort in the current project term by importing valuable new stocks and testing techniques. The ploidy manipulation technique that resulted in Yukon Gold was also developed with NRSP stocks--by NRSP6 staff. Wisconsin cooperators isolated and incorporated the gene providing durable resistance to late blight from a wild species that had been collected in Mexico and preserved and studied in the genebank long before its potential was recognized. Washington collaborators incorporated potent nematode resistance. In 2017, Idaho collaborators reported incorporation of resistance to greening (responsible for 10-15% of crop losses)-- discovered by NRSP6 staff. Cooperators used NRSP6 stocks to develop breeding stocks resistant to verticillium and scab, and donated those back to the genebank. NRSP6 staff helped Oregon researchers identify germplasm with high folate and resistance to nematodes. We produced custom hybrids and propagules to help Industry partners breed lines with much greater levels of an anti-appetite compound aimed at reducing obesity. At least 70% of named US cultivars have our exotic

germplasm in their pedigrees. For example, in Wisconsin, of the past 8 cultivar releases from the breeding program, 6 have wild species germplasm as parents obtained directly from NRSP6. Each of the four US cultivars published in American Journal of Potato Research in 2016 have *wild species* originating at NRSP6 in their pedigrees. NRSP6 staff bred cold tolerant families from which two new cultivars were selected for release in 2018 in Peru. Sequencing the potato genome depended on the use of genetic stocks from NRSP6 developed by cooperators at Virginia Tech. The revolutionary intragenic Innate potato lines from Simplot in Idaho were developed through the use of exotic germplasm from NRSP6. Two new potato pests—Zebra chip and *Dickeya*-- have become very serious in recent years. We are cooperating with state and federal scientists in Colorado, Texas, New York, and Washington, screening for and finding potent resistance in exotic germplasm from NRSP6. All these advances would not have been possible using germplasm in the common breeding pool-- they needed to be accessed from exotic germplasm. And that exotic germplasm is only available in the USA from NRSP6. The use of NRSP6 germplasm by stakeholders has been very robust in the past, increasing knowledge and breeding products that have had a great positive impact on the crop.

NRSP6 supports evaluation studies of cooperators by producing custom propagules

An additional useful sketch is found in the genebank interview in the Badger ComonTater and other public outlets found on the “In the News” page on the NRSP6 website... https://www.ars-grin.gov/nr6/news_press.html

Most new potato cultivars have NRSP6 stocks in their pedigrees

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, and look 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 2017 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 2017 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 2016 is most representative = **136 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:2016.