ANNUAL REPORT
FY 2018

NRSP-6: UNITED STATES POTATO GENEBANK

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

COOPERATIVE AGENCIES AND PRINCIPAL LEADERS

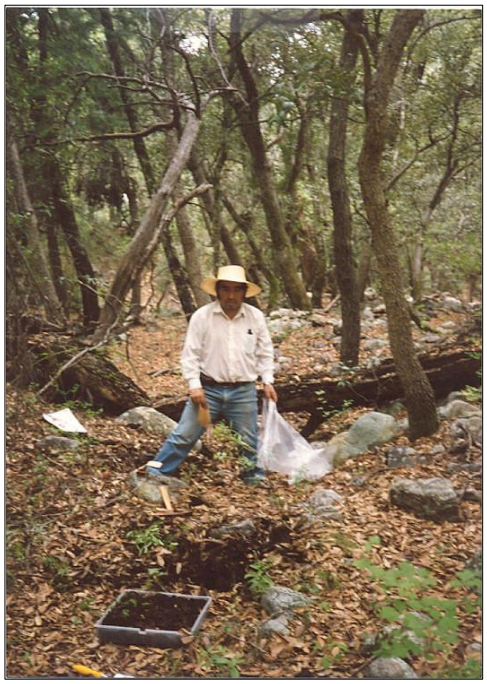
State Agricultural Experimental Stations		Representative
Technical Representatives		
Southern Region		C. Yencho
Western Region		D. Holm
North Central Region	Vice chair (2019)	D. Douches
Northeastern Region		W. De Jong
Administrative Advisors		
Southern Region		J. Meullenet
Western Region		J. Loper
North 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	Chair (2019)	J. Parsons

PROGRESS AND PRINCIPAL ACCOMPLISHMENTS

A. Acquisitions and associated work

In 2018, we collected 33 germplasm accessions from an expedition to Arizona and New Mexico with the support of K. Williams of the USDA Plant Exploration office at Beltsville. We found potatoes in completely new places, notably above the Gila Cliff dwellings in NM and eastern foothills of the Chiricahuas in AZ. Another special feature of this year's expedition was participation of René Gomez of the International Potato Center (CIP), a reprise of the CIP participation by Alberto Salas in our very first collecting expedition in 1992. A detailed trip report is available on GRIN, attached to every new accession record.



CIP collaborators collecting in Arizona: Alberto Salas (left, 1992), René Gomez (right, 2018).

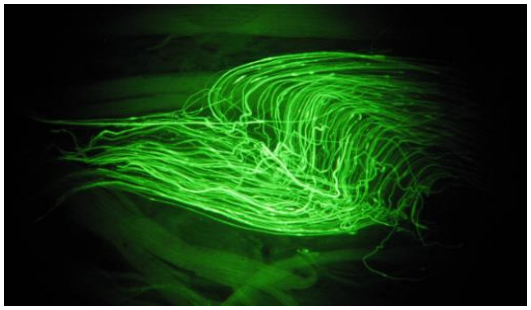
We also sought and received 9 new clonal breeding stocks and cultivars from various donors, for example, Voyager bred by HZPC of the Netherlands (→). We continued the process of acquiring clones for which PVP has expired. The NRSP-6 web page (http://www.ars-grin.gov/nr6) was updated to include all new stocks and screening information. Clients who have ordered from NRSP-6 within the past four years were contacted three times in 2018, 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 completed work on a monograph of species of northern South America. His extensive map collection and other collecting documentation was moved to USPG at Sturgeon Bay (→). We continued research on crafting core collections within species *demissum*.

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 screen houses at Sturgeon Bay were used for other such experiments grown in pots.

Propagation: In 2018, we hand-pollinated 222 families of 20 plants each in the greenhouse for seed increase and performed 18,436 *in vitro* transfers to maintain fresh propagules of clonal stocks. We developed a working protocol for observing pollen tubes (↓) in styles with a fluorescent microscope, which will be a useful new way to assess pollen potency when making crosses at the genebank.



Germplasm health monitoring: We did 524 tests for PSTV and 220 more for the six common potato viruses.

Characterization: We did 1,582 replicated germination tests, 35 ploidy evaluations and 44 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.

Evaluation and Technology:

Peru connection: With Peru cooperators and J. Palta of University of Wisconsin, we celebrated formal release of a new INIA variety bred at USPG and selected at Puno (→). We started a project for frost resistance breeding with the University at Cusco. We also continued collaboration on projects with colleagues in the NGO CITE-papa, and our sister genebank, CIP, in Lima.

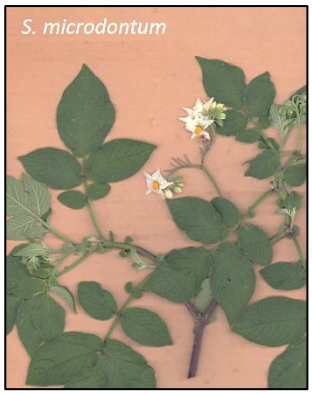
Ornamental *S. jamesii*: We bred a seed family of a light green *S. jamesii* mutant, "Renee's chartreuse", an attractive ground cover (↓) with freeze-tolerant tubers that should overwinter.

Egg-yolk specialty potatoes: This year's mass selection population had over 95% individuals with dark golden flesh. The initiative to produce a selfing line also appears to be succeeding, with some S2 families with uniform golden flesh (→).

Tuber freezing: With collaborator J. Palta of University of Wisconsin we continued study of tuber freezing tolerance in *S. jamesii*, finding survival after one week at -15C.

Root vigor screening: We grew 6 individuals of each of 3 populations of 25 species in perlite, harvesting dried tops and roots (↓) for root vigor evaluation.

Dickeya / tuber calcium screening and GBS genotyping: A broad screening identified *S. microdontum* (→) as a source of *Dickeya* resistance. So we generated tubers of 50 populations of the *S. microdontum* core collection in three environments and overlaid with calcium fertilization. With New York, Colorado, and Wisconsin cooperators, sources of strong resistance that interacts with other factors were found. PepsiCo GBS genotyped these stocks for us at no cost.



"Spaghetti" watering system: One large screenhouse was outfitted with automatic watering to individual pots. This will allow systematic germplasm screening for response to nutrients, hormones, water stress, pH, and other factors.

Nematode resistance evaluations. We arranged for the production of uniform "astrotubers" (←) with the Wisconsin company CETS's growth chambers for lab-based nematode screening by Cornell cooperators.

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 2018, a total of 6788 units of germplasm were sent as 185 domestic orders to clients in 34 states, and 3062 units of germplasm as 24 foreign orders to 13 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 2018, 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	IV	DNA	Plants	TF	Total	PIs
Domestic	1706	4041	888	32	104	17	6788	6018
Foreign	2715	4	339	4	0	0	3062	784
Total	4421	4045	1227	36	104	17	9850	6802

[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), TF = Tuber Family/(1).

E. Outreach

A joint meeting of the NRSP6 TAC and the National Plant Germplasm Coordinating Committee was held at Sturgeon Bay at the end of May (←). Bamberg chaired the Potato CGC and served as Editor in Chief of AJPR. We hosted agriculture students and other visitors from Colombia, Brazil, and Switzerland (↓). Staff member Alfonso del Rio served on the organizing committee of World Potato Congress in Cusco, Peru in May, 2018.

Two presentations with published abstracts were made at PAA in Boise, and we wrote a book chapter (accepted) on nutritional opportunities in new potato outlets.

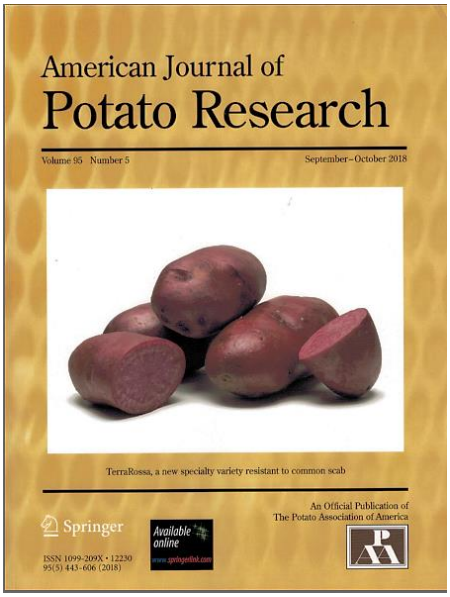
Student Lydia Kramer completed a study comparing methods of ploidy estimation and presented it at the PAA meeting in Boise (→).

Our University of Utah collaborators published a YouTube video (←) and a paper in PNAS on anthropological research showing potatoes of the southwest USA were used by man for >10K years (see https://unews.utah.edu/utah-home-to-earliest-use-of-wild-potato-in-north-america/ and PNAS 114:7606).

All germplasm documentation, and details about technology, outreach, administration, 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. 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. Each of the three US cultivars published this year in American Journal of Potato Research in 2017 have *wild species* originating at NRSP6 in their pedigrees (→).



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

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.

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 2018 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 2018 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 2017 is most representative = 129 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:2017.