APPENDIX CONTENTS

NRSP-6 TAC Zoom Meeting Minutes

August 18th, 20202

Chair: Rich Novy

Vice Chair: David Douches

Minutes by: Max Martin

Participants:

John Bamberg <john.bamberg@ars.usda.gov>; William Barker <william.barker@wisc.edu>; Benoit Bizimungu <benoit.bizimungu@agr.gc.ca>; Peter K. Bretting <peter.bretting@ars.usda.gov>; Walter De Jong <wsd2@cornell.edu>; David S. Douches <douchesd@msu.edu>; Ronald French <Ronald.D.French@aphis.usda.gov>; Joyce Loper <loperj@science.oregonstate.edu>; Jean-Francois Meullenet <jfmeull@uark.edu>; Joseph E Munyaneza <joseph.munyaneza@ars.usda.gov>; Richard G Novy <Rich.Novy@ars.usda.gov>; Joshua Parsons <Joshua.Parsons@pepsico.com>; Philipp W. Simon <Philipp.simon@ars.usda.gov>; Ann Stapleton <ann.stapleton@usda.gov>; Craig Yencho <Craig_Yencho@ncsu.edu>;

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Meeting started at 10:00 am CST

Rich N: Main topic of today's meeting is that the recommendation from the NRSP-6 review committee of the SAESD's is to not renew off the top funding of NRSP-6. SAESD's will have a full vote on this in September. If they vote not to renew the project, there is a one-year grace period and the funding would end in September of 2021.

Asked for the approval of the 2019 minutes as provided by Sagar. David D motioned to accept the minutes, first by David and 2nd by Craig Y. Minutes were approved.

Asked for the approval of the 2020 agenda. David D motioned to except the agenda, first by David and 2nd by Benoit B. Agenda approved.

Ann S. and Craig Y needed to leave the meeting early so they were moved up on the agenda.

Ann Stapleton: New NIFA National Program Leader introduced herself, and had no updates from NIFA.

Craig Y: Will advocate for the Genebank with our Ag Experiments Station representatives in SE. No germplasm report for the SE region. Kathy Haynes will be replaced, but the position will be moved to Orono, Maine. Interviews have occurred already and we should know Kathy's replacement in a few weeks.

Bill Barker: SAESD NRSP-6 representative. Stated that SAESD's NRSP-Review Committee (RC) recommendation is that funding of NRSP-6 be terminated. Everyone universally agrees that the Genebank is critical and it performs exceedingly well. That is not the criticism that they are basing their decision on. For a long time, it has been suggested that there needs to be more support from industry. John B did a nice job of working with the two commercial entities that breed potatoes. The RC did not feel that industry support went up fast enough and that $150,000 a year was an overly large support for a project that has been going on for so long. NRSP's were not to be legacy projects that go on forever. This Genebank is funded differently than any other Genebank. I (Bill B) don't have any optimism that it will be funded again.

Jean Francois M: There is not overwhelming support from the south for the Genebank. Will talk to his colleagues and get as many to support it as he can. Hard to get support for long term projects. The idea of reduced support to $50,000 has been tossed around.

Rich N: Asked that everyone read the paragraph from SAESDs NRSP-6 RC recommendation paragraph 4, pasted below. It appears that the overall feeling of NRSP-6 RC is that funding of NRSP-6 lies with ARS and not with Experiment Station Section.

> No other ARS programs with a single commodity are supported by the NRSP mechanism as off-the-top Experiment Station funds and all other gene repositories are supported by industry, such as the National Clonal Germplasm Repository for Citrus, as an example. Moreover, language in the Agriculture Improvement Act of 2018 (the 2018 Farm Bill) included a charge to USDA-ARS to develop a strategic plan for sustainability of the National Plant Germplasm System (NPGS). As such, the NRSP RC concluded that the responsibility of funding NRSP6's efforts ultimately lies with ARS, not the Experiment Station Section (ESS).

The experiment station directors state that the genebank is funded differently, and that the USDA should revamp how the Genebank is funded.

David D: What I read from this letter is that they want it funded in a different way.

Craig Y: I agree that we need to move on to a new funding strategy, in that the Potato Genebank is hanging out there different from any other commodity and we need to get it back in the fold.

John T. For the past 3 years in the Western region discussions about NRSP-6 has come up regarding and whether we should continue funding it off the top. Most NRSP's move on to other funding. Western states want see some other method of supporting potato germplasm. Everyone knows the value. There has to be a better way to fund this.

Rich N. 25 years of potato breeding, and really understand the importance of NRSP-6. From the discussion it looks like funding will be lost, so I would like the discussion to focus on addressing this shortfall.

John B. Pointed out that all these arguments against status quo funding of USPG have been addressed over the past three years and the "Midterm" plan appended to the agenda was finalized over a year and a half ago. Note that it describes our thorough search for alternate sources of support. He updated why NIFA special grants turned out to not be an opportunity.

He mentioned that if states wanted a different mechanism, it always made sense for them to reconfigure their state contributions, not expect ARS or Industry to take over, and described how contacts had been made with the WR and NCR leadership. He opined that many said it made sense in theory, but nobody was inclined to commit until a crisis happened. He mentioned that we have been pointing out for years that the current funding mechanism is not broken. It was considered appropriate for over 70 years. He pointed out that when NRSPs were invented about 1990 the explicit stated intent was for stable long-term funding, not the short-term investment program. He pointed out that the official current NRSP guidelines say in italics for emphasis that not all projects must phase out and that we have carefully and repeatedly presented the RC with the case for why USPG is a perfect fit for ongoing support. He said that these and several other salient points are posted as a link on the genebank homepage, and were made available for directors participating in the regional spring meetings. Discussed what the 10 or 20 percent cut would mean to the Genebank. As the proposal says, we could absorb a 10% cut. If more, we would eliminate custom work and evaluation that promote the use of germlasm by our customers. If even more, we would reduce or eliminate the clonal collection. For a long time JB was looking for donors for $30K. As a University employee Max M salary is funded from this account, nonrenewal of the NRSP-6 budget would impact this position. John suggested the specific counterproposal of $75K for FY21-23 to cover Max should be made from the floor at the ES meeting next month.

Josh P: Asked what percentage of orders of seed vs tissue culture and tubers.

Jesse S: Orders are split at a 60% true seed, 20% tissue culture, and 20% tubers.

Jeff E: We all know we need a genebank and we need to figure out how to fund it. It is not right to put this on the genebank staff and we should have a committee of the stake holders and develop a recommendation to the community to work on solving this.

Rich N. We need to educate the industry of the genebank and its importance to the potato community. Perhaps Peter can comment on how the funding of NRSP-6 is different than other genebanks and discuss a model of how we can address the shortfall for NRSP-6.

Peter B. Presentation on the history of the funding of the Genebanks. This presentation will be attached. Four of the Genebanks are partially funded by off-the-top funds from the region in which they are located. NRSP-6 started out as an interregional supported project and then in the early1990's was changed over to the NRSP-6 model.

Rich N. How would you go about changing NRSP-6 to a regional project with funding similar to that of the other four genebanks that were mentioned?

Bill B. Probably not going to be a viable option to ask the central regional directors to provide off-the-top funding for supporting the Genebank at Ames and the Potato Genebank.

John B. I had put out the idea to state experiment station directors with a large potato production and value (the Western and NC regions are the main producers) that those two regions split the 20% of the cost for NRSP-6 off the top funding = $30K, in a 2:1 cost share based on that corresponding approximate value of production of the crop. This did not go anywhere.

Bill B. This issue predates the pandemic and all the Universities are now heavily impacted. Trying to get increased funding from anyone during these fiscally tight times is unlikely.

Jeff E. Not reasonable to expect NC region to pick up the bill. This is not what I was after I just wanted clarification. Let's see what the Potato lobby can do. It is a powerful group and maybe they can get something written into the Appropriations Bill to cover the funding of NRSP-6.

Joyce L. Is it a possible to get this funded from the ARS budget? Would this work or are there other things that are at play that would be obstacles to that approach?

Peter B. Addressed that there have been targeted increases in a few areas in the ARS budget. Funding increases for germplasm are driven by commodity groups. Hawaii coffee industry pushed for a genebank for coffee. Citrus industry got an increase for the Citrus germplasm. Congress directed a new Hemp germplasm set up in Geneva and appropriated money to get this done. Bottom line is that commodity groups can get this done.

Rich N. If we lose the funding at the end of September how do we come up with additional sources for funding the Genebank. Peter mentioned that there was some increase for a few commodities. Let's see what we can do moving forward.

Jeff E. Can we get some of the money that will be available due to researchers retiring in Madison? (Shelley J and David S.) Could the priorities be changed so that some of those funds could be used to fund the Genebank?

Joe M: Money that is earmarked for specific areas cannot be moved around to cover other projects. They are very much coded and the stakeholders watch that very closely. Need to bring new money to get it appropriated to things like the Genebank.

Tamas H: Executive Director Wisconsin Potato & Vegetable Growers Association: He will bring it up at the next state manager meeting, which is also attended by Potatoes USA. They do a lot of lobbying. A review committee needs to look at what the options are and where to ask for the money. $150,000 is not that much when you look at the benefit nationwide, and he will talk to the directors of the other major potato growing states.

Joe M: Permanent funding has to come from the Congress and this is what is needed for funding the Potato Genebank.

Rich N: Tamas, I think it is a good idea to share this information with the other directors and come back to us, and we will form a committee with the breeders and industry involved and decide how to move forward to get permanent funding for the Genebank.

Tamas H: I will bring it up at the next meeting and have John B., Rich N., Jeff E., and David D., join us in a future Zoom meeting to educate our group on the Genebank and the funding problem.

Ron French, from APHIS had a report on what has been processed and personal changes. Processed 70 true potato seed lots, and clonally we were able to test 40 clonal accessions. Next year we are planning to process 56 seed lots and 44 clonal accessions.

David D: Presented the North Central Germplasm report.

Walter D: Presented the North East Germplasm report.

Craig Y: Had no germplasm report for the Southern region.

David Holm was not present so no germplasm report from the Northwest.

Rich N: Presented the USDA Germplasm report.

Benoit B: Presented the Germplasm report for Canada.

These reports are on the NRSP-6 web site.

Joe M: Talked about the new ARS Grand Challenge Synergies Project. The idea is to get ARS scientists to work together to work on a project that is really too big for any individual to take on. One was awarded to Shelley, Paul, and Dennis to support diploid breeding projects and haploid selection.

John B: Gave a report on the NRSP-6 Annual Report, which is posted on the Genebank web site. He pointed out that many of the activities highlighted in the report would go away with uncompensated loss of NRSP6 support, since they are the custom evaluation, germplasm development, characterization that has been said to be an outstanding advantage of the potato genebank. He also noted that this kind of work creates demand for orders so is responsible for some of the strong distribution numbers.

Rich N: Commented that the knowledge and familiarity with the germplasm at the Genebank is what makes it so much more valuable. An example is S. microdontum and its resistance to tuber greening.

David D: Comment that the work John B and Jiwan P are doing in Peru is a great connection and a give back to the country from which the germplasm originated.

Next meeting will be held at the Genebank on Tuesday, June 22nd 2021, with that being dependent on the status of the COVID-19 pandemic and how the SAESD votes.

Some talk if the NRSP-6 is not funded, perhaps this committee will be associated with the Potato CGC.

For 2020 - 2021

Chair, David Douches

Secretary, Benoit Bizimungu

A farewell to Shelley Jansky and David Spooner.

A big thank you to the great work that they did for the potato community.

Zoom sign off at 1:20 pm CST

NRSP6 TAC Meeting (via Zoom)
2020 Agenda
Tuesday, August 18th, 2020
10:00 AM-1:30 PM Central Time

Rich Novy = Chair
Dave Douches = Vice Chair (was to have been Chair in 2020)
Max Martin = Secretary

1. Welcome, introductions, announcements
2. Review and approve 2019 minutes and 2020 agenda

Reports

3. Administrative Advisor Report: Bill Barker, University of Wisconsin
4. Discussion of continued NRSP6 funding: Rich Novy/John Bamberg
5. Additional Reports: NIFA, ARS-NPL, and APHIS—others?
6. US and Canada Regional Technical Reports
    - NC: Dave Douches
    - NE: Walter De Jong
    - West: Dave Holm
    - South: Craig Yencho
    - USDA: Rich Novy
    - Canada: Benoit Bizimungu

7. NRSP6 updates and announcements for committee feedback (Bamberg)
    - Please review the 2019 Annual Report prior to the meeting

8. 2021 Meeting
9. Election of Secretary
10. Adjourn

ANNUAL REPORT
FY 2019

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		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	Chair (2020)	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 2019, we collected 15 germplasm accessions from an expedition to AZ, NM, TX, and CO with the support of USDA Plant Exploration office at Beltsville. We found potatoes in completely new places, notably Chimney Rock National Monument (→). Another special feature of this year's expedition was participation of UT and OH collaborators doing DNA collection for a joint NSF grant relating anthropology and genetic patterns of wild potato populations. Each new accession is online in GRIN, and is linked to a detailed collecting trip log describing its origin.

We also sought and received 18 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 2019, 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 documentation in the herbarium specimens moved to University of Wisconsin. We continued research on crafting core collections within species *fendleri* and *boliviense* and started characterization of species *kurtzianum*.

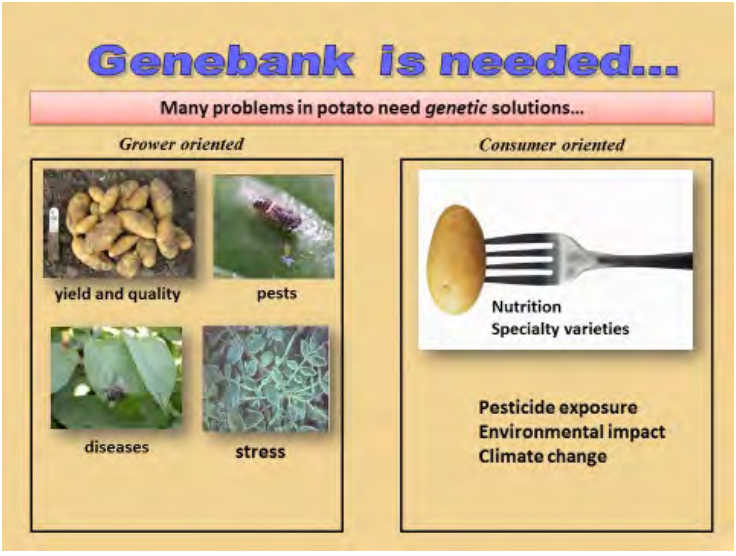
C. Preservation and Evaluation

Propagation: In 2019, we hand-pollinated 195 families of 20 plants each in the greenhouse for seed increase (↓) and performed 19,522 *in vitro* transfers to maintain fresh propagules of clonal stocks.

Germplasm health monitoring: We did 889 tests for viruses.

Viability monitoring: We did 1,579 replicated germination tests, 31 ploidy evaluations and 38 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.

Trait evaluation and Technology:



Potato germplasm has a broad spectrum of traits that can benefit both the grower and consumer (→). The genebank's supporting role for research is not just to supply propagules, but to facilitate discovery and characterization of these traits through evaluation and technology development.

Peru connection: In 2019, we continued building evaluation partnerships with many expert cooperators. Particularly notable among these is our cooperation with Peru (↓), deploying novel germplasm in breeding that has now resulted in new registered cultivars.

Nearly two acres of individual field plots, four large screenhouses, ten greenhouse compartments and a tissue culture lab were available at the UW Ag Research Stations at Hancock (→) and Sturgeon Bay, Wisconsin. These were used for seed, tuber and *in vitro* multiplication, and numerous evaluation experiments.

Egg-yolk specialty potatoes: This year's mass selection population had 100% individuals with dark golden flesh. The initiative to produce a selfing line also appears to be succeeding, with some S3 families with uniform golden flesh (→).

Root vigor screening with new "spaghetti" watering system: We started evaluation of the nearly 100 populations of *S. kurtzianum* in the NRSP6 genebank. The new irrigation system allowed characterization of root vigor differences and tolerance to deficient nitrogen and drought (←), as well as tuber yield and size (↓).

Dickeya / Zebra chip psyllid DNA genotyping, metabolites: We built on previous cooperative screening with Cornell and USDA scientists that found extremes of resistance to these important diseases by creating segregating populations that could be used to detect genetic and metabolite markers associated with the traits.

Tuber trait characterization technology: Since the inception of the genebank, we have not had an adequate way to generate tubers for systematic analysis of tuber traits. For this we need optimized conditions to stimulate tuberization, even for species with unusual daylength and temperature requirements. We needed a way to produce replicate batches of tubers over time in exactly the same conditions. We needed the ability to precisely apply test environments like varying fertilizer, water, etc. Finally, we needed to be able to do all this with tight phytosanitary control to minimize the risk of disease spread. This year we received a generous donation of two specialized tuberizing chambers (←). We intend to complete installation and use them for numerous projects that study tuber traits.

Crossing technology: NRSP6 germplasm is already in the pedigrees of many commercial cultivars, but we could expand that benefit of exotic species by making hybridization easier. This year we synthesized and selected a line of *verrucosum* backcrossed into *tuberosum* cytoplasm. Its superior qualities as a bridge species include self incompatibility, very vigorous flowering, buds that do not fall off, and high female fertility. With this unique stock, we were able to make novel interspecific hybrids (→).

Exploring novel approaches to drought tolerance: This year we followed up on a longstanding hunch that mutants deficient in the plant hormone gibberellin might be more drought tolerant. Populations that segregate for these dwarf mutants revealed that mutant seedlings (←) withstand drought stress that kills all of their normal siblings. This could be a useful clue to breeding for drought, especially if the gene confers tolerance in heterozygous form. Water use efficiency will be an increasingly important trait as water availability is expected to become more limited with climate change.

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 2019, a total of 6659 units of germplasm were sent as 183 domestic orders to requesters in 34 states, and 3383 units of germplasm as 14 foreign orders to 10 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. See Impact Statement section for how this germplasm is being put to work.

In 2019, 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	1088	3679	1073	46	754	19	6659	5093
Foreign	3215	0	168	0	0	0	3383	377
Total	4303	3679	1241	46	754	19	10042	5470

[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

Staff attended local, regional, national and international potato research and breeding professional meetings and gave presentations. Bamberg chaired the Potato CGC. We hosted foreign visitors Dr. Akio and Miyako Miyamoto from Obihiro University in Japan and visitors included foreign agriculture students from Colombia, Georgia, Turkey and Brazil (↓).

Two local students learned germplasm concepts and techniques as summer workers.

Because we are active in professional associations, a broad spectrum of potato researchers are familiar with project staff. Thus, we receive numerous contacts for advice on how to specialize germplasm and the best germplasm-handling techniques.

Complete germplasm documentation and details about technology, outreach, administration, and staff publications are readily accessible at our website.

IMPACT STATEMENT

In recent 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 testing techniques and importing valuable new stocks. 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 state collaborators incorporated potent nematode resistance. In 2017, Idaho collaborators reported incorporation of resistance to greening (responsible for 10-15% waste)-- *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 State researchers identify germplasm with strong 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 (see detail below). NRSP6 staff bred cold tolerant families from which a new cultivar, Winay, was released 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. In the current NRSP6 project, we are cooperating with state and federal scientists in Colorado, Texas, New York, and Washington state, screening for and finding potent resistance in exotic germplasm from NRSP6. Folate deficiency causes severe birth defects. With help of NRSP6 staff, state scientists from Oregon identified wild species selections and custom hybrids available only from NRSP6 with high folate and a way to make screening for folate much easier. 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-- and this process is increasing in the current project term. Each of the three US cultivars published this year in American Journal of Potato Research in 2018 have wild species originating at NRSP6 in their pedigrees. The cultivar Atlantic is a good example of the how the long-term job of genebanking needs perpetual support. This cultivar released in 1976 has in its pedigree *andigena* PI 205624 (imported 1953) and *chacoense* PI 175446 (imported 1949). It has been the parent of numerous additional important cultivars, and in 2018 was still in the top 10 of certified seed acres in 2018 in USA and Canada. This huge benefit to US agriculture was possible because Atlantic parents were imported and preserved for breeding use at its very start of the genebank 70 years ago.

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.

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 in Digitop produced hits which the reader can regenerate. Staff publications (for 2019 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. The result for 2018 is **134 papers**.

Keyword Anywhere(Solanum) AND Keyword Anywhere(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) AND Keyword Anywhere(USDA and Solanum and tuberosum)(DATE=2018-2018).

2020 North Central Utilization of Germplasm Resources from NRSP-6

North Dakota State University
Susie Thompson

In 2019, the NDSU potato breeding project accessed plantlets of PI584994 (IVP 101) for use in extracting dihaploids from superior cultivars and advancing selections. We will begin that process this fall with the addition of a new graduate student this summer interested in diploid breeding. Many advancing selections in our program have parents available through the genebank, including clones such as M7 and M3 from Dr. Shelley Jansky's program.

University of Wisconsin
Jeff Endelman

The Endelman Lab requested several in vitro accessions from the genebank this past year that had been reported to contain specific late blight resistance genes. This germplasm was used as a positive control during research into the genetic basis of late blight resistance in elite US germplasm.

University of Minnesota
Laura Shannon

We have included the following clones we obtained from NRSP6 in our crossing block this year: Early Rose, Viking, Sangre, Desiree, Symfonia.

Additionally, we have been collaborating with the genebank and Pepsi Co on genotype by sequencing analysis of 730 genebank accessions ranging from diploid to pentaploid. Heather Tuttle, a Master's student in the lab, is working on developing core subsets of these genotyped collections in order to facilitate trait screening. We can capture 90% of the diversity in the collection with 45% of the genotyped diploids and 10% of the genotyped tetraploids.

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 SC in cycle 5 is now 85%. The SC phenotype is not simply introgressed into the self-incompatible germplasm. We will be using Sli KASP markers to characterize our diploid germplasm.

We have used Alca Tarma as a source of **PLRV resistance**. BC2 populations have been generated for selection of more adapted progeny that combine both PLRV and PVY resistances. Through marker-assisted selection we had a population that contained over 90 progeny that have both markers for PVYadg (RYSC 3) and PLVR resistance. A subset of these are being evaluated in Idaho for PLRV, PVX and PVY resistance in the field and greenhouse. |We now have two selections with resistance to all three viruses. We are also trying to extract dihaploids from the triple virus resistant selection MSCC725-232.

***Solanum chacoense* for Colorado potato beetle resistance**

USDA8380-1 (PI 458310, 80-1)

The strong host plant insect resistance observed in 80-1 has largely been attributed to the presence of the unique foliar glycoalkaloids leptines and leptinines (Sanford, et al., 1996; Sanford, et al., 1997; Sinden, et al., 1986; Sinden, et al., 1980). However, despite decades of research, the genetic underpinnings of leptine biosynthesis and accumulation remain elusive and introgression of this trait into cultivated potato has not been achieved. We generated a recombinant inbred line population from a cross between 80-1 and the *S. chacoense* self-compatible inbred line M6 (Jansky, et al., 2014) segregating for Colorado potato beetle resistance under field conditions, foliar glycoalkaloid content and self-fertility traits. To detect loci associated with and examine the inheritance patterns of these traits, we SNP genotyped individuals in the F_2, F_4 and F_5 generations. Combined bi-parental linkage mapping, whole genome sequencing and expression profiling approaches in the F_2 generation identified several candidate genes within QTL on chromosomes 2, 7 and 12 associated with Colorado potato beetle resistance and glycoalkaloid accumulation (Kaiser, et al., 2020). We are currently validating the function of these candidate genes in 80-1 knock out lines using CRISPR/Cas9 technology. Segregation for Colorado potato beetle resistance in the F_5 generation and incomplete resistance observed in crosses between resistant recombinant inbred lines and cultivated diploid clones suggests that the trait is quantitatively inherited.

In addition to providing a valuable immortal resource, this recombinant inbred line population has illuminated the complex nature of self-fertility traits in *S. chacoense.* The presence of *Sli* in the homozygous condition in M6 is hypothesized to confer self-compatibility, but self-compatibility does not segregate as a single dominant gene in this population. In fact, we observed distorted segregation on chromosomes 1,3,8 and 12. Selection against the homozygous 80-1 genotype on chromosome 1, which harbors the S-locus, suggests that *Sli* in M6 does not completely inactivate the gametophytic incompatibility reaction. We are currently quantifying pollen tube growth, fruit set and seed set upon selfing in the F_5 generation and assessing residual heterozygosity that may be necessary to maintain fertility.

PI 133644

Dr. Shelley Jansky observed that this PI was segregating for self-compatibility and after extensive literature review hypothesized that it may be related to M6 (personal communication). After SNP genotyping 48 individual genotypes of PI 133644 we determined that M6 likely did not originate from this PI and that these individuals are more closely related to 80-1. We phenotyped these individuals for pollen tube growth, fruit set and seed set upon selfing and identified several regions on chromosomes 3, 5, and 11 associated with these traits. Interestingly, chromosomes 1 and 12 were not significantly associated with self-compatibility in this PI. Using KASP markers developed in the Netherlands (Clot, et al., 2020), we are currently investigating if self-compatible individuals in this PI contain the M6 *Sli* allele. Phenotyping these individuals also informed our stylar squash protocol, namely illustrating the necessity of self-pollinating at least 30 flowers and collecting replicated styles over the course of several weeks of selfing.

The object of my research is to increase the efficiency of interspecific crosses between reproductively isolated "Endosperm Balance Number 1 (EBN1)" species and cultivated germplasm.

1) The EBN1 Project

As mentioned earlier I am making a concerted effort to increase the efficiency of crosses between "EBN1" species and cultivated germplasm. A significant barrier to interspecific hybridization between these species and cultivated germplasm is endosperm failure. Endosperm regulates the early development of the embryo and is a major food store for the developing seed (Lester & Kang, 1998). In angiosperms, the process of double fertilization occurs when one sperm cell fuses with the egg cell to form an embryo, while a second sperm cell fuses with the polar cell to form the endosperm (Raghavan, 2003). The development and specifically the rate of cellularization of the endosperm must occur in concert with the development of the embryo; otherwise, endosperm failure occurs and embryo growth is arrested (Lafon-Placette and Köhler, 2016). In interspecific and interploidy crosses the parental dosage between the two parents can be out of balance. This powerful post zygotic barrier maintains the ploidy level and integrity of species.

The species used in this project are the following: *S. verrucosum*, *S. pinnatisectum*, *S. cardiophyllum*, *S. bulbocastanum*, *S. jamesii*, and *S. commersonii*. With the exception of *S. verrucosum* and *S. jamesii*, each species was selected because of their durable resistance to one or several of the following pathogens: late blight *(P. infestans),* Potato leafroll virus (PLRV), Verticillium wilt (*Verticillium dahlia*), Colorado potato beetle (*Leptinotarsa decemlineata*) bacterial wilt (*Ralstonia solanacearum*), and Early Blight (*Alternaria solani*).

Each of these species represents an extremely valuable resource for pathogen resistance. However, they are extremely difficult to make crosses with. In order to make crosses with these species it is necessary to do complicated ploidy manipulations or make bridge crosses with species such as *S. verrucosum* before making crosses into cultivated material. Because it is our objective to stay at the diploid level, we elected to use *S. verrucosum* to make bridge crosses. However, such bridge crosses yield very few fruits and even fewer seeds (0.01 seeds per pollination) (Jansky & Hamernik, 2009). This low efficiency is prohibitive even though it is less time and resource consumptive when compared with somatic doubling or embryo rescue. In this project we will be looking at the molecular mechanisms behind prezygotic interspecific barriers in order to hopefully increase the efficiency of these crosses.

Solanum bulbocastanum **PI275197**

This PI was requested several years ago, and we selected a specific individual (SBGG505-A) from this PI that was later used to make bridge crosses with *S. verrucosum* clone SV607845.02 (PI607845). We have since learned that this PI is no longer listed in GRIN; so we don't have any specifics other than it is *S. bulbocastanum*, it is highly floriferous and male fertile, and we were able to make two hybrids between SBGG505-A and SV607845.02.

PI243508

Again, this PI was requested several years ago. We selected two individuals from this PI to use for bridge crosses (SBGG500-A and SBGG500-B), based on their fertility, and vigor.

Solanum cardiophyllum **PI558041**

Dr. John Bamberg had mentioned that some *S. cardiophyllum* had desirable tuber traits and could also increase crossing efficiency in bridge crosses (personal communication). We selected a several individuals to evaluate them in some interspecific crosses. We have only kept one clone (SCGG511-B) as the others displayed extreme susceptibility to early blight making them difficult to work with.

***Solanum commersonii* PI320266**

This PI was initially used by Dr. Susan Otieno in an effort to understand more about the bacterial wilt resistance within this PI. Since this germplasm was readily available to at MSU and had valuable traits we decided to incorporate it into the breeding program.

***Solanum jamesii* PI592417**

Several *S. jamesii* PI's were planted out in the field in 2018 (PI275169, PI592417, PI612435, PI620869, PI941944, PI673360, PI673364, PI673370, and PI676012). Many of these did not perform well under our climate conditions and it was difficult to get pollen in sufficient quantity and quality for making crosses. After trialing a couple individuals, a single clone was selected (SJGG520-A) from PI#592417 because of its floriferousness and ability to thrive under our field and greenhouse conditions. This clone will be used to understand more about the prezygotic molecular mechanisms preventing interspecific crosses between EBN1 species and cultivated germplasm.

***Solanum pinnatisectum* PI253214**

As with the *S. bulbocastanum* PI's listed, these *S. pinnatisectum* PI's were requested several years ago. This PI performed well in the field here in Michigan, and in trials it displayed resistance to late blight (POTATO.LBLIGHT.KIRU.2001), potato virus Y (Cai et al. 2011), and Colorado potato beetle (POTATO.CPB.RADCLI.84). I will be using this PI to make bridge crosses and have grown out seedlings to make crosses this fall.

PI275232

We selected two individuals from the field based on their fertility (SPGG544-A and SPGG544-B) I have made many crosses with SV607845.02 and have two possible hybrids that will be confirmed in the coming month through SNP genotyping. This PI like the other has resistance to several important pathogens. We will also be using this Pi to characters prezygotic barriers between EBN1 species and cultivated germplasm.

***Solanum verrucosum* PI161173**

When we made several hundred pollinations between EBN1 species (*S. bulbocastanum*, *S. jamesii*, and *S. pinnatisectum*) in the fall of 2019, we only used one *S. verrucosum* clone (SV607845.02). We requested this PI in order to find more *S. verrucosum* clones to use in bridge crosses. This PI was selected because it had been successfully used by Dr. Shelley Jansky in bridge crosses (Jansky & Hamernik, 2009). We have grown out 30 individuals and will be trailing them in bridge crosses with *S. bulbocastanum*, *S. commersonii*, and *S. pinnatisectum* this fall.

PI607845

This PI was requested for use in Colorado Potato Beetle resistance breeding. Three clones had been selected from this PI and they were evaluated for their ability to make bridge crosses. Of the three clones only one (SV607845.02) successfully set fruit with *S. bulbocastanum*, *S. jamesii*, and *S. pinnatisectum*. We have been able to get two hybrids with this clone and *S. bulbocastanum* clone

SBGG505-A, we also have two unverified hybrids with *S. pinnatisectum* clone SPGG544-A. We will be making more bridge crosses this fall as well.

It has been demonstrated that *S. verrucosum* may lack a functional *S-RNase* and that this could likely the reason that *S. verrucosum* is considered self-compatible (Eijlander, 1998). However, the clone SV607845.02 has displayed consistent self-incompatibility and has at least a partial *S-RNase* sequence. We will be evaluating the functionality of the *S-RNase* within this clone within the coming months. We hypothesized that *S. verrucosum*'s ability to act as a receptive parent for many species was rooted in its lack of a functional *S-RNase*. Finding a partial sequence does raise questions about the assumption that all *S. verrucosum* lacks *S-RNase*.

***Solanum chacoense* USDA8380-1 (PI 458310, 80-1)**

We are using 80-1 this fall as a control when we evaluate the *S. chacoense* clone M6 on the impact of SLi on interspecific crosses as 80-1 has displayed strong self-incompatibility.

2) *Solanum verrucosum* bridge crosses

We have been trialing several *S. verrucosum* bridge crosses to determine their compatibility with cultivated germplasm. The following *S. verrucosum* x *S. jamesii* crosses are currently being evaluated:

B22-1-3 M3

B38-1 M3

D19-2 M3

Ver x Jam 41.1

Ver x Jam 41.2

Ver x Jam 41.4

We have also been trialing the following crosses on their compatibility with our cultivated material.

GS399 (*S. verrucosum* x *S. cardiophyllum*) – one successful cross with US-W4

GS401 (*S. verrucosum* x *S. commersonii*) – several successful crosses

GS402 (*S. verrucosum* x *S. commersonii*) – very low success rate, many parthenocarpic fruits

GS403 (*S. verrucosum* x *S. pinnatisectum*) – does not flower in our conditions

GS404 (*S. verrucosum* x *S. pinnatisectum*) - does not flower in our conditions

3) Exploratory material

We are trailing some material in order to determine if we can use them in our program. There are three major groups:

Group 1: This is a set of populations created by Dr. John Bamberg to incorporate traits for large tubers from *S. cardiophyllum* PI597678 into populations of other desirable EBN1 species. we have grown 30 individuals from the following families and will be evaluating tuber type this fall.

AjR 10

AjR 08

(sph-nry x cph 21) IM

(trn x cph 21) IM

(pnt X cph21) IM

Group 2: This set of individuals was created by Dr. John Bamberg by crossing a single clone (Ver41) from PI653784 to USW4 in order to create clones that can be used to create bridge crosses with EBN1 species without emasculation of the flowers, within a *S. tuberosum* background. We will be making bridge crosses with these clones and *S. bulbocastanum*, *S. commersonii*, and *S. pinnatisectum* this fall.

BC5 01.03

BC5 05.02

BC5 05.04

BC5 06.03

BC5 06.04

Group 3: I am evaluating 30 individuals from PI558245 and PI175435 for potential use in interspecific crosses this fall. I am planning on making some test pollinations to see if we can use PI243355 to make some bridge crosses with *S. verrucosum* or some of the BC5 clones.

PI558245 *S. palustre*

PI175435 *S. kurtzianum*

PI243355 *S. clarum*

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2019 DISTRIBUTIONS TO THE NC REGION

Orders	Name	Organization	City	State	Comment	Total units	Use
1	Aarestad, Sandi	Valley tissue Culture, Inc.	Halstad	Minnesota	Potatoes for stocking.	17	Research
1	Andersson, Dawn	Keweenaw Seed Swap and Plant Exchange	Calumet	Michigan	Yellow variety developement.	15	Home Gardening
1	Bohlen, David		Florissant	Missouri	Planting potatoes in Missouri.	10	Home Gardening
1	Boylan, Kathleen		Lonedell	Missouri	Growing potatoes in Missouri	1	Home Gardening
2	Caravati, Curzio	Kenosha Potato Project	Kenosha	Wisconsin	Four clones for tuber increase for seed savers.	15	Home Gardening
1	Carley, Cari Schmitz	University of Minnesota	Saint Paul	Minnesota	Tubers of chipping breeding program.	11	Research
2	Cohen, Zachary	University of Wisconsin	Madison	Wisconsin	To use as putative ancestral hosts of Colorado Potato I	16	Research
1	Coombs, Joseph	Michigan State University	East Lancing	Michigan	Clonal accessions for breeding work.	106	Research
1	Del Rio, Dr. Alfonso	University of Wisconsin	Madison	Wisconsin	DNA work for ver BC, Dakota Trailblazer and PI 24344	6	Research
3	Douches, Dr. David S.	Michigan State University	East Lansing	Michigan	Leaves from russet nugget x mcd hybrids for SNPs	40	Research
2	Endelman, Jeffrey	University of Wisconsin - Dept of Hort	Madison	Wisconsin	Breeding work.	12	Research
1	Enyard, Richard		Terre Haute	Indiana	Testing growth in different soils.	59	Home Gardening
1	Fiesel, Paul	Michigan State University	East Lansing	Michigan	Germplasm will be used for the study of defense comp	4	Research
2	Greaves, Dr. John A.	Kemin Industries, INC	Des Moines	Iowa	in vitro clones for Arvind.	1397	Research
1	Hanson, Jeff	Hanson & Associates, LLC	Cottage Grove	Wisconsin	Evaluate skin disease in muck soil with different Ph an	36	Research
2	Horswill, Theresa		Manitowoc	Wisconsin	Garden in Manitowoc, WI	47	Home Gardening
7	Karki, Hari	University of Wisconsin	Madison	Wisconsin	Mapping and cloning late blight genes.	43	Research
2	Kauth, Philip	Seed Savers Exchange	Decorah	Iowa	Potato varieties for Seed Savers Exchange.	6	Home Gardening
1	Maiers, Jennifer		Conneaut	Ohio	Looking for low potassium potatoes.	30	Home Gardening
1	Maronek, Carole	Silver Poplar Studios	Ellison Bay	Wisconsin	Tasting tubers.	10	Home Gardening
1	McColly, Fred	Indiana University Northwest	Lake Station	Indiana	Perennial Garden Project.	4	Research
2	Miao, Max	University of Wisconsin	Madison	Wisconsin	Examining microbial community of the rhizosphere of I	80	Research
1	Navarro, Felix	Hancock Agricultural Resarch Station	Hancock	Wisconsin	Display tubers from tuber increase.	7	Research
1	Newman, Michael		Saginaw	Michigan	Planting potatoes in Michigan.	12	Home Gardening
2	Palta, Dr. Jiwan	University of Wisconsin	Madison	Wisconsin	Calcium tubers.	129	Research
2	Petrick, Janina	CETS Technology	Sussex	Wisconsin	Testing different method of rooted cuttings propagation	170	Research
1	Rich, Wendell J.	Ingredion Incorporated	Indianapolis	Indiana	Evaluate starch content.	16	Research
1	Saunders, Michael		Avalon	Wisconsin	Growing potatoes for finding good taste.	5	Home Gardening
2	Schenck, Craig	Michigan State University	East Lansing	Michigan	Chemical composition of defense compounds in potat	6	Research
3	Simrell, Merle	De Somerville Farm	Walker	Missouri	Breeding work.	22	Research
1	Smith, Heather		Gladwin	Michigan	Growing potatoes in Michigan	1	Home Gardening
1	Witherell, Andy	Wisconsin Seed Certification Lab	Madison	Wisconsin	Using as host for PVA	9	Research
1	Zarka, Kelly	Michigan State University	East Lansing	Michigan	Breeding program stock.	3	Research

USDA Report on use of NRSP-6 Germplasm distributed in 2019
Rich Novy, August 18, 2020

In 2019, there were 1,989 units shipped in 34 orders to twelve USDA cooperators in four states. Eleven of 12 recipients of germplasm responded to my request for information regarding the use of requested germplasm with their summaries provided below and an overall summary provided at the end of this document.

John Bamberg, Sturgeon Bay, WI: In brief we are working on:

- Better ways to make hybrids with *jamesii* (JamX). I am writing the paper now, but abstract was published from PAA meeting in Grand Rapids.
- A pure family of very orange-fleshed specialty type (*Criolla*) including an inbred lines.
- Families broadly segregating for Dickeya resistant tubers (BAO materials)
- Making a core collection of *kurtzianum* (ktz) including screening for root vigor; heat and drought resistance.
- Investigating variation for glycemic
- Drought and heat potential of GA deficient dwarfs, as well as breeding these traits for Peru and sharing with Max Feldman's program
- CPB resistance characteristics of *jamesii*, including insights from pops native to the southwest USA.
- Marker characterization of *commersonii* (cmm) accessions for core collection and predicting common bacteria wilt resistance breeding potential.

Rodney Cooper, Wapato, WA: Crosses of *Solanum microdontum* and *S. bulbocastanum* F2 segregating lines were screened for resistance to potato psyllid. Many of the *S. bulbocastanum* crosses were resistant to potato psyllid, with very few living psyllids remaining on plants after 21 days (1 psyllid generation).

Dennis Halterman, Madison, WI: As part of our 5-year CRIS project we are developing a collection of 2EBN species that are genotypicially and geographically diverse. Our plan is to phenotype these species for various traits, including disease and insect resistance, and then genotype them using SNP genotyping and RenSeq (to find R gene sequences). So far, we have screened species for resistance to *Phytophthora infestans* (late blight), *Alternaria Solani* (early blight), and Colorado potato beetle. We just had a paper accepted (with minor revision) at Plant Disease that presents results of screening wild species for late blight resistance. We found a few species with resistance that had not been documented before.

Shelley Jansky, Madison, WI: Outlining germplasm use for Bethke/Halterman as well:

- A collection of 312 wild and cultivated *Solanum* accessions was grown in a greenhouse to produce tubers. They are being used for a tuber metabolome genome-wide association study.
- A set of 86 diploid wild species accessions was requested for our ongoing OSQR project to create a wild species diversity collection. They are being screened for resistance to late blight, early blight, Colorado potato beetle and Verticillium wilt.
- 384 accessions of wild potato species were screened for resistance to potato late blight using the clonal lineage US23; 107 accessions had some resistance to late blight.
- 260 accessions were screened for resistance to potato early blight using detached leaf assays. Of these, 73 accessions showed some level of resistance and were chosen for rescreening.

Rick Jones, Beltsville, MD: Sample tubers were obtained and propagated in the green house to obtain DNA samples and assess changes in specific genes. Enfula was used to initiate carotenoid biosynthesis studies in support of a nutritional enhancement project at Beltsville. White Peachblow was obtained for use in characterizing sequence variation of specific stress related genes in an heirloom variety. Both projects are ongoing and awaiting a new breeding position.

Susanne Lawrence, Beltsville, MD: The accessions we ordered were the progenitor and the line used for the potato genome sequence. We have been working with a family of C2H2 zinc finger protein (ZFP) genes that act as transcriptional regulators. Initially commercial varieties of potato were used to attempt to sequence the potato genome, but it was too complicated and redundant to succeed. Consequently, a diploidized monoploid was used for sequencing

the genome. We received those lines from your genebank and were able to clone our genes of interest since those lines were most similar to the published genome sequence. While many species have numerous C2H2 ZFPs, potato has many more. For example, StZFP2 in potato is one of six C2H2-ZFPs clustered together on chr 11, while tomato has only two. Another set of C2H2 ZFPs of interest to us were impossible to clone from our commercial variety. Once we had the line used for genome sequencing our task was easier. However, given the pandemic and the inability to work in the lab, we have yet to publish this work.

Vessela Mavrodieva, Beltsville, MD: Our lab, that is part of USDA-APHIS PPQ, has used the potato accessions as healthy controls and to assess plant matrices effect on detection of pospiviroids using real-time RT-PCR protocol from Naktuinbouw, NL. Potato total plant RNA (healthy) was spiked with PSTVd infected RNA from tomato for assay validation studies. This work was part of the assay validation project for detection of quarantine pospiviroids in imported tomato seeds for a pilot program run by our agency. Our lab conducted the testing using the validated methods. The results of this testing informed regulatory actions and issuance of a Federal Order DA-2019-21 (Aug 9, 2019) that amended entry requirements for Importation of tomato and pepper seeds from all countries into the United States. No publication has been made.

Roy Navarre, Prosser, WA: We received a set of tubers representing the mini-core collection. These tubers were used to assess flavor, texture and skin in order to obtain a better understanding of how much variance is possible in these traits among diverse potato germplasm relative to commercial potatoes. This aided our understanding of what reasonable goals are for enhancing these traits in commercial potatoes.

Lev Nemchinov, Beltsville, MD: We were looking for the sources of resistance to the root lesion nematode *P. penetrans* as well as germplasm harboring R1B-19 and R1B-17 resistance genes to late blight as well as non-R gene-harboring potatoes.

Xiaohong Wang, Ithaca, NY: Accessions of *Solanum* species (mainly *Solanum vernei*, *S. boliviense*, *S. brevicaule*, *S. berthaultii*, and *S. microdontum*) were screened for resistance to potato cyst nematodes (*Globodera rostochiensis*) and a list of clones exhibiting strong resistance to a virulent population (Ro2) of *G. rostochiensis* was obtained. Initial testing indicated that some of the clones also have *G. pallida* resistance. Screening for *G. pallida* resistance is ongoing and clones identified to have strong and broad-spectrum resistance against *Globodera* nematodes will become valuable material to breed for durable nematode resistance in U.S. potato cultivars.

Huijun Yang, Ithaca, NY: We have obtained wild potato germplasms from Potato Gene Bank. And our purpose is to screen for novel resistance to potato cyst nematodes *Globodera rostochiensis* and *Globodera pallida*, which can cause up to 80% yield loss of potato crop. Most of current known PCN resistance genes were originated from wild potato species. But they are only targeting relative narrow range PCN species or pathotypes. our goal is to identify new broad spectrum PCN resistance gene(s) to facilitate breeding new potato varieties. We have obtained multiple PCN resistant accessions from *Solanum verne, Solanum brevicaule, Solanum microdontum, and Solanum boliviense* from our preliminary screenings. Especially among *Solanum brevicaule* tested, two of them were found to be very interesting. One showed significant resistance to both *G. rotoschiensis* (pathotype Ro1 and Ro2) and *G. pallida* (pathotype pa2/3). And the other one showed resistance to *G. rotoschiensis* (pathotype Ro1 and Ro2). All of those screening and validation are still ongoing. One manuscript is in prep currently.

USDA Germplasm Summary of Use:

Disease Resistance genes: Dickeya; bacterial wilt/brown rot; late blight; early blight; Verticillium wilt

Pest Resistance genes: Colorado Potato Beetle; potato psyllid; root lesion nematode; potato cyst nematode

Quality Characteristics: Orange flesh (Criolla); glycemic index; tuber characteristics; carotenoid biosynthesis; flavor, texture, and skin attributes

Environmental Stress Resistance: Heat and drought tolerance

Other: Tuber metabolome genome-wide association study; transcriptional regulation; validation and detection of PSTV for developing regulatory actions on importation of tomato and pepper seeds

Technical Report to the NRSP-6
B. Bizimungu, Agriculture and Agri-Food Canada, August 18, 2020

i) Introduction and Utilization of potato accessions from NRSP-6 Project

During 2019, the Potato Introduction Station (NRSP-6, Sturgeon Bay, WI) supplied potato materials to researchers at **four** institutions or private breeders in Canada. Previously, germplasm orders were also received from public scientists (breeders, pathologists, entomologists, and geneticists), university researchers, private commercial breeders and hobby breeders.

ii) Utilization of potato accessions from NRSP-6 Project by Canadian researchers:

- Use in crossed for germplasm enhancement or pre-breeding purposes-especially for disease and insect resistance at Agriculture and Agri-Food Canada (AAFC): Sources of those traits include S. *tarijense*, S. *demissum, S. phureja, S. bulbocastanum, S. chacoense, S. pinnatisectum,*and *S. oplocense*.
- Evaluation of specific traits for use in breeding- including drought tolerance, taste and culinary attributes.
- Breeding methodology development: development of doubled haploidy technology for diploid/nbred lines development, standardization of protocols for genome editing, host-pathogens interactions

iii) Canadian Potato Gene Resources Collection

- The 'Potato Node' of Agriculture and Agri-Food Canada's Plant Gene Resources of Canada (PGRC) is located at the Fredericton Research and Development Centre, NB.
- The potato genetic resources collection contains 184 clones, including modern Canadian-bred potato cultivars, heritage cultivars, and selected breeding parents. Accessions in the repository are maintained *in vitro* or as tubers.
- New additions received in 2019 and planned for 2020 include:
    - Germplasm from Private breeders including wild species selections and hybrid clones (derived from parental lines introduced from NRSP6), late blight resistant French Fry breeding parents (carrying *RB* gene from *S. bulbocastanum*).
    - AAFC public cultivars and breeding lines of importance.
- 22 requests (478 units) processed until March 15, 2020.

iv) Cultivar release 2019-2020: AAFC cultivars founded on Canadian gene bank accessions:

1. **AAC Odyssey** (pending registration) - gene bank accession: AC Blue Pride.
2. **AAC Blue Sapphire** (pending registration) - gene bank accession: AC Blue Pride.

3. **AAC Eastern Russet** (pending registration) - gene bank accession: Shepody.
4. **AAC Intrepid Russet** (registered 2020) - gene bank accession: Norgold Russet.
5. **AAC Mimosa** (registered 2020) - gene bank accession: F79070.

The National Plant Germplasm System: 2020 Status, Prospects, and Challenges

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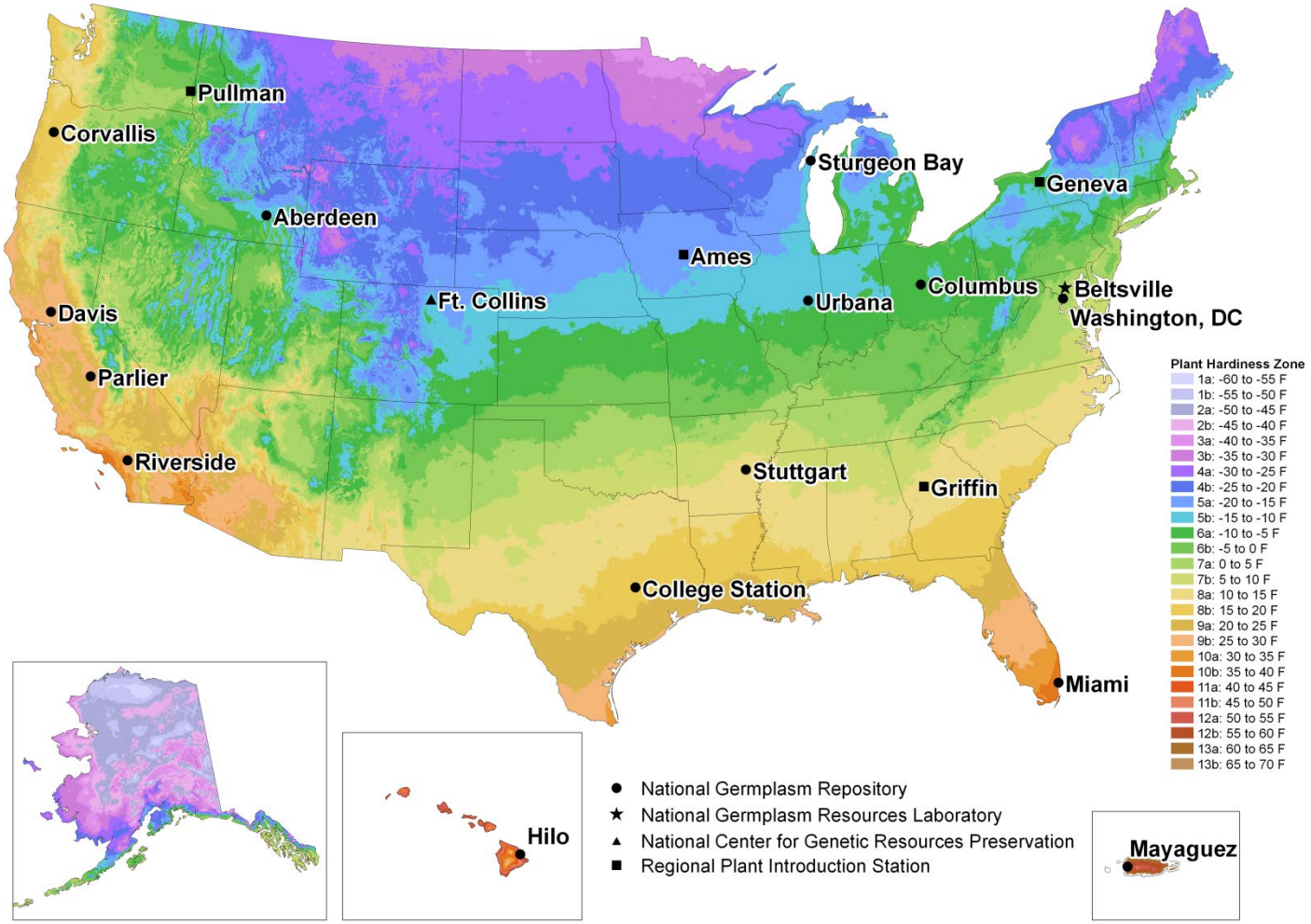
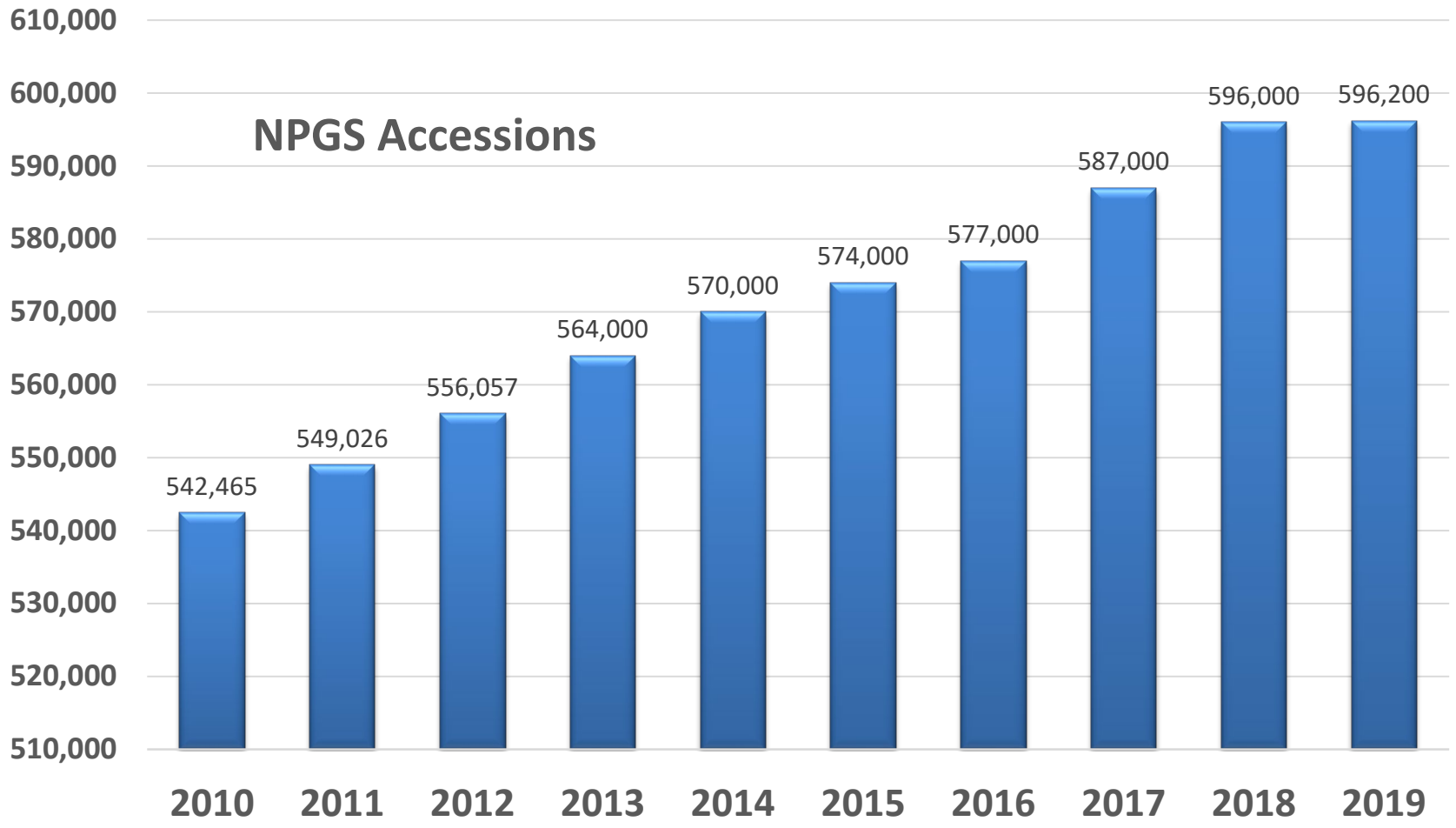
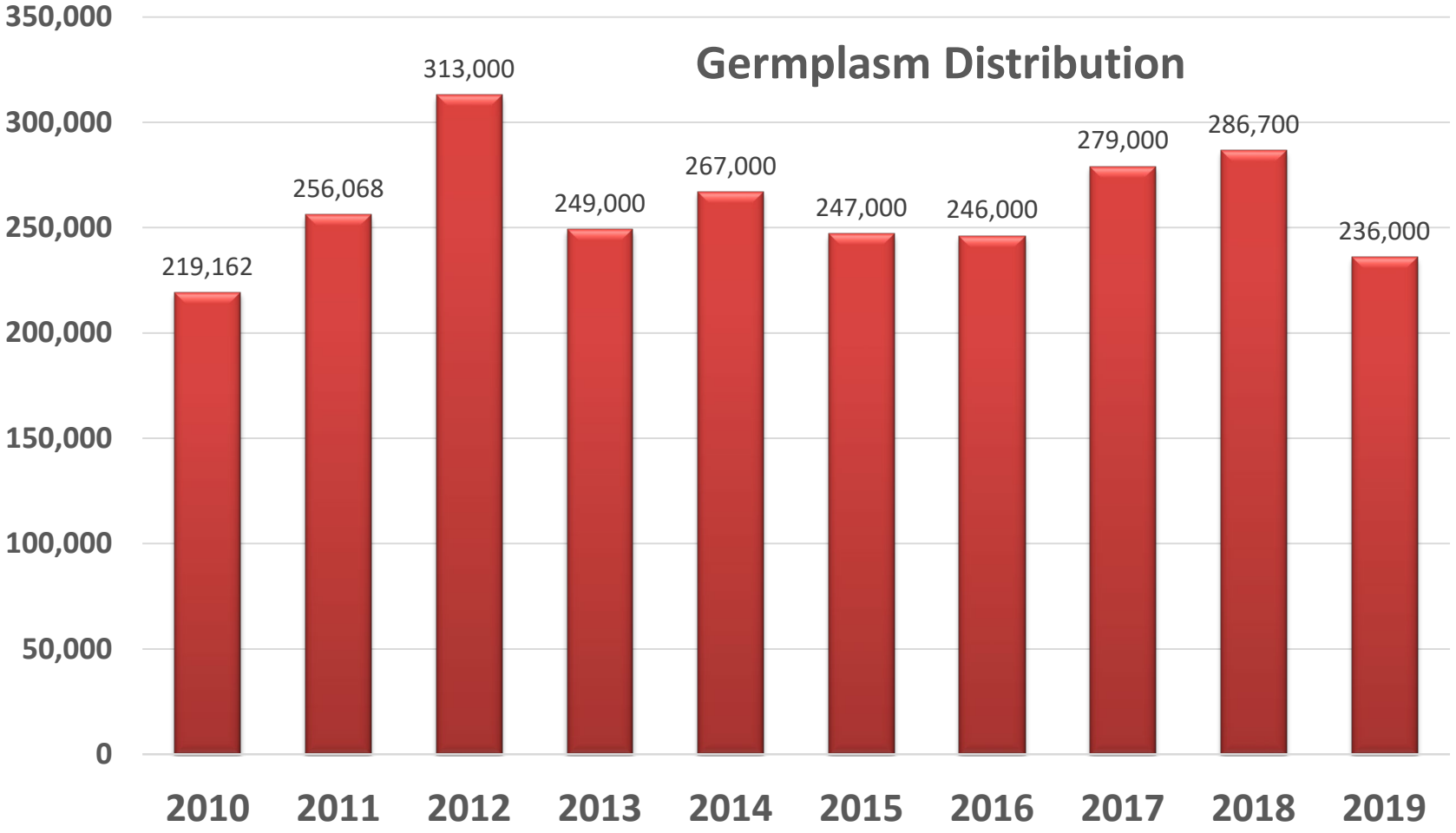
USDA National Plant Germplasm System (NPGS)



Number of NPGS Accessions 2010-2019



Demand for NPGS Germplasm 2010-2019



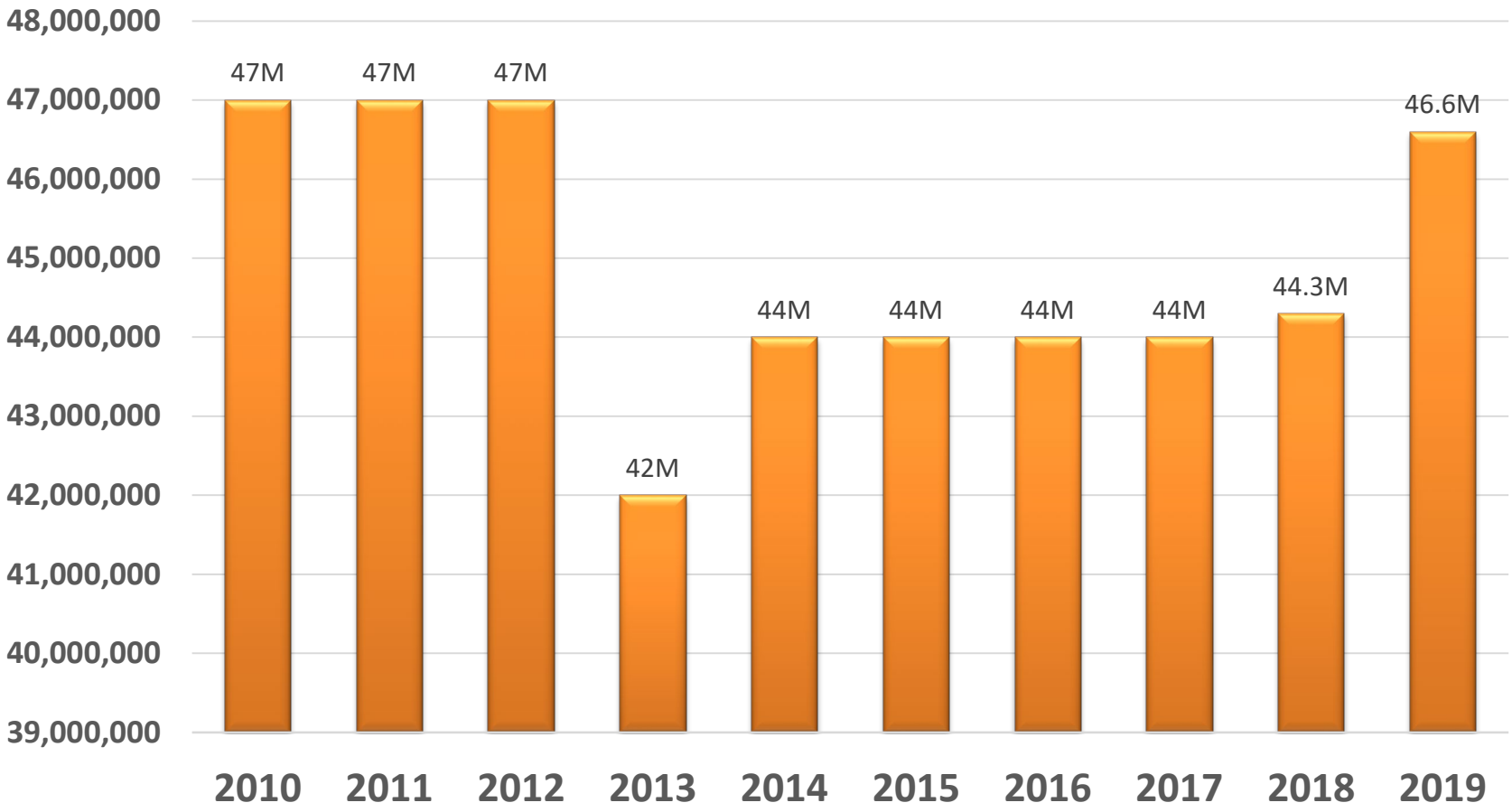
Effects of CoVID-19 as of 4 August 20

- **Many international germplasm shipments have been ceased because of suspended service and uncertain delivery conditions.**
- **Some NPGS genebanks have ceased all germplasm shipments because of Federal, State, and local (university) directives for social distancing, stay-at-home, etc. But Aberdeen, Ames, Corvallis, Davis, Geneva, Mayagüez, Pullman, Riverside and Sturgeon Bay are shipping some germplasm.**
- **GRIN-Global is functioning normally.**
- **Effects on FY 21 and future budgets?**

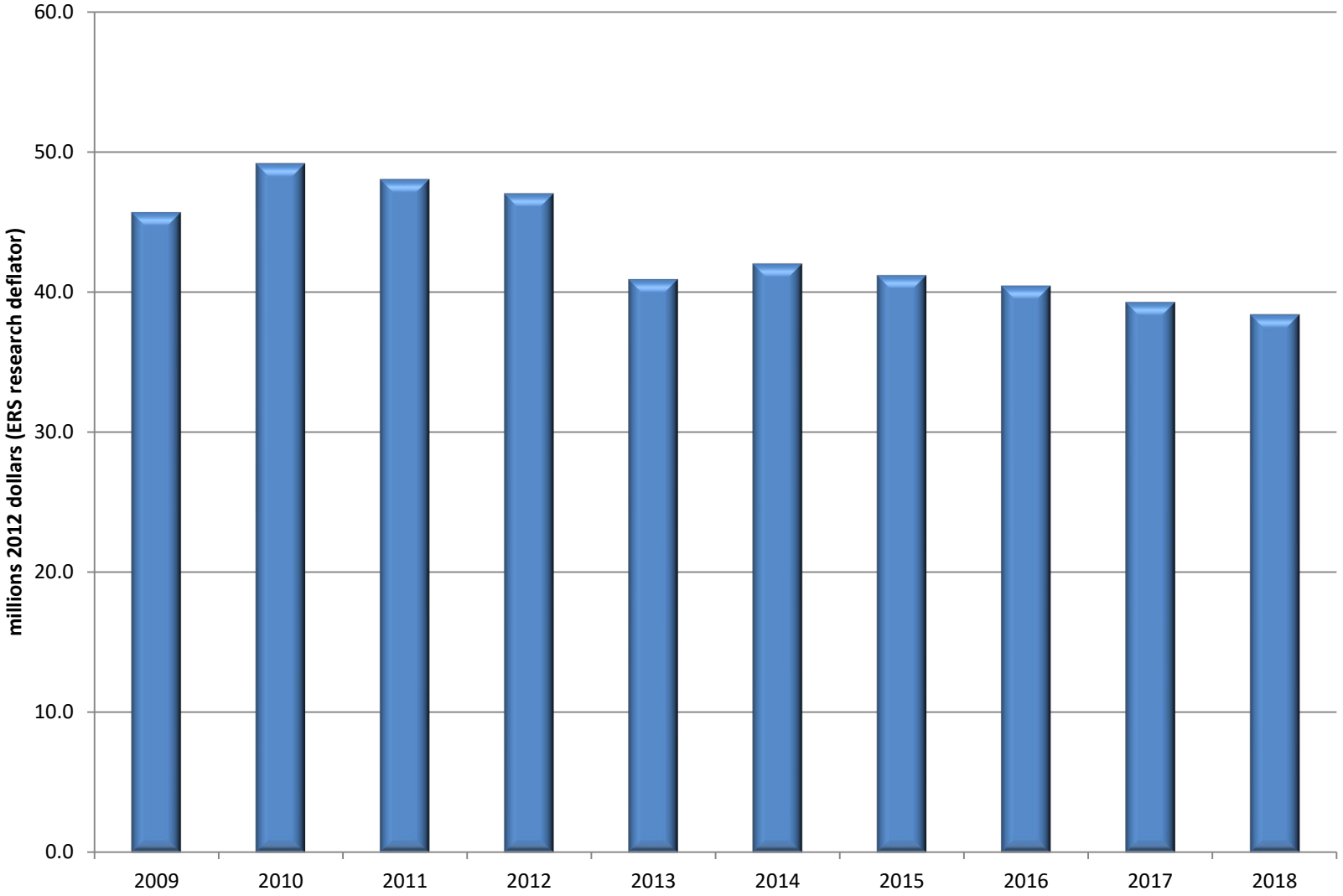
ARS National Plant Germplasm System

BUDGET

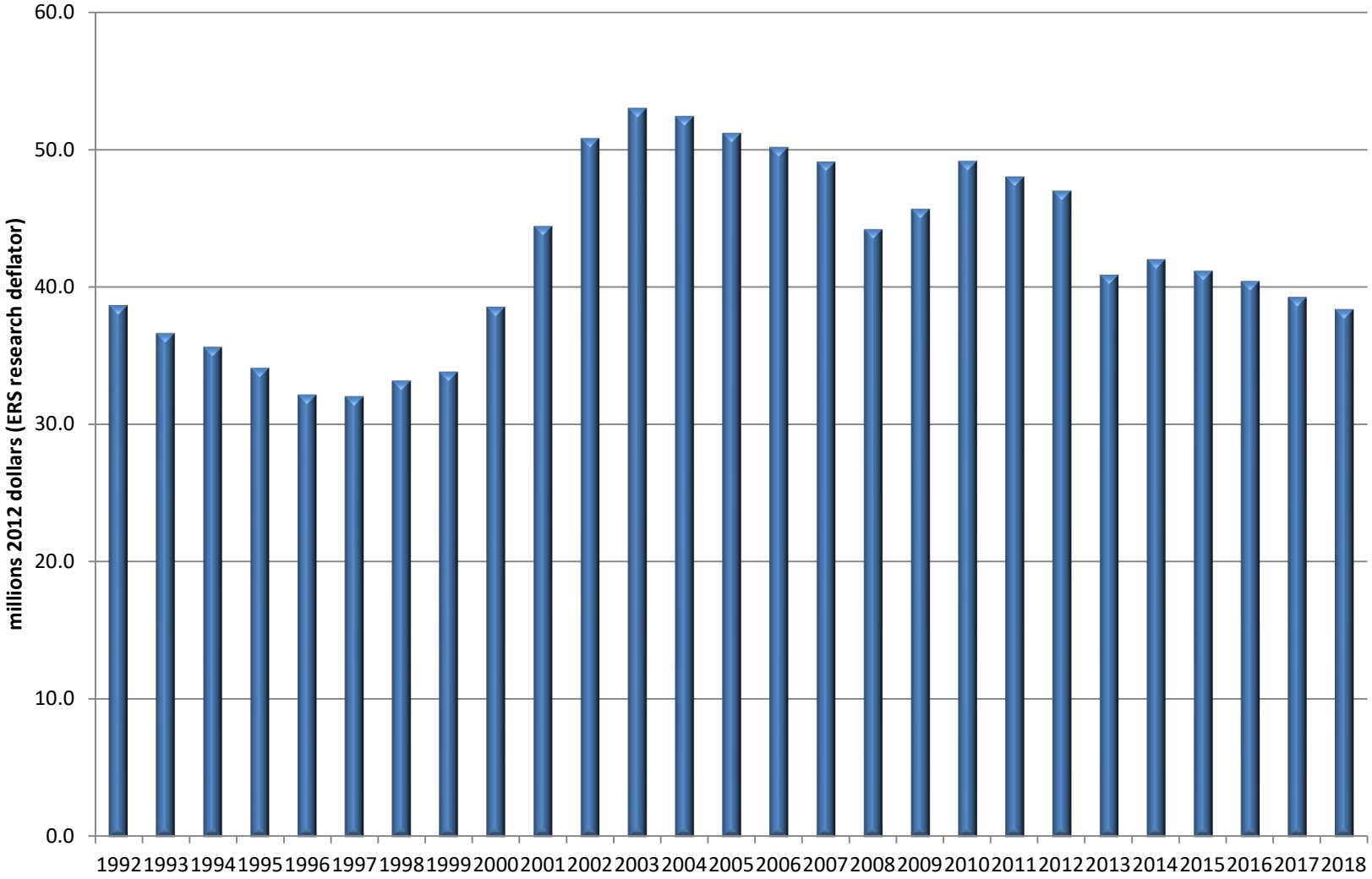
2010-2019



ARS NPGS real (deflated) budget, 2009-2018



ARS NPGS real (deflated) budget, 1992-2018



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; hiring and training new staff.**
- **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: Foundations for Crop Innovation

- 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 Jinguo Hu, RL (ARS-Pullman) and MaryLou Polek, RL (ARS-Riverside).**
- **Welcome and best wishes to Adam Mahan, Soybean Curator at ARS-Urbana; Todd Rounsaville, Woody Landscape Plant Geneticist at ARS-USNA, Washington, DC; Cullen McGovern, IT specialist at ARS-NLGRP, Ft. Collins, and Alex Sanchez, who moved from ARS-SHRS Miami to become nursery manager at ARS-NCGR, Davis.**
- **With the hiring freeze lifted, we are recruiting leadership and curatorial staff at Hilo, HI; Pullman, WA; Ames, IA; College Station, TX; Corvallis, OR; Riverside, CA; Geneva, NY; and Miami, FL.**

Plant Genetic Resource (PGR) Management Training Initiative

- **At least 1/3 of NPGS PGR managers could retire within 5 yrs.**
- **Currently, no formal, comprehensive program exists for training new PGR managers.**
- **G. Volk (ARS-Ft. Collins) and P. Byrne (CSU-Ft. C.) secured a USDA/NIFA grant for a workshop at Ft. C. 24-26 April 2018 that discussed designing & developing a training program for PGR management to be delivered primarily through distance-learning.**
- **The workshop generated numerous insights; workshop participants secured a NIFA Higher Education Challenge grant. An extensive survey for PGR training/learning needs was conducted and published in Crop Sci. 59:2308–2316 (2019). doi: 10.2135/cropsci2019.05.0324**
- **Instructional e-books under development--see https://colostate.pressbooks.pub/cropwildrelatives/ for an e-book about conserving crop wild relatives.**

FY 19 ARS NPGS Budgetary Increases

- **Coffee genetic resources ($1.9 million): Hilo, HI; Mayagüez, PR; Ft. Collins, CO; Beltsville, MD.**
- **Citrus genetic resources ($1 million): Riverside, CA; Ft. Collins, CO.**
- **Industrial hemp genetic resources ($500,000): Geneva, NY.**

NPGS Video

- **Pullman, Griffin, Ames, Corvallis, and Geneva staff developed a new tactic for discouraging "non-research requests" for germplasm by communicating that the NPGS benefits everyone by ensuring global food security through research and breeding, not by providing seeds for home gardens.**
- **Led by Barbara Hellier at Pullman, the NPGS genebanks and USDA Communications filmed a video of NPGS operations accessible from the ARS YouTube site at: https://youtu.be/uHOclGNELuw**
- **Feel free to post this link on your websites, and share it with customers/stakeholders, colleagues, family, and friends.**