

Annual Report for Calendar Year 2018

USDA-Agricultural Research Service
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EXECUTIVE SUMMARY AND HIGHLIGHTS

The Western Regional Plant Introduction Station (WRPIS) is one of the four regional plant introduction stations in the United States. Activities at WRPIS focus on acquisition, preservation, characterization, evaluation, documentation and distribution of assigned germplasm collections along with conducting mission-related research. This station includes five curatorial programs and three research programs (one in plant pathology, one addressing alfalfa genetics and the other on faba bean germplasm enhancement). The operation is primarily funded by three CRIS projects [two belong to National Program (NP) 301 and one NP 215] managed through the USDA-ARS Plant Germplasm Introduction and Testing Research Unit (PGITRU), on the Washington State University (WSU) campus in Pullman, WA. Two of the projects (the National Temperate-adapted Forage Legume (TFL) Germplasm Project and the Alfalfa Genetics Research Project) are located on an USDA-ARS worksite in Prosser, WA co-located with the WSU's Irrigated Agriculture Research and Extension Center (WSU-IAREC). The Regional Multistate Research Project (W-6) also contributes considerable funding (~12% of the total operation budget) which covers the salary and fringe benefits for six full-time state employees working for the WRPIS. In addition, funds help defray partial costs associated, land rent, equipment, supplies and farm operations for germplasm regeneration, seed increase, characterization, evaluation and enhancement research. Our goals are achieved through close collaboration among scientists in various disciplines such as agronomy, horticulture, plant pathology, genetics, plant physiology and botany. As part of the Regional Multistate Research Project, work is conducted in close association and collaboration with scientists of the State Agricultural Experiment Stations, other state and federal agencies, as well as the private sector. Our research is also conducted in active collaborations with scientists at international centers, universities and non-governmental organizations. The global crop plant research community continued to show a high interest in the WRPIS germplasm collections. In 2018, we distributed a record high number of 44,659 packets of seed samples to 835 requestors residing in each of the 50 domestic states and 43 foreign countries. WRPIS scientists made 21 poster or oral presentations at various regional, national and international conferences, and published 15 research papers in peer-reviewed scientific journals.

2018 highlights:

- On December 31, 2018, there were 100,968 accessions belonging to 1,107 genera, 4,887 species (5,593 taxa) in the WRPIS collection.
- We acquired 2,717 native plant accessions collected by the Seeds of Success (SOS) project, 53 expired IPR/CSR accessions from NGRP and 31 other miscellaneous accessions from various sources. In addition, we received three thousand *Brachypodium distachyon* lines with T-DNA insertions generated by John Vogel of the DOE Joint Genome Institute. All these lines were added to the Germplasm Resources Information Network (GRIN)-Global database under one accession and added to WRPIS for storage and possible distribution only.
- We distributed a total of 44,659 packets of seed samples to 835 requestors with addresses in each of the 50 domestic states and 44 foreign countries. Fifty-four percent (23,973 packets) were distributed to the U.S. and 46% (20,686 packets) were distributed to foreign countries. Requestors in the 13 Western states received a total of 9,794 packets from WRPIS.
- We uploaded 20,973 observation data points on 6,561 accessions into the GRIN-Global database. These data points are on 108 established descriptors for 9 different crop species.

Our collaborators contributed 12% and WRPIS staff provided 88% of the evaluation data. The database is accessible by researchers worldwide via the Internet.

- We entered 2,086 seed viability records into GRIN-Global database. Among these, the seed storage personnel at WRPIS tested 74, the National Laboratory for Genetic Resource Preservation (NLGRP), Fort Collins, CO tested 1,332, Tangent Seeds, Tangent, OR tested 300, our Horticultural Crops program tested 275 and our Temperate-adapted Forage Legumes program tested 95 accessions.
- A total of 8,830 digital images of 6,153 accessions were uploaded into the GRIN-Global database. Of these, 5,787 were seed images.
- We regenerated 2,218 inventories of diverse plant germplasm and shipped 1,994 seed inventories to the NLGRP and 120 inventories to the Svalbard Global Seed Vault, Svalbard, Norway for secured backup.
- We published results on pre-acclimation temperature influences freezing tolerance of faba bean. Seedlings grown under a controlled “warm” 17/12°C (day/night) pre-acclimation environment were initially less freezing tolerant than those grown under a “cold” 12/5°C temperature treatment. We suggest that when screening faba bean genotypes for freezing tolerance, researchers should consider testing germplasm across a range of relevant field based pre-acclimation temperatures.
- We identified W6 lentil genetic resources and QTL associated with good levels of partial resistance to *Aphanomyces* root rot (*Aphanomyces euteiches*) using the W6 lentil core collection and genome-wide association study approach. The SNP markers identified will be converted to breeder-friendly assays for use in marker-assisted selection to mitigate damage of root rots in lentil crop.
- We identified a total of 53 significant single-nucleotide polymorphism (SNP) markers associated with salt tolerance and located 49 loci throughout eight alfalfa chromosomes. A Basic Local Alignment Search Tool (BLAST) search of the regions surrounding the SNPs revealed 21 putative candidate genes associated with salt tolerance. The genetic architecture for traits related to salt tolerance characterized could help in understanding the genetic mechanism by which salt stress affects plant growth and production in alfalfa and in marker-assisted selection for alfalfa genetic improvement.

Cover story: Phenotypic diversity of the W6 table beet collection. The NPGS cultivated *Beta vulgaris* subsp. *vulgaris* collection has 1,845 accessions with material from all beet types including sugar beet, fodder beet, leaf beet (both chards and potherbs) and table beet. Over the last 30 years the collection has been extensively evaluated, but the focus has been on sugar beets. Consequently, there was little data on accessions that make-up the table beet collection. Plant, plot, and root images along with descriptor data was collected collection accessions. Phenotypic data and images have been uploaded into our GRIN-Global database for breeders to use when selecting desirable parental accessions in developing varieties to satisfy consumers.

Upper: Examples for root shape, leaf density and color; Lower: Examples for root flesh color among the accessions (Cover story prepared by Barbara Hellier, Curator for *Beta* and Horticultural Crops Germplasm).

REPORT

ADMINISTRATION

Scot Hulbert (Administrative Advisor)
Ann Marie Thro (USDA-NIFA Representative)
Michael Fitzner (USDA-NIFA Representative)
Peter Bretting (USDA-ARS National Program Staff)
Robert Matteri (USDA-ARS PWA Area Director)
Jinguo Hu (USDA-ARS Research Leader and Station Coordinator)
James Dann (USDA-ARS Program Support Assistant--vacant since August 2018)

PERSONNEL

Two critical vacancies were filled in 2019. Our Seed Storage and Database Manager, Mr. Dave Stout retired on March 17, 2018 and this position was on the high priority list to be recruited. It was advertised in November 2018 and the interviews were conducted in February 2019 after the ending of the federal government shutdown. There were nine qualified applicants, one received another offer and withdrew before the interviewing and another applicant declined our job offer after the interview. We conducted on-line interviews with three potential candidates, but the process ended with no-selection. To timely respond to the increasing number of germplasm requests from the user community, the Research Leader reassigned Ms. Lisa Taylor to this important position after consulting with the Area Office and an USDA-ARS HR Specialist. Ms. Taylor received her B.S. degree in Environmental Science from Northern Arizona University and joined USDA-ARS-Pullman in 2004. She has a good background in plant biology and environmental sciences, having taken courses in plant taxonomy, economic botany, genetics, microbiology, molecular biology and chemistry. She was hired as the Plant Geneticist's Technician applying various kinds of DNA markers for plant germplasm characterization. In 2012, she became the Supervisory Research Geneticist's Technician assisting in pulse crop germplasm characterization and enhancement. Ms. Taylor started as the Seed Storage and Database Manager position in March 2019 with responsibilities for managing the facility, the existing 100,000 plus accessions and their associated information in the GRIN-Global Database, and supervising three/four part-time employees in organization, distribution and germination of plant germplasm. Ms. Taylor is learning fast how to use the GRIN-Global database since she is fortunate to have a very good mentor, Mr. Stout, one of the original group of individuals who started GRIN and has contributed substantially to the recent upgrade to GRIN-Global. Mr. Stout has been helping the station part-time since his retirement last April. We greatly appreciate Mr. Stout dedication to managing the many agriculturally important plant genetic resources at the WRPIS.

Our Program Support Assistant (PSA) position has been vacant since August 2018 when Mr. James Dann relocated to USDA-ARS-Florence, SC. Our Area Office listed this critical vacancy as one of the high priorities to be filled. During the time when HR was preparing the advertisement, Ms. Carla Olson expressed her desire to apply for this position. The Pullman HR specialist proposed a very efficient way to fill our PSA position by reassigning Ms. Olson directly to this position and obtained official approval for the process. Ms. Olson has 12 years of experience working in different USDA-ARS research Units in Pullman. She joined USDA-ARS in 2007 as the PSA for the Land Management Research Unit. Ms. Olson worked in the PGITRU from 2014-2016 and was selected as the PSA at the Northwest Sustainable Agroecosystems Research Unit in 2016. Beginning in May 2019, Ms. Olson will officially start her PSA position

in our Unit. Everyone in the Unit is excited and welcomes Ms. Olson back! We truly appreciate the strong support of our Area Office and Location Office for this important action. We also appreciate the collaborative spirit of the PSAs at the other USDA-ARS research Units in Pullman for filling in to complete, on time, the copious amount paperwork during the vacancy of this critical position.

There is still a long list of federal vacancies to be filled in the Unit. These include, the **Agronomy Grass and Safflower Curator** position from which Ms. Vicki Bradley retired in June 2018. In addition, Ms. Jessica McGowan, a **Biological Science Technician** who had been with the program for three years and was the Acting Agronomy Grass and Safflower Curator from July 2018, resigned in February, 2019 after being offered an administrative position with WSU. Well-qualified employees must be hired into the Curator and Technician positions to effectively manage the 23,000 grass and 2,300 safflower accessions. The Unit's **Research Plant Pathologist**, Dr. Frank Dugan, retired October 2018. This position has been critically important as it has assisted our curatorial programs in keeping healthy plants by identifying and managing pathogens and ensuring the production of high-quality seed for long-term conservation. Our Unit manages diverse plant germplasm belonging to ~5,000 plant species. Each year, we regenerate plants on the farm and in the greenhouses. At the recommendation of Dr. Peter Bretting, National Program 301 Leader, we will pursue the recruitment of a Category-4 (Service Scientist) Plant Pathologist, following the example of other regional PI stations. Another vacancy was created when Mr. Bill Boge, an **Agricultural Research Science Technician** working under Dr. Long-Xi Yu with alfalfa genetics research program at Prosser, WA, retired in May 2017. In spite of this critical vacancy, Dr. Yu has been doing a great job in his position by obtaining extramural research funds from both public and private sources and making significant progress in applying genomics tools to alfalfa improvement. Filling this support position would provide much needed technical support to his productive program. A **Biological Science Technician** position for conducting seed germination tests to monitor seed viability has been vacant for some time. Lastly, a **Biological Science Technician** position is to be recruited to assist the Supervisory Research Geneticist for pulse crop germplasm characterization and enhancement.

On the state side, Ms. Julia Christian was hired in August 2018 as one of the Pullman farm Technicians. Ms. Christian has been a hard worker and has a strong background in farming. She has been a great addition to the WRPIS team! Recently (February 2019), Mr. Charles Golob, Pullman Farm Manager, expressed his desire to return to WSU Turf Research Program where he was working prior to being assigned to WRPIS. Washington State University started the search for a new Farm Manager early May 2019. Mr. Golob plans to help the station with 50% of his working hours until the Farm Manager position is filled. On June 11, WSU announced that Ms. Saber Grass was selected as the Pullman Farm Manager starting on June 17, 2019.

RESEARCH PROJECT

Calendar year 2018 was the first year in executing two newly approved 5-year project plans, "Management of Priority Legume, Oilseeds, Vegetable, Forage Grass, Sugar, Ornamental, and Medicinal Plant Genetic Resources and Associated Information" and "Management of Temperate-adapted Forage Legume Genetic Resources and Associated Information" at Pullman and Prosser locations, respectively. These two projects are relevant to the Agricultural Research Service's National Program 301 Plant Genetic Resources, Genomics, and Genetic Improvement.

Dr. Yu successfully renewed his alfalfa research project being executed at the Prosser worksite. The project plan is entitled “Enhancing Resistance to Biotic and Abiotic Stresses in Alfalfa” and is relevant to the Agricultural Research Service’s National Program 215 Pasture, Forage, and Rangeland System. The project went through an internal review and an external expert review processes organized by the Office of Scientific Quality Review. The new plan covers the period from March 4, 2019 to March 3, 2024.

The current USDA-NIFA Multistate Research Project W-6 entitled “Management and Utilization of Plant Genetic Resources and Associated Information” is in its third year of the five-year cycle. Excellent progress has been made in each of the project’s six objectives.

FUNDING

There was no change to the total USDA-ARS budget in 2018 (\$2,931,800). Of this, \$2,293,754 was allocated for the Plant Germplasm service and research project in Pullman, WA; \$254,724 for the Temperate-adapted Forage legume germplasm project and \$438,292 for the Alfalfa Genetics research project both in Prosser, WA. The discretionary dollar per SY was \$35,297. The ‘in kind’ support from the NIFA Multistate Research Project W-6, through Washington State University was \$446,257.

In addition, the Cool Season Food Legume Germplasm Curator Dr. Clarice Coyne, together with two other collaborators, received a \$45,000 research grant from the USA Dry Pea and Lentil Council to support applied pea and lentil genomics research, respectively. Dr. Coyne serves as Co-PI on a AFRI SCRI lentil disease evaluation and genomics “Lentil, from the Ground Up” grant of \$3.2 million (\$1 million to WSU), the PI on a USDA-ARS Pulse Crop Health Initiative grant on pea protein “More Peas, More Protein, More Profit” of \$178,000, the Co-PI on the US-Israeli Binational Science Foundation drought study in wild pea of \$180,000 and the Co-PI on a WA State Specialty Crops disease resistance screening in lentil of \$199,000. These grants support Dr. Yu Ma, a Postdoctoral Research Associate. Dr. Yu has five collaborative grants by both public and private sources totaling \$160,000 to support his research program. For example, of the \$400,000 grant entitled “Marker assisted breeding in elite alfalfa germplasm to enhance biomass productivity during drought” and funded by Alforex (now Corteva Agriscience), \$210,000 goes to Dr. Yu and \$190,000 to Dr. Ian Ray of New Mexico State University. This project is for a total of four years, from 2017 to 2021. Dr. Yu also obtained a new grant from NIFA-AFRP in collaboration with Dr. Zhiwu Zhang of the Crop and Soils Department at WSU. This proposal is entitled “Genomics enabled purging selection to develop 200 alfalfa inbred lines toward high yield hybrid production” and was funded at \$295,000 with \$80,000 to USDA-ARS-Prosser for three years. Temperate-adapted Forage legume germplasm Curator Dr. Brian Irish obtained a research grant from the U.S. Alfalfa Farmer Initiative (USAFRI). The project is entitled “Spring black stem and *Stemphylium* leaf spot resistance screening in the USDA-ARS National Plant Germplasm System’s *Medicago* spp. genetic resources”. Dr. Irish also manages an Inter-Agency Agreement with the Bureau of Land Management (BLM) with an annual amount of \$125,000 supporting a Horticulturalist at WRPIS implementing NPGS-WRPIS component of the national Seed of Success (SOS) program.

FACILITIES

The WRPIS facilities at Pullman and Central Ferry remained the same during the year. There are 34,800 square feet of greenhouse facilities (22,375 sq. ft. Federal, 12,425 sq. ft. WSU) and 157.3

acres of farmland (86.2 acres Federal, 71.1 acres WSU). WRPIS staff uses 12 laboratories (5 Federal, 7 WSU), and 22 offices (4 in Federal buildings, 6 in a Federal mobile office building, 12 in WSU buildings). The USDA-ARS Alfalfa Research Geneticist and the Forage Germplasm Curator have assigned office, greenhouse and laboratory spaces at the Prosser worksite in both Federal and WSU facilities.

In 2018 we continued improving infrastructure at Central Ferry in stages every year with partial support from year-end funding from the Area Office. In 2018, two new structures were erected at Central Ferry, including a 30' x 80' bubble greenhouse and a 35' x 100' greenhouse (**Figure 1**). The bubble greenhouse is already in use. The metal frame of this bubble house was purchased in the mid-1980s and the new greenhouse kit was purchased four years ago from Winandy Greenhouse Company. Our Farm Manager Mr. Kurt Tetrick worked out every detail and assembled the greenhouse with a small crew of term or temporary helpers. Now the new greenhouse is waiting for electric wiring for lighting. We would like to install LED lighting in the new greenhouse, but there is not sufficient fund to purchase all the required equipment this year. This new greenhouse will be replacing an old greenhouse that was built in 1971. These two greenhouses will help us to catch up with the needed regenerations for the ~17,000 *Phaseolus* bean accessions. Aimed at producing virus-free seed, our bean regenerations have always been conducted in the greenhouses.



Figure 1. The bubble (upper) and new (lower) greenhouses at the WRPIS Central Ferry Farm.

Little progress has been made to replace the 28.5 acres of farmland lost due to the Pullman-Moscow Regional Airport Expansion. This farmland was assigned to WRPIS by WSU for germplasm regeneration and research purposes. Proper crop rotation is necessary to produce quality seeds for long-term conservation and for distribution to researchers who request samples from WRPIS. The potential land parcel being proposed as a replacement for WRPIS to use will be charged with an annual rent of approximately \$100 per acre. This is a substantial financial impact to WRPIS. We will have to budget an additional \$3,000 per year for renting farmland. It is our hope that the WSU will work out the issue of identifying proper land pieces for the WRPIS to use soon.

Relocating the Temperate-adapted Forage Legume germplasm management operation to Central Ferry from Prosser remains a major issue in the WRPIS' 2019 Annual Resource Management Plan (ARMP). This was proposed to maintain the genetic integrity and avoid gene-flow and adventitious presence (AP) of genetically engineered (GE) transgenes in the NPGS alfalfa regenerations and in the germplasm collection. After the deregulation of the genetically-engineered Roundup Ready Alfalfa (RRA) and the low-lignin trait, necessary measures including using new insect-proof cage covers over the regeneration plots were taken to reduce the chance of AP in the alfalfa germplasm. The Prosser site is surrounded by commercial alfalfa hay production fields in which the genetically-engineered glyphosate resistant alfalfa is planted. Recent surveys have even found RRA plants on the roadside on the WSU IAREC Roza research farm. It would be best to relocate the germplasm operation to the Central Ferry Farm that is more isolated from alfalfa production fields. This proposal was endorsed by the W6 Technical Advisory Committee (TAC) at its 2014 annual meeting. However, with the current funding level it has not been possible to make the move. A combined effort of USDA-ARS Pacific West Area Office and Headquarters is needed for materializing this relocation.

GERMPLASM MANAGEMENT

The five curatorial programs at WRPIS manage the diverse crop species assigned to the station by the National Plant Germplasm System (NPGS). These crop species are divided roughly into ten groups: 1) forage and turf grasses; 2) cool season food legumes (pea, lentil, chickpea, faba bean, lupin, etc.); 3) Temperate-adapted Forage legume crops (alfalfa, clover and trefoil); 4) beans; 5) lettuce; 6) safflower; 7) garlic; wild onion and onion relatives; 8) sugar beet; 9) selected ornamentals; and 10) medicinal and miscellaneous plant species. **Figure 2** shows the number of accessions for major crop groups maintained at WRPIS. As of April 29, 2019, the WRPIS holds 100,968 accessions. This is approximately 17% of the total NPGS holdings of 597,024 accessions. As for numbers of plant taxa, WRPIS ranks number one among all NPGS sites since WRPIS holds 43.3% of the total genera and 30.6% of the total species in the NPGS. Most WRPIS accessions are maintained as seed, with a small proportion of vegetatively propagated accessions (garlic, wild onion species, rhubarb, and a few vegetables, grasses and ornamentals).

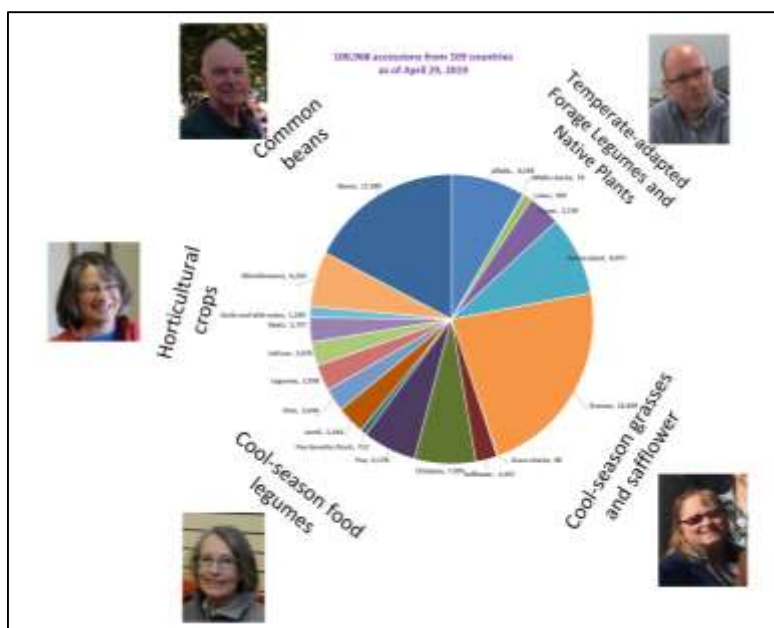


Figure 2. The five Curators and their assigned crop groups maintained at WRPIS. The Cool season grasses and safflower curator Vicki Bradley retired in June 2018 and this critical vacancy will be recruited.

The Agronomy and Native Plants Program (Vicki Bradley retired in June 2018 and this Curator position will be recruited) manages 34,133 accessions of cool season turf and forage grasses, safflower and the native plant accessions collected in recent years by the BLM's Seeds of Success (SOS) project. Following Ms. Bradley's retirement, the Native Plant component responsibility was transferred to Dr. Irish of the Temperate-adapted Forage Legumes Program and Dr. Coyne has taken on Acting Agronomy Curator responsibilities. **The Cool Season Food Legumes Program** (Dr. Coyne) curates a total of 22,789 accessions of pea, chickpea, lentil, faba bean, and lupine. **The Phaseolus Beans Program** (Dr. Ted Kisha) manages a collection of 17,549 accessions, all belonging to the *Phaseolus* genus. **The Temperate-adapted Forage Legumes Program** (Dr. Irish, located in Prosser, WA) manages the alfalfa, clover, trefoil and their wild relatives with a total of 13,343 accessions. **The Beta and Horticulture Crops Program** (Ms. Barbara Hellier) manages 12,890 sugar beet, lettuce, garlic, and many miscellaneous species accessions that have potential use for ornamental, medicinal and restoration/revegetation purposes.

Germplasm Acquisition

During the 2018 calendar year, additions to the WRPIS collections included 2,717 native plant accessions from the Seeds of Success (SOS) project, 53 expired IPR/CSR accessions from NLGRP and 31 other miscellaneous accessions from various sources. In addition, we received three thousand *Brachypodium* lines with T-DNA insertions generated by John Vogel of the DOE Joint Genome Institute. All these T-DNA insertions were entered into GRIN-Global as one accession and added to WRPIS for storage and possible distribution only. As of December 31, 2018, there were 100,968 accessions belonging to 1,107 genera, 4,887 species (5,593 taxa) in the WRPIS collection (**Figure 3**). The value of these collections continues to grow as international access to additional germplasm is increasingly limited by the changing political environments.

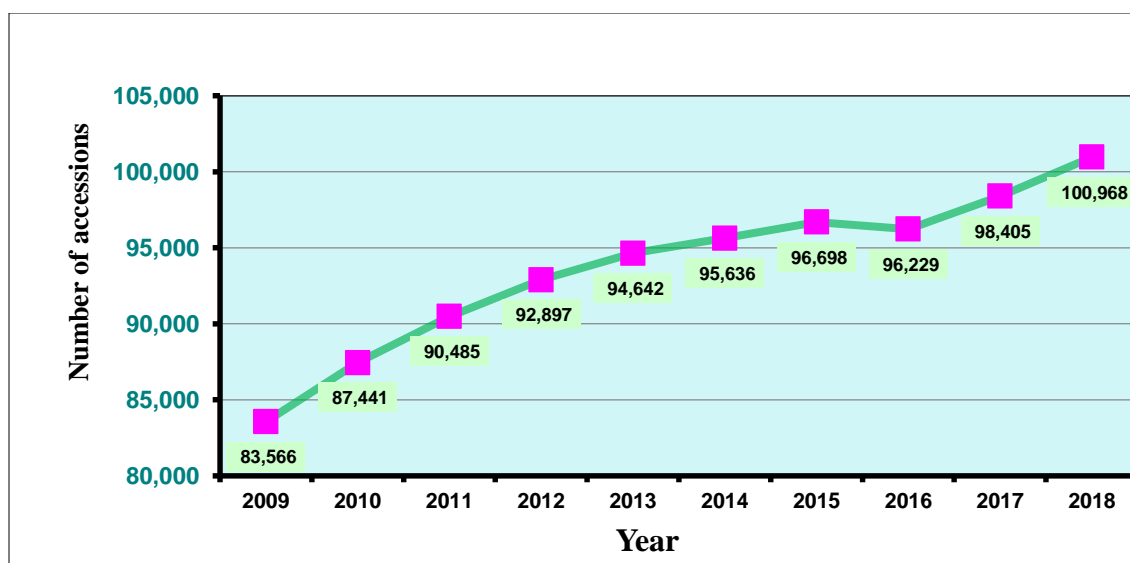


Figure 3. Total number of accessions managed by WRPIS since 2009 (numbers recorded at the end of each calendar year).

Germplasm conservation

In 2018, WRPIS curatorial programs regenerated 2,218 inventories by following the established, labor-intensive procedures and protocols for maintaining the genetic integrity and health of all germplasm collections. These included necessary physical isolation, hand planting and transplanting, controlled hand and insect pollination, hand harvesting, cleaning and packaging for storage and distribution.

We entered 2,086 seed viability records into the GRIN-Global database. Among these, the National Laboratory for Genetic Resource Preservation (NLGRP) in Fort Collins, CO tested 1,332 accessions, Tangent Seeds Company, Tangent, OR tested 300, WRPIS Horticultural program tested 275, the Temperate-adapted Forage Legume (TFL) genetic resources program tested 95 and the Pullman Seed Storage program tested 74.

For security backup, we sent 1,994 inventories to NLGRP in Fort Collins, CO and 120 inventories to the Svalbard Global Seed Vault, Longyearbyen, Svalbard, Norway through the NLGRP in 2018.

Germplasm evaluation and characterization

In 2018, a total of 20,973 observation data points on 6,561 accessions were uploaded into the GRIN-Global database. These data points were collected on 108 established descriptors for nine different crop species. Our collaborators contributed 12% and WRPIS staff provided 88% of the evaluation data. The GRIN-Global database, and its information, is accessible by researchers worldwide via the Internet.

In collaboration with the Department of Food Science and Human Nutrition at WSU, our *Phaseolus* Curator, Dr. Kisha, continues to analyze bean accessions for protein, extractable phenolics and non-extractable proanthocyanidins. This past year, following the previous discovery of the large differences in phenolics and protein, even within market classes, the program analyzed accessions of red and black bean market classes (**Figure 4**). Black bean extractable phenolics ranged from 200-1000 mg/100g, while the range in red beans was 300-1200 mg/100g. Non-extractable proanthocyanidins in black beans showed a range of 250- 2500 mg/100g, and red beans ranged from 500-2000 mg/100g. Analysis of these important nutritional compounds will continue for other market classes.

Over the past several years, and in cooperation with the Legume Curator of the Smithsonian Institution, more than 70 populations *P. polystachios* have been acquired, throughout the Eastern United States. However, collection efforts across its range have led to a recovery rate of less than 30% from previously collected or historical sites, suggesting a steep decline in this species. Several of the populations collected were infested with weevils, reducing seed viability and threatening population survival. These accessions are currently being regenerated at the WRPIS. A genetic diversity analysis depicting regional genetic variation throughout the species habitat will assist breeders in selecting a diverse set of accessions for research and breeding. Preliminary evaluation shows distinct differences among geographic locations (**Figure 5**).

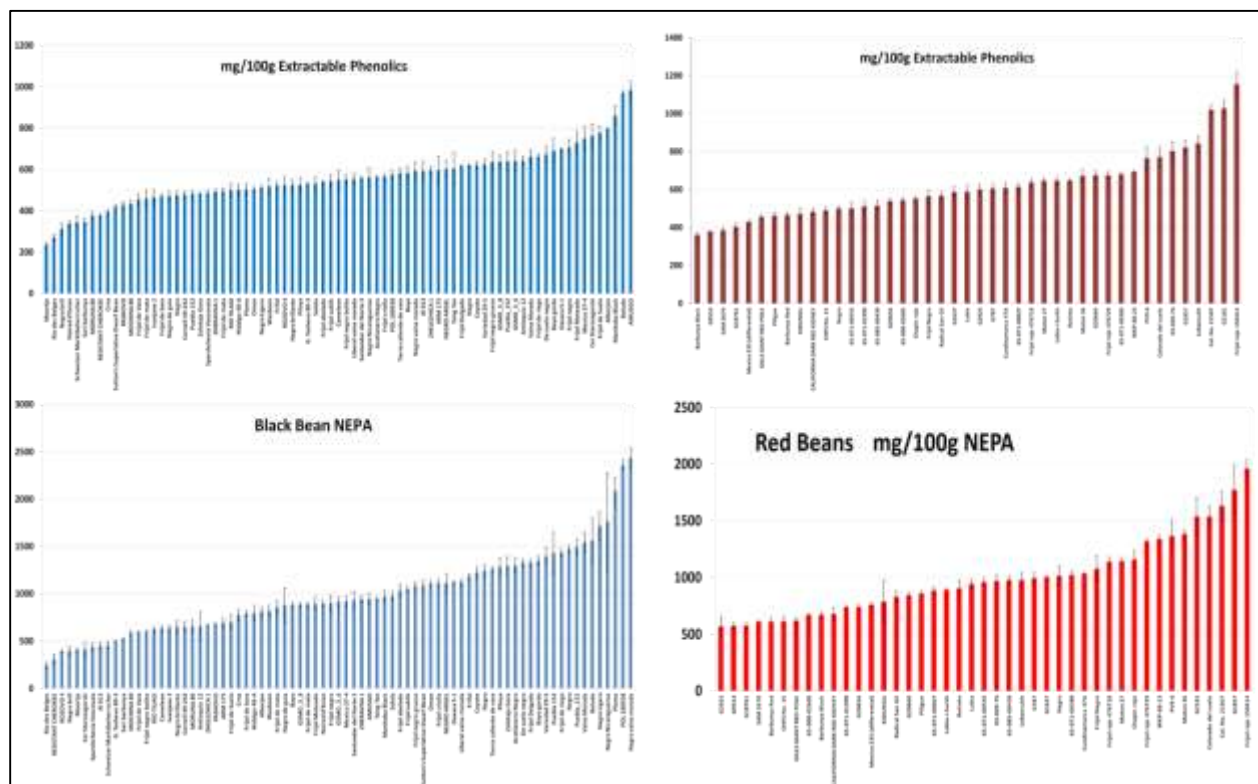


Figure 4. Graphs showing the range of extractable (top) and non-extractable (bottom) phenolics of black (left) and red (right) bean accessions from the NPGS collection.

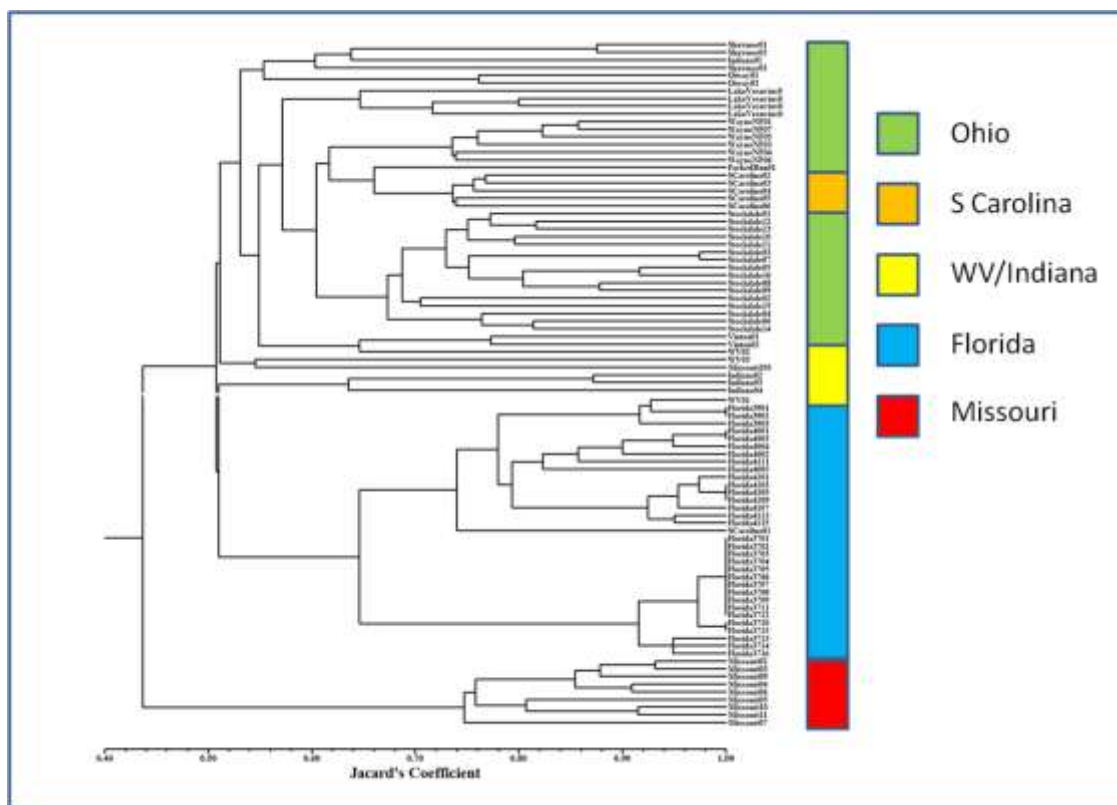


Figure 5. Distinct genetic differences among populations of *P. polystachios* collected from various geographic locations as accessed with a small number of DNA markers.

Research Plant Pathologist, Dr. Dugan, completed studies on comparing infection by *Fusarium proliferatum* in aerial garlic bulbils versus rates in seed cloves, and on rates of infection of bulbils in the WRPIS Pullman farm. Rates in bulbils were much reduced compared to rates in cloves when both cloves and bulbils originated from the same infected bulbils. Rates of bulb infection at the WRPIS farm varied, but were substantial compared to what is desirable in distributed germplasm. This project was partially supported by a germplasm evaluation grant to Ms. Hellier and Dr. Dugan from the USDA-ARS NPGS Root & Bulb Crop Germplasm Committee and its results were published online in 2018 and in print early in 2019 (Crop Protection Journal). *Botrytis cinerea* was confirmed as a pathogen of faba bean in Washington State (“First Report” presented as poster in June 2018).

Cool Season Food Legume Curator, Dr. Coyne, cooperated on two projects. One was on the discovery of two domestication events in garden pea (*Pisum sativum* L.) using W6 landrace and wild pea accessions. This result has implications on where to focus plant explorations to fill gaps in the W6 *Pisum* collection. The second was a follow up QTL study on vernalization of wild chickpea using PI 527934, which found vernalization (necessary to initiate flowering/seed production) QTL do not correlate to free tryptophan content in the seed. This furthers our understanding for breeding winter-hardy chickpea.

Germplasm distribution

Figure 6 shows the annual number of seed packets distributed for each of the past ten years. This year’s distribution of 44,659 packets to 835 requestors, was the highest on record for WRPIS,

with an increase of 5.1% from the previous year, but more than doubled the distribution packets in 2010. This indicates a high interest of the germplasm user community in WRPIS collections. Among the distributed packets, 54% or 23,973 packets were sent to addresses covering each of the 50 U.S. states and 46% or 20,686 packets were sent to requestors in 44 foreign countries.

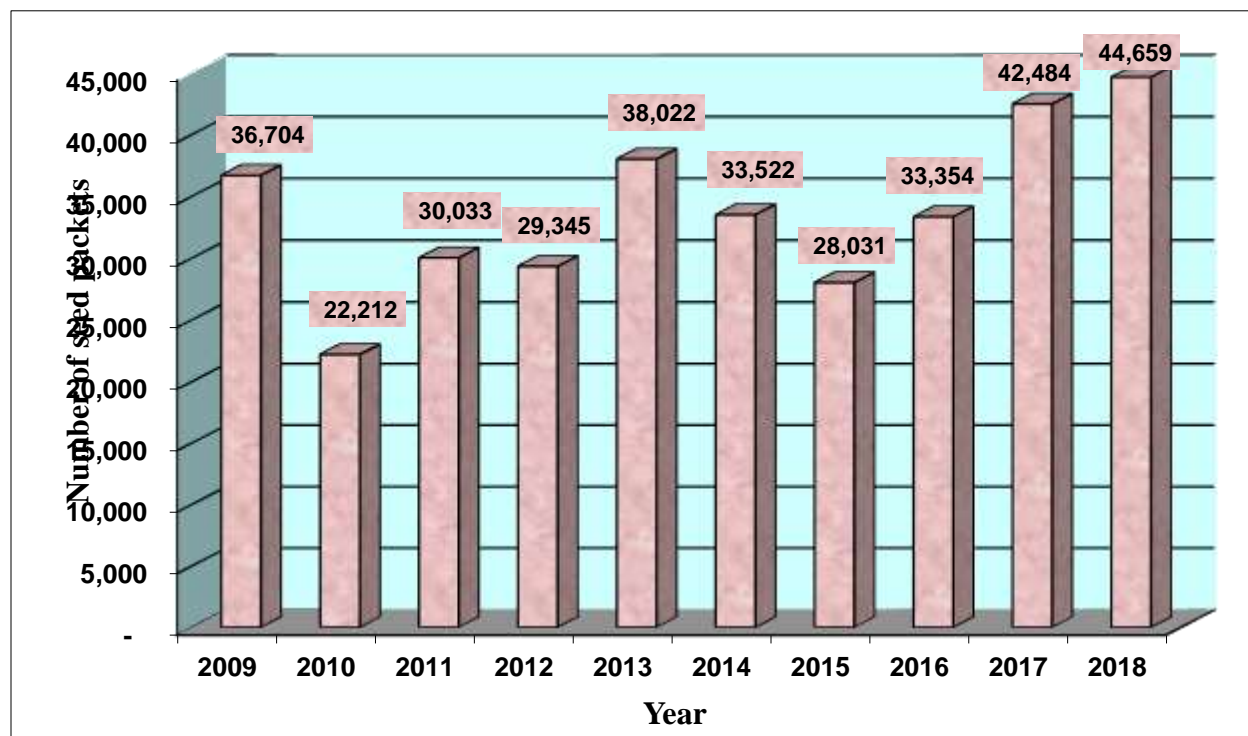


Figure 6. Number of seed packets distributed annually by WRPIS from 2009 to 2018.

Germplasm utilization in the 13 Western States

According to data generated by Mr. Stout, former WRPIS Seed Storage and Database Manager - who has been helping us part-time, and Mr. Bo Gao, IT Specialist, the 13 Western states (AK, AZ, CA, CO, HI, ID, MT, NV, NM, OR, UT, WA, and WY) germplasm user received 37,628 packets from all repositories in the NPGS in 2018. This was an increase of 17% from the previous year. Among the NPGS distributions, 9,794 packets were shipped from the WRPIS. The germplasm usage in the Western 13 States accounted for 26% of NPGS total and 69% of WRPIS' total domestic distribution. These genetic resources from NPGS were used for research and education in diverse scientific disciplines and contributed significantly to scholastic and economic activity in the western region.

Table 1 provides the numbers of packets distributed in 2018 to each of the 13 Western States by the WRPIS and the entire NPGS, respectively. The number received by each state varied from 14 (Hawaii) to 6,330 (Washington) from the WRPIS and from 103 (Wyoming) to 14,817 (California) from the NPGS. Germplasm users in Utah State did not request as many samples as in 2017, but the percentage of all samples from W6 station remained almost the same (80% in 2017 and 79% in 2018). Washington and California were the top two states in terms of receiving germplasm from WRPIS and NPGS in 2018.

Table 1. Numbers of plant germplasm packets distributed in 2018 to each of the 13 Western States by W6 station and the entire NPGS (data provided by Mr. Stout and Mr. Gao).

States	Number of packets distributed		
	From W6	From NPGS	% from W6
Washington	6330	14817	0.43
California	1123	8615	0.13
Colorado	663	2538	0.26
Montana	414	2392	0.17
Oregon	368	2204	0.17
Utah	311	395	0.79
Nevada	250	1940	0.13
Idaho	108	1810	0.06
New Mexico	89	467	0.19
Arizona	81	1660	0.05
Wyoming	26	103	0.25
Alaska	17	185	0.09
Hawaii	14	502	0.03

Summary of individual curatorial programs

1. Agronomy and Native Plants Program

Curator: Vicki Bradley/Vacant since June 2018 (full-time)

(Acting - Agronomy: Clare Coyne; Acting - Native Plants: Brian Irish)

Technician: Bob Guenther (full-time)

Technician: Jessica McGowan/Currently vacant (full-time)

Horticulturist: Mike Cashman (full-time)

The program was extended to include the native plants program after the retirement of the Agronomy Research Scientist, Richard Johnson in 2016. It includes the collections of cool season grasses, safflower and native plants.

- A. In 2018, we harvested seeds from 210 accessions of various grass species that were planted in previous years. Some of the perennial species need two or three years in the ground to produce enough seeds. We planted seeds of 230 grass accessions for harvest in 2019. We did not plant any safflower accessions due to the anticipated Curator's retirement.
- B. Biological Science Technician Ms. McGowan was the "Acting Curator" after Ms. Bradley's retirement. Ms. McGowan initiated and signed an MTRA (Material Transfer Research Agreement) with SeedTec company of AAK USA Richmond Corp. in Woodland, CA. SeedTec agreed to analyze up to 3,000 safflower accessions for total oil content using the non-destructive Nuclear Magnetic resonance (NMR) spectroscopy, and to send that data back to WRPIS in order to be added to the GRIN-Global database. In return, WRPIS will plant 90 breeding lines with seeds provided by SeedTec for a winter survival field trial on our Central Ferry Farm and collect data and seeds from surviving plants for SeedTec. This MTRA is being executed, and to date SeedTec sent us the oil content data of 1,187 safflower accession (**Figure 7**) and winter survival trial was planted in October 2018. In February 2019, Ms. McGowan was offered a position with WSU and resigned from USDA-ARS. Dr. Coyne has been the Acting Agronomy Curator for the Grass and Safflower germplasm.

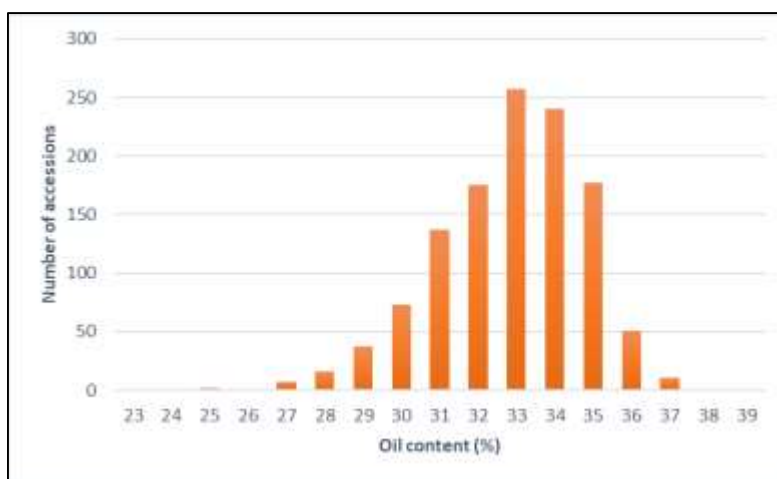


Figure 7. A histogram for % oil content for 1,187 WRPIS safflower accessions measured with Nuclear Magnetic Resonance (NMR) spectroscopy at SeedTec, Woodland, CA. The mean is

32.3% with a range from 22.8 to 38.6%). The data has been uploaded to our GRIN-Global database.

- C. The native plants project continued to collaborate with Bureau of Land Management (BLM) to manage the native plant seeds collected by the Seed of Success (SOS) Program in the U.S. (**Figure 8**). Passport data associated to each collection was entered into the GRIN-Global database. Seed samples were processed and split three subsamples for backup and distribution. One sample was sent to the NLGRP in Fort Collins, CO and two kept at the PGITRU for backup and distribution. The total number of active SOS accession in the NPGS system as of the end of 2018 was 16,381 of which 8,607 were in the Native maintenance policy. The Native maintenance policy group are accessions that have not been taken on or adopted by active programs in the NPGS and are kept and distributed by the PGITRU in Pullman, WA. In 2018, 805 accessions were transferred to other NPGS curatorial programs, including ones here in the PGITRU, bringing the number to a total of 7,774 SOS accessions currently managed by active programs in the NPGS. In 2018, a total of 1,361 order items in 151 requests were shipped to germplasm users for plant scientific research and/or educational purposes from the Native maintenance policy group. Many of the distributions were intended for use in the development of native plant materials to facilitate environmental restoration of lands administered by the BLM as well as other agricultural research activities. In 2018, a total of 2,654 accessions (received from BLM-partner seed cleaning facilities) were added to the NPGS collections with the accompanying data records loaded into the GRIN-Global database. The large number of accessions added in 2018, was mostly due to the expedited processing of a large backlog of accumulated of SOS collections at the PGITRU over the past few years.

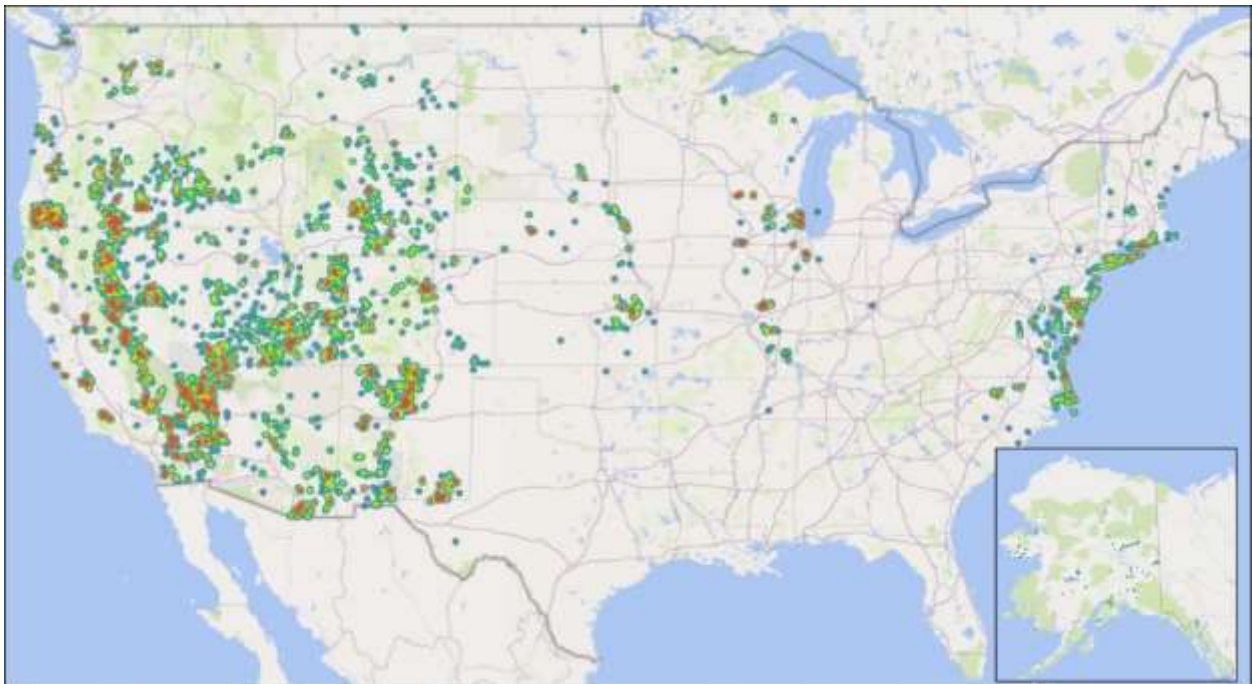


Figure 8. Map of the continental United States and Alaska (inset) depicting the locations, using heat map, where >16,000 native SOS seed accessions have been collected from.

Ms. Vicki Bradley retired on June 23, 2018 after 31 years of federal service including four years in the Air Force and 27 years with the Agricultural Research Service working as an Agronomist and Curator for the National Plant Germplasm System (NPGS). Ms. Bradley started serving in the Air Force after finishing a year in college during the Vietnam War era. She continued her education, after being discharged from the Air Force, and earned a B.S. and later an M.S. in Agronomy from Montana State University. Her work with the NPGS began in 1991 as an Agronomist and Curator for cool season grasses and safflower germplasm. In 2016, the curatorial program she led was extended to include native plants and related research, after the retirement of the Research Agronomist at the WRPIS. Ms. Bradley had been supervising two full-time Technicians, a supporting Biologist, managed the diverse germplasm collections, and coordinated an Inter-Agency collaborative project on native plants.

Ms. Bradley had made significant contributions to the mission of WRPIS by effectively managing the 34,133 cool season turf and forage grasses, safflower and the native plant accessions and by diligently serving the plant research community. Her remarkable service record has been greatly appreciated by our stakeholders. For example, Mr. John R. Hardison, Professor of Plant Pathology, Oregon State University, Corvallis, OR wrote a letter to USDA Secretary Thomas Vilsack and copying to WA State Senator Patty Murray in 2009 appraising Ms. Bradley's timely supplying of much needed grass germplasm to plant breeders in the U.S. and foreign Countries. Dr. M. C. Engelke, President of the U.S. Turfgrass Breeders Association (TBA) and Professor of Texas A&M at Dallas, TX wrote a letter in 2006 to WRPIS appreciating her efforts in maintaining the standard check cultivars used in turfgrass improvement programs with the statement of "the timely response that Ms. Bradley has given the TBA members in shipping the samples so promptly, when they are requested, is exceptional."

Ms. Bradley's efforts in managing the safflower germplasm and associated information is truly outstanding! The safflower germplasm collection is among the best managed collections with a high percentage of availability for distribution in NPGS. She managed the Safflower Genetic Resources website, that hosts all information about safflowers and attracts thousands of visitors each year. Ms. Bradley recently arranged for migration of the older Html format to the WordPress format for ease of editing and adding information to the site. Her impact on the safflower community is evidenced by the fact that she was elected Chair of the International Safflower Germplasm Advisory Committee in 2010 and she had been serving in that post since. Recognizing Ms. Bradley's contribution, WRPIS and the PWA Area Office nominated, and the Organization of Professional Employees of the U.S. Department of Agriculture (OPEDA) awarded, Ms. Bradley with the 2010 Unsung Hero award. She is truly a hero and deserved this prestigious award! Ms. Bradley had been very active in the NPGS community and served in various capacities in the Plant Germplasm Operations Committee and participated actively in many meetings and workshops. She had been serving with the USDA-ARS Pullman location EEO and Outreach Committee and was involved in organizing annual events. These included recruitments of USDA-ARS volunteers to serve as the judges at the Jefferson Elementary School Science Fair in Pullman, WA and arranging the Veterans Day Celebration Potluck for USDA-ARS-Pullman location. Ms. Bradley also led in organizing numerous Unit events such as farewell and seasonal parties. The WRPIS will miss her greatly.

2. Cool Season Food Legumes Program

Curator: Clarice J. Coyne (full-time)

Technician: Britton Bourland (full-time)

Post-Doctoral Scientist: Yu Ma (Supported by grants from the USA Dry Pea and Lentil Council and the Northern Pulse Growers Association)

- A. This program manages the germplasm of all cool season food legumes including pea, chickpea, lentil, faba bean, *Lathyrus* and numerous legume species with usage other than food. We grew 1,104 accessions for regeneration of low quantity or low germination or for security backup (**Figures 9 and 10**). Included were 100 accessions of wild *Cicer reticulatum*, crossable to cultivated chickpea, newly collected and donated from Turkey. Trait data for 12,908 observations was collected on each accession under regeneration and additional descriptor data of 21,400 observations was taken on accessions in 4,134 plots in replicated evaluation experiments.



Figure 9. WRPIS chickpea regenerations. Upper: Technician Mr. Britton Bourland with chickpea regenerations at the Central Ferry Farm; Lower: Wild chickpea PI 510656 (*Cicer reticulatum*) growing in hydroponics, a good option for accessions donated with few seed.



Figure 10. Hand transplanting lupine regeneration plots at the Pullman Farm on May 2, 2019.

- B. Notable was the participation in an international (U.S., Canada, Morocco, Spain, Italy, India, Bangladesh) Genome Canada project “AGILE” of phenotyping a collection of 324 accessions (3 reps) genotyped using a lentil exome capture assay. 2018 saw the completion of this 3-year project.
- C. Root rots are an increasing problem in lentil production. Post-doctoral researcher Dr. Ma has identified W6 lentil genetic resources and QTL associated with good levels of partial resistance to *Aphanomyces* root rot (*Aphanomyces euteiches*) using the W6 lentil core collection and genome-wide association study approach (**Figure 11**). The SNP markers identified will be converted to breeder-friendly assays for use in marker-assisted selection.



Figure 11. *Aphanomyces* Root Rot Resistance in Lentil project. Left: Post-doctoral researcher Dr. Ma is collecting root rot index data; Right: Replicated experiment setting in the greenhouse.

- D. Chickpea production is increasing in acreage in the U.S. with expanding domestic and export markets. Coyne cooperated on a project determining multiple post-domestication origins of kabuli chickpea through allelic variation in a diversification-associated transcription factor for flower color. The research involved 322 accessions of wild and domesticated chickpea which were genotyped with 538 single nucleotide polymorphisms (SNPs) markers. The data indicate a genetic bottleneck in cultivated lines and points to potentially useful genetic variation discovered in wild species of chickpea.

3. Temperate-adapted Forage Legumes Program

Curator: Brian M. Irish (full-time)

Technician: Estella Cervantes (full-time)

WSU Farmer: Jesus 'Jesse' Prieto (full-time, but ½ on this project)

Research Intern: Sara Shellenberger (soft-funded by U.S. Alfalfa Farmer Initiative)

The Temperate-adapted Forage Legume (TFL) genetic resources program is an important component of the PGITRU in Pullman, WA and operates at the USDA-ARS worksite in Prosser, WA. The project focuses on acquiring, maintaining, characterizing, evaluating and distributing alfalfa, clover, trefoil and their wild relative germplasm accessions as well as database-maintaining all associated documentation.

- A. During the 2018 CY, the TFL initiated a U.S. Alfalfa Farmer Initiative (USAFRI) funded project entitled “Spring black stem and Stemphylium leaf spot resistance screening in the USDA-ARS National Plant Germplasm System’s *Medicago* spp. genetic resources”. Spring black stem (SBS) and Stemphylium leaf spot, caused by *Phoma medicaginis* and *Stemphylium* spp., respectively, are important alfalfa foliar fungal plant pathogens for which good disease resistance is not available in commercial cultivars (**Figure 12**). The project aims to 1) optimize inoculation protocols for fungal species causing SBS and SLS diseases of alfalfa; 2) systematically screen through alfalfa germplasm for disease resistance to SBS and SLS; 3) define host range for SBS and SLS diseases in subsets of representative *Medicago* spp. taxa; 4) Evaluate Standard Check variety and inventories for reaction to SBS and SLS diseases; and 5) make data, and associated information, publicly available through presentations, publications and through the USDA-ARS National Plant Germplasm System’s GRIN-Global database. A WSU Research Intern position was hired and is being supported by this grant.

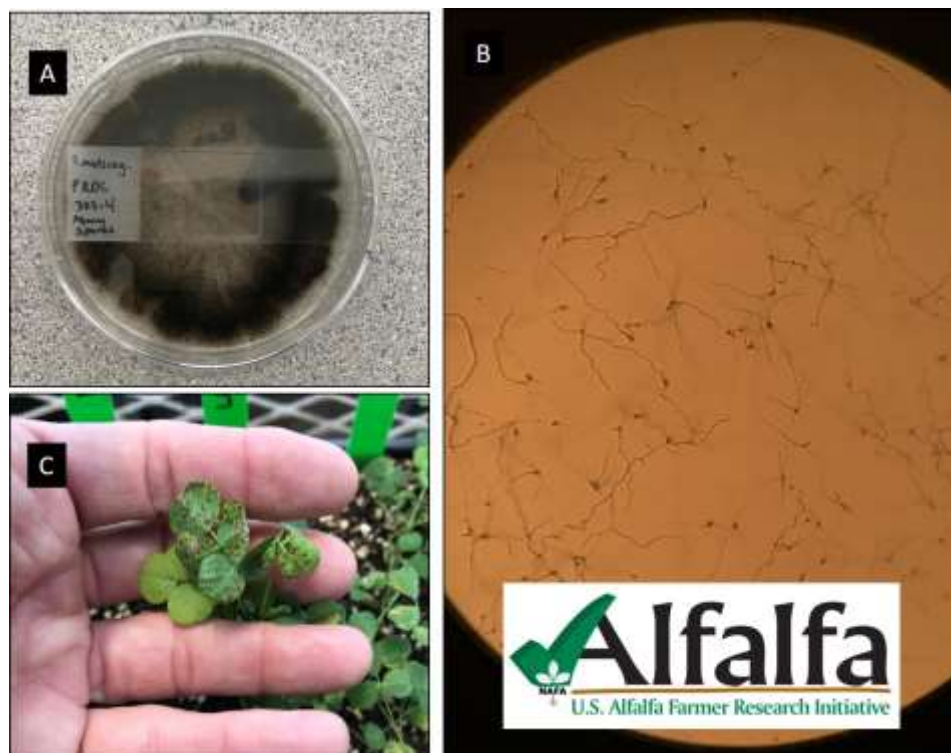


Figure 12. Spring black stem, caused by *Phoma medicaginis*, is an important disease of alfalfa during cool wet spring conditions for which disease resistance is not available in commercial cultivars. A) black mycelium and conidia of the fungus in culture; B) germinating conidial spore suspension under a microscope field of view; and C) Inoculated plants ready to be scored for their disease reaction.

- B. For the 2018 growing season a total of 169 accessions were planted for regeneration including 73 *Medicago* species, 76 *Trifolium* species and 20 *Lotus* species and 14 sentinel alfalfa plots for adventitious presence transgene detection. In the fall of 2017, 54 accessions were established for overwintering with an additional 66 accessions established in the spring of 2018. Due to low seed recovery from the prior year regenerations efforts, 19 - 2016 fall-established accessions and 30169 - 2017 spring-established accessions were carried over for a second-year increase. Phenotypic traits for many of the accessions regenerated during the year were collected and captured by scanning and generating voucher images for flowers, pods and seed.
- C. For the 2018 calendar year a total of 7,688 alfalfa, clover, trefoil and their crop wild relative accessions were distributed in 146 orders to 164 cooperators. Just over 14% of the order requests, and subsequent shipments, were from/to international cooperators.
- D. All threshed, cleaned and chalcid-free seed from 2017 increases was submitted to Seed Storage Manager to be included in the Pullman cold storage and made available for distribution late in the calendar year. An average of close to 151 grams of seed per accession/plot was achieved for seed cleaned for the 2017 growing season (vs. 300 grams/plot for 2016). All passport and associated information as well as germinations to determine baseline viability (75 accessions tested) and voucher images (391) were

provided to technical personnel for loading into the Germplasm Resource Information Network (GRIN) Global database.

- E. In 2018, efforts began to systematically characterize an annual medic (*Medicago* spp.) genetic resources collection originating from the Crimean Peninsula of Ukraine. The collection consists of close to 100 accession in ten different taxa. These accessions, along with another group of close to 100 reference accessions in the same taxa from the WRPIS existing collections, were field established from greenhouse transplants. The plants in the field were used to characterize individual accessions for phenotypic diversity using a set of over 20 individual IPGRI-generated descriptors. Data is being summarized from the first year and it appears a second-year planting will be needed to finalize collecting all descriptors. Prior to field establishment, DNA was extracted for all Crimean and reference accessions and will be used to genotype accessions. Comparisons between field generated phenotypic information with genotypic data will aid in determining gaps or redundancies in genetic diversity coverage as well as refine taxonomic relationships in accessions.
- F. The threat of gene-flow for the genetically engineered glyphosate herbicide resistance trait in alfalfa to the field regeneration site continues to be high and is only expected to increase as a second genetically engineered trait in alfalfa has been deregulated (low-lignin) and commercial transgenic alfalfa plantings in the area continue to increase. To monitor this potential gene-flow a total of 14 sentinel plots were included in the regeneration field in 2018. These plots are located on each of the regeneration field corners as well as centrally and are of the 'Vernal' alfalfa variety. In 2018, sentinel plots were both covered and uncovered, to assess the potential gene-flow to the field site (uncovered) and into the cages (covered). All sentinel plots are regenerated using standard regeneration protocols. Seed harvested from these plots is destructively sampled/tested for adventitious presence of glyphosate resistance at the end of the season. In addition, conventional commercial alfalfa seed lots being used to establish new hay fields on the WSU experimental farms are also being tested to establish baseline adventitious presence levels and avoid any high-level transgene contaminated seed lots. From the seven covered 'Vernal' alfalfa variety sentinel plots around regeneration fields which were tested in 2018, more than 25,000 seed were tested, and no AP was detected. Five out of four out of the seven uncovered plots showed positive results in testing, indicating gene-flow to the regeneration site. These efforts relate to the continued monitoring for adventitious presence of transgenes in the germplasm being regenerated at the Prosser, WA worksite.

4. Horticulture Crops Program

Curator: Barbara Hellier (full-time)

Technicians: Marie Pavelka (full-time); Alex Cornwell (full-time)

The *Beta* and Horticulture Crops Program is responsible for 12,869 accessions in four maintenance groups – *Beta* (Sugarbeet, table beet, chard and leaf beet, fodder beet, and wild *Beta* and *Patellifolia* species), *Allium* (garlic, leeks, chives and all wild *Allium*), Lettuce (cultivated

lettuce and wild *Lactuca* and related genera) and miscellaneous (minor forage legumes, industrial crops, ornamentals, medicinal and culinary herbs, rhubarb, and restoration and revegetation species).

- A. In 2018 the program focused on regeneration and collection maintenance activities. We maintained the clonal collections of garlic and rhubarb, both a working collection for distribution and back-up plantings. Maintenance of the *Allium sativum* collection includes harvesting, cleaning, distributing, and replanting the collection yearly. For rhubarb, maintenance involves digging plants, washing roots/crowns, processing pieces for distribution and replanting to have appropriately aged material for the following year's requests. In 2018, we distributed 431 packets of garlic in 23 orders and 60 crown pieces in 9 orders for rhubarb.
- B. In addition to the clonal collections, we regenerated 70 accessions of *Lactuca sativa* and continued to work with the NPGS station in Parlier, CA to regenerate 8 crisphead type lettuce accessions. We established regeneration plots of 65 annual/perennial/biennial accessions of *Achillea*, *Amorpha*, *Anthyllis*, *Artemisia*, *Astragalus*, *Beta*, *Geum*, *Grindelia*, *Lomelosia*, *Nigella*, *Papaver*, *Patellifolia*, *Onobrychis*, *Salvia*, *Scabiosa*, *Scorpiurus*, *Thermopsis* and *Thymus* and harvested seed from 100 accessions established previously. We provided seed yield and 100 seed weights for harvested seed and collected plot, plant and inflorescence images, herbarium samples and descriptor data on regeneration plots. We also tested 275 inventories of *Beta* for viability.
- C. We were awarded evaluation funding from the sugarbeet CGC to screen *Beta* accessions for resistance to seven diseases and insect pests – *Cercospora* leaf spot, rhizomania, *Rhizoctonia* root rot, Curly top virus, sugarbeet cyst nematode, sugarbeet root aphid, and sugarbeet root maggot. Six collaborators with established screening nurseries or programs from across the U.S. performed the evaluations.
- D. We finished two small trials looking at improving regeneration methods for leek and garlic. For leek, we tested overwintering techniques using wind barriers and frost covers. With changing weather patterns, we found that providing overwintering protection with medium weight frost covers ensured the best survival of our *Allium ampeloprasum* accessions. We also tested the impacts of planting garlic into heavy sudangrass stubble; sudangrass is one of the cover crops planted on our farms. We found that planting the diversity of our garlic collection into heavy sudangrass stubble did not adversely impact survival or bulb size. We did not look at fungal or nematode pathogen loads which should be done in the future.

5. *Phaseolus* Bean Program

Curator: Ted Kisha (full-time)

Technician: Dawn Tachell (full-time)

The *Phaseolus* Beans Program manages a collection of 17,878 accessions consisting of 57 taxa, all belonging to the *Phaseolus* genus.

- A. We analyzed protein and extractable phenolics and non-extractable proanthocyanidins within NPGS accessions of red and black bean market classes. Black bean extractable phenolics ranged from 200- 1000 mg/100g, while the range in red beans was 300- 1200 mg/100g. Non-extractable proanthocyanidins in black beans showed a range of 250- 2500 mg/100g, and red beans ranged from 500- 2000 mg/100g. Analysis of these important nutritional compounds will continue for other market classes.
- B. Pesticide use in the greenhouse was having deleterious effects on some accessions and the spider mites were very damaging and difficult to control. We continued and enhanced the Integrated Pest Management Program using black lady bugs, green lacewing larvae, and predatory nematodes to control greenhouse pests such as spider mites, aphids and thrips in the past two years. Now the plants, especially those of the *Phaseolus coccineus*, which appeared to be easily damaged, are looking much healthier.
- C. The biocontrol agents include some spider mite destroyers (*Stethorus punctillum*), spider mite predators (*Phytoseiulus persimilis*, *Neoseiulus californicus*, *Mesoseiulus longipes*), green lacewing eggs (*Chrysopa rufilabris*), "Double Death" nematode predators (*Steinernema carpocapsae* and *Heterorhabditis heliothedis*). We irrigate in the nematodes shortly after planting and put out the green lacewing eggs one time (one tag of 100 eggs) in each row about one month after planting. We have extended the green lacewings use to Greenhouse #44 and the Central Ferry research farm.

MISSION-RELATED RESEARCH PROGRAMS

A. Alfalfa Genetics Research Program

Research Geneticist Long-Xi Yu (full-time)

Technicians: Martha Rivera (full-time); Vice-Boge (vacant since April 2017)

Post-Doctoral Associate (Supported by grants from USDA-NIFA AFRP program and a collaboration project with Alforex Seeds and New Mexico State University): Charles Hawkins who left in October 2018 and the search for a qualified individual has not succeeded and is continuing.

Our alfalfa genetics research focuses on enhancing resistance to biotic and abiotic stresses in alfalfa, including developing molecular markers and germplasm for breeding alfalfa varieties with improved resistance to these stressors.

- A. Verticillium wilt (VW) of alfalfa is a devastating disease and causes serious forage yield reductions in the northern United States and Canada. To understand the genetic base of VW resistance in alfalfa, in the present study, we used a full-sib F1 population segregating for VW resistance by crossing two parents, 55V50-58 × 55V50-118 resistant and susceptible to VW, respectively. The population was phenotyped after inoculating a mixture of VW strains to the seedlings and scored for disease resistance in the F1 progeny. The same population was genotyped by genotyping by sequencing (GBS). Single-dose alleles (SDAs) derived from GBS markers were used for genetic mapping. High density linkage maps were constructed, and 32 linkage groups were obtained for each parent. Least square means of the disease resistance scores from three replicates were used for mapping quantitative trait loci (QTL) associated with VW resistance. Five

QTL were identified, and they were in 4 linkage groups. The QTL (qVW-8C) located on LG 8C contributed a major effect while the additional QTL showed minor effects. The result agrees with previous genome-wide association studies where VW resistance loci also identified on the similar chromosome locations. Candidate genes associated with disease resistance were identified. They include NBS-LRR disease resistance gene and a multidrug resistance ABC-transporter. With further investigation, these markers can be used for selecting alfalfa lines with resistance to Verticillium wilt.

- B. Enhancing drought/salt resistance and water use efficiency of alfalfa is important to meet the challenges of finite available water resource. Many agricultural lands in the western United States consist of soil with high concentrations of salt, which is detrimental to alfalfa (*Medicago sativa* L.) growth and production, especially in the region where water resource is limited. Developing alfalfa varieties with salt tolerance is imperative for sustainable production under increasing soil salinity. In the present study, we used advanced alfalfa breeding populations and evaluated five traits related to salt tolerance including biomass dry weight (DW) and fresh weight (FW), plant height (PH), leaf relative water content (RWC), and stomatal conductance (SC) under control and salt stress (**Figure 13**). Stress susceptibility index (SSI) of each trait and single-nucleotide polymorphism (SNP) markers generated by genotyping-by-sequencing (GBS) were used for genome-wide association studies (GWAS) to identify loci associated with salt tolerance. A total of 53 significant SNPs associated with salt tolerance were identified and they were located at 49 loci through eight chromosomes. A Basic Local Alignment Search Tool (BLAST) search of the regions surrounding the SNPs revealed 21 putative candidate genes associated with salt tolerance. The genetic architecture for traits related to salt tolerance characterized in this report could help in understanding the genetic mechanism by which salt stress affects plant growth and production in alfalfa. The markers and candidate genes identified in the present study would be useful for marker-assisted selection (MAS) in breeding salt-tolerant alfalfa after validation of the markers.



Figure 13. Field trial for salt tolerance of alfalfa accessions and breeding lines at the WSU Othello, WA research farm. Individuals with resistance or susceptible to high salinity are shown.

B. Pulse Genetics Research Program

Research Geneticist: Jinguo Hu

Technician: Lisa Taylor (full-time)

The Pulse Genetics Research Program conducts laboratory and field research with the objective of identifying, enhancing and developing desirable germplasm lines with enhanced productivity and end-use quality of faba bean (*Vicia faba* L.) and other pulse crops to meet the need of the export-driven, expanding U.S. pulse industry.

- A. When attending the 7th International Food Legume Research Conference in Morocco in May 2018, Dr. Jinguo Hu met Dr. Zain El Abidine Fatemi, a Moroccan public faba bean breeder and initiated a discussion on collecting faba bean landraces from Morocco to fill the gaps in NPGS collection. Morocco is known to be an important center of diversity for faba bean since many landraces have been developed to adapt the diverse geographical, agroecological and climatic conditions in the past. Currently the landraces are being used for about 90% of the faba bean production area in Morocco. These landraces display a wide range of variability for agronomic traits. They agreed that it is a good time to collect this rich genetic resource and add it to the national plant germplasm system for current and future generations of plant breeders to improve this crop towards global food security. Morocco is one of the a few countries that are still open to U.S. scientists to collect plant germplasm. The proposal was funded by the USDA Plant Exchange Office and the plant exploration trip was planned in June 2019. Due to the critical vacancy of the Program Support Assistant position in the unit, Dr. Hu's travel for this planned collection trip could not be arranged in time. We are working on an alternative way to collect the Morocco faba bean landraces.
- B. The winter hardy faba bean germplasm developed at WRPIS has been distributed to various states for pulse and cover crop trial in 2018. Dr. Reza Keshavarz, agronomy research scientist at Western Colorado Research Center used several WRPIS faba bean lines for a new project funded by Colorado Specialty Crop Block Grant with the aim to evaluate production potential of grain legumes in Colorado. **Figure 14** shows the flowering plant that were planted in October 2018. The picture was taken on April 29, 2019. Reza said that there was no winter kill last winter.
- C. Supported by a grant from the USA Dry Pea and Lentil Council, we collaborated with Dr. Girish Ganjyal, WSU Food Science Department, to develop and validate of near-infrared spectroscopy calibrations to measure whole seed quality characteristics (**Figure 15**). A graduate student, Ms. Yujing Zhu, who is pursuing a mater degree in Food Science has completed the wet lab analytic work of the content of six nutritional components (crude protein, total starch, crude fat, moisture, ash, and total fiber content) of 124 pea accessions in the Ganjyal lab. A total of 340 spectra from 220 pea germplasm accessions and breeding lines provided by Dr. Coyne of WRPIS and Dr. Rebecca McGee of the USDA-ARS Grain Legume Genetics and Physiology Research Unit were generated. A predictive model is being developed and validated for a rapid, non-destructive, low-cost,

environmentally-friendly, and accurate method for predicting the nutrient content from the NIR spectra pattern of pea seed samples for use in improving nutrition of pea through breeding.



Figure 14. Flowering fall-planted faba bean plants in western Colorado. The seeds were provided by Dr. Hu at WRPIS and planted October 2018. Photos by Reza Keshavarz on April 29 (left) and May 30 (right), 2019.

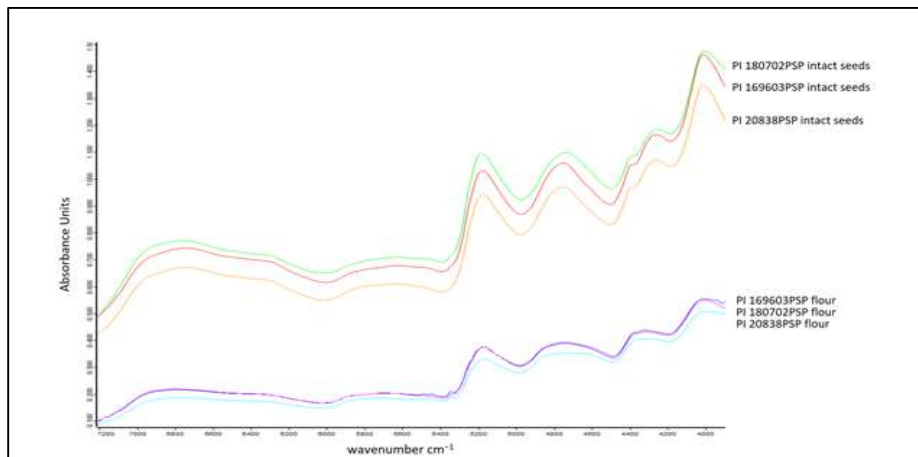


Figure 15. Typical NIR spectra patterns obtained from intact seeds and flour samples for three pea germplasm accessions.

- D. We published results from a research project aimed at answering questions about pre-acclimation temperature and its influences on freezing tolerance of faba bean. It was found that seedlings grown under a controlled “warm” 17/12°C (day/night) pre-

acclimation environment were initially less freezing tolerant than those grown under a “cold” 12/5°C temperature treatment. It was also found that stem and particularly root tissues were primarily responsible for slower cold acclimation, and that there was a genotype-specific response of above-ground tissues to the pre-acclimation treatment. We suggest that when screening faba bean genotypes for freezing tolerance, researchers should consider testing both above and belowground tissues across a range of relevant field-based pre-acclimation temperatures.

C. Plant Pathology Research Program

Research Plant Pathologist: Frank Dugan (retired/vacant)

Technician: Shari Lupien (full-time)

Doctoral Student: Gretchen Freed (graduated in December 2018)

The Plant Pathology Research Program encompasses all aspects of plant pathology pertinent to plant species (native and introduced) in the National Plant Germplasm System (NPGS), with emphasis on diseases and symbioses of fungal etiology pertinent to germplasm at WRPIS.

- A. Camas (*Camassia* sp.) bulbs retain profound cultural value as an important food resource and article of commerce that were utilized for millennia by over 60 indigenous groups across western North America. Investigations of fungal communities associated with camas plant tissues, seeds, and associated soils will enhance our understanding of wetland ecology. Ms. Gretchen Freed assessed both below- and aboveground fungal communities associated with camas plants growing in six biogeographically distinct wetland habitats in the Pacific Northwest (PNW) located in OR, ID, and WA using high-throughput technology in sequencing the fungal ITS (Internal transcribed spacer). Operational taxonomic units (OTUs) affiliated with at least 200 fungal families were found in root, tunic, leaf, rhizosphere, and proximal soil samples (n = 2,984 OTUs) and significant variation in fungal community composition was explained by sample type, habitat of origin, and their interaction. This study provides a baseline understanding into the composition and diversity of fungal communities associated with camas growing in wetland habitats in the PNW.
- B. In collaboration with USDA-ARS Northwest Irrigation and Soils Research Laboratory (WISRL) in Kimberly, ID, Dr. Dugan compiled a catalog of all species names in *Penicillium* for fungi responsible for blue mold in bulbs, roots and tubers; some names can be used with much greater confidence than others. Results are now published (2019, Mycotaxon).

Dr. Frank Dugan, Research Plant Pathologist in the PGITRU, Western Regional Plant Introduction Station (WRPIS), Pullman, Washington, retired on September 29, 2018 after 31 years with USDA. Twenty-one of these years were with the Agricultural Research Service, 10 years with the Forest Service, and an additional five years were working as a Collection Scientist, for the American Type Culture Collection (ATCC), in Rockville, MD and Manassas, VA. During his career Frank contributed greatly to the taxonomy of plant pathogenic fungi and the etiology of diseases by applying integrated traditional morphotaxonomy, histology and contemporary molecular-genetic methods to effectively test novel taxonomic and etiological hypotheses. He demonstrated that a transiently produced fungal synanamorph was

phylogenetically diagnostic, and that teleomorphs could abort to directly produce anamorphs. He designed a unique system of dual in planta inoculations to reveal distinct morphological differences between closely related fungi, and he modified published techniques for nitrate-nonutilizing (nit) mutants to further demonstrate lack of conspecificity. He documented that both commercial and non-commercial seed garlic constitute a consistent source of pathogens of *Allium*, discovered the first sources of resistant germplasm, and documented differences in host range for several fungi previously considered a single species. He pioneered use of the trap plants in climate-controlled wind tunnels to quantify biological control of a plant pathogen in post-harvest debris. With collaborators, Dr. Dugan completely revised the conventional wisdom on species and host range of powdery mildews of cool season legumes in the PNW. His multidisciplinary syntheses (archaeobotany, paleolinguistics, paleoclimatology, molecular genetics) enabled novel, well-supported inferences on history and social impacts of crop and fungal germplasm. His recent accomplishments include a series of publications on blue mold distinguished host ranges of multiple, closely-related *Penicillium* species on multiple edible or ornamental bulb hosts, with instances of resistance identified and relative virulence of disease agents quantified; a new species of *Alternaria* was isolated and described from oat-grass; and a first report for North America was issued for a species of dodder on chickpea. Competitive abilities of the *Ascochyta* blight fungus relative to other fungi were shown to be a function of a key metabolite; a novel pathogenic *Fusarium* was isolated from *Hibiscus* and a new pathogen of stored sugar beet roots was described and named as *Penicillium cellarum* sp. nov., together with demonstrating its pathogenicity and environmental preferences. Dr. Dugan has published over 140 peer-reviewed research papers and book chapters, contributed numerous entries to encyclopedias including the McGraw-Hill Encyclopedia of Science and Technology and authored four books (including three "best sellers") for the American Phytopathological Society (APS) Press. His monographs and reviews on historical and anthropological impacts and utilization of fungi are in all major agricultural libraries worldwide.

Dr. Dugan has been very active in serving the research communities. He was invited to serve on numerous committees, panels and/or offices. He served as a member of the National Science Foundation (NSF) Advisory Committee for the International Collection of Arbuscular & Vesicular-Arbuscular Mycorrhizal Fungi (INVAM), West Virginia University, Morgantown, WV, August 1998, review of collection holdings, procedures, documentation and service to stakeholders; he chaired Mycology and Germplasm Committees in both Mycological Society of America and APS; he was invited to review proposals and made recommendations for Plant Sciences Institute, USDA-ARS; Washington State Agricultural Research Center, WSU; Cool Season Food Legume Crop Germplasm Committee; and, U.S. Civilian Research & Development Foundation. Since joining WRPIS in 1999, Dr. Dugan has reviewed numerous manuscripts for Canadian Journal of Botany, Canadian Journal of Plant Pathology, Crop Protection, Phytoparasitica, Mycologia, Mycological Research, Mycotaxon, Phytopathology, European Journal of Plant Pathology, Journal of Applied Microbiology, Letters in Applied Microbiology, Mycology Progress, Plant Disease, etc. He also has served on editorial boards of North American Fungi since 2004 and on the Editorial Board for APS Press since 2011.

A native of Montana, Dr. Dugan received a B.S. in 1970 from University of Washington, majoring in Biological Oceanography. After working for the U.S. Forest Service, Lolo National Forest, Missoula, MT for several years, he began graduate studies in Forestry at the University of

Montana, earning an M.S. in 1988. He continued his graduate study at WSU and completed his Ph.D. in Plant Pathology in 1992. Before beginning work at WRPIS in 1999, Frank worked as a Research Associate, USDA-ARS Tree Fruit Research Lab, in Wenatchee, WA for two years and as a Collection Scientist, ATCC, Rockville, MD and Manassas, VA for five years. Dr. Dugan plans to remain in the beautiful Palouse area, maintain his involvement with research on fungal plant pathogens and being active interacting with faculty members of the Plant Pathology Department of both WSU and University of Idaho for which Dr. Dugan has held adjunct faculty appointments for many years.

Committees, Presentations and Other Services

During 2018 WRPIS Scientists and Curators served as committee members or chairs of the respective national Crop Germplasm Committees (CGC) and other academic or social organizations. Research Plant Pathologist **Frank Dugan** is adjunct faculty with WSU Department of Plant Pathology, and with the College of Natural Resources, University of Idaho. He is a member of the American Phytopathological Society (APS), finished his 6-year term as Senior Editor on the APS Press Editorial Board, is a member of the APS Mycology Committee, the APS Collections and Germplasm Committee, and Mycological Society of America. He served on advisory committees for the newly established WSU Plant Clinic and the Montana State University Pulse Crops Diagnostic Laboratory, is on a graduate committee for one Ph.D. student at University of Idaho and chaired the graduate committee for one Ph.D. student in WSU Department of Plant Pathology. In 2018, he was a reviewer for Economic Botany, Plant Disease, Archives of Phytopathology and Plant Protection, and Mycologia. Research Geneticist **Long-Xi Yu** is adjunct faculty with WSU Department of Crop and Soil Sciences. He serves as member of The Association of Official Seed Certifying Agencies (AOSCA) National Alfalfa and Miscellaneous Legumes Variety Review Board and member of the editorial board of Journal of Plant Biology and Soil Health and the AIMS Agriculture Journal. Supervisory Research Geneticist and Research Leader **Jinguo Hu** serves as an Associate Editor for the Crop Journal (Elsevier). He is also on the Editorial Board of *Acta Agronomica Sinica* (a monthly journal published by the Crop Science Society of China). He is an Adjunct Professor of the Department of Crop and Soil Sciences, WSU. He serves as a member in the Plant Germplasm Operations Committee and in various Crop Germplasm Committees (CGC) including the Root and Bulb CGC, the Leafy Vegetable CGC, the Sugarbeet CGC, the Food Legume CGC and the Pea CGC. He co-organized and chaired the Plant Molecular Breeding Workshop at the 26th International Plant and Animal Genome Conference in San Diego, CA. The Agronomy and Native Plants Curator and now retired **Vicki Bradley** was the Chair of the International Safflower Germplasm Advisory Committee, an *ex officio* member of the Forage and Turf Grass CGC, the New Crops CGC, and the Medicinal Plants CGC. She was also an Adjunct scientist with the Department of Crop and Soil Science at WSU. Ms. Bradley was a member of the Plant Germplasm Operations Committee, serving on the *in situ* and the Crop Wild Relatives subcommittees. She was a member of the USDA-ARS Pullman Location EEO and Outreach Committee, and was the editor for the Safflower Genetic Resources Homepage. Cool Season Food Legumes Curator **Clarice Coyne** is an Adjunct faculty in the Departments of Horticulture and Crop and Soil Sciences and a member of the Graduate School faculty. She serves as advisor for one M.S. graduate student and is served on one Ph.D. and two M.S. graduate student committees at WSU. She co-supervised two post-doctoral research associate at WSU and is serving *ex officio* on three CGCs including *Pisum*, Food Legume, and Clover and Special Purpose Legumes. Dr. Coyne serves on the Scientific Advisory Board for INRA project in Dijon, France. Coyne is a member of American Association for the Advancement of Science, American Society of Agronomy, Crop Science Society of America (CSSA), North American Pulse Improvement Association. Serving on Crop Science Editorial Board, CSSA Technical Editor, Div. C-1, C-8. She has served as peer-reviewer for the journals: Crop Science, Molecular Breeding, BMC Genomics, Czech Journal of Genetics and Plant Breeding and Theoretical and Applied Genetics. Temperate-adapted Forage Legume Curator **Brian Irish** is an *ex officio* member of the Alfalfa CGC, and the Clover and Special Purpose Legume CGC. Brian Adjunct Faculty member in WSU Crop and

Soils Sciences. He reviewed for several journals in 2018 including Crop Protection, Plant Disease, and HortScience. Brian is the chair elect for PGOC and serve on several PGOC committees. Horticulture Crops Curator **Barbara Hellier** is an *ex officio* member of the Root and Bulb, Leafy Vegetable, New Crops, Sugarbeet, Clover and Special Purpose Legume, Medicinal and Aromatic Oil and Herbaceous Ornamental Crop Germplasm Committees. She is also a member of the PGOC Medicinals and *in situ* Subcommittees. She is a member of the American Society for Horticultural Science (ASHS) and a member of the American Society of Sugarbeet Technologists. *Phaseolus* Curator **Theodore Kisha** continued his service as a member and chair of the Genetics and Germplasm Professional Interest Group of the ASHS and a member of the "Center for Research on Invasive Species and Small Populations (CRISSP)" at the University of Idaho. As chair of the ASHS, he coordinated a workshop on germplasm databases, including an introduction to the new GRIN-Global database for U.S. and international ASHS members. Every year, Dr. Kisha mentors a graduating high school intern through the U.S. Department of Education Upward Bound program of Washington.

During the year, WRPIS scientists and curators were actively engaged in conducting mission-related research and in serving the scientific community. They made a total of 21 oral or poster presentations at either scientific or general public meetings, contributed two book chapters, and published 15 peer reviewed scientific journal articles in 2018. They were invited to review research manuscripts by editors of the following scientific journals: BMC Genomics, Canadian Journal of Plant Science, Crop and Pasture Science, Crop Journal, Crop Protection, Crop Science, Ecological Restoration, Economic Botany, Euphytica, European Journal of Plant Pathology, Genome, Industrial Oil Crops, Journal of Food Composition and Analysis, Journal of Phytopathology, Journal of Plant Registrations, Journal of Sugar Beet Research, HortScience, Molecular Breeding, Mycologia, Mycotaxon, Phytopathology, *Pisum* Genetics, Plant Breeding, Plant Disease, Plant Genetic Resources, Plant Journal, Plant Pathology, Studies in Mycology and Theoretical and Applied Genetics.

Scientific Papers Published in 2018

Peer reviewed journal articles (15):

- Beharav, A., Hellier, B., Richardson, K.L., Lebeda, A. and Kisha, T., 2018. Genetic relationships and structured diversity of *Lactuca georgica* germplasm from Armenia and the Russian Federation among other members of *Lactuca* L., subsection *Lactuca* L., assessed by TRAP markers. *Genetic Resources and Crop Evolution*, 65(7), pp.1963-1978.
- Dohle S, Berny Mier y Teran JC, Egan A, Kisha T, and Khoury CK (2018). “Wild beans (*Phaseolus* L.) of North America”. In: Greene SL, Williams KA, Khoury CK, Kantar MB, and Marek LF, eds., *North American Crop Wild Relatives, Volume 2: Important Species*. Springer, 770 pp.
- Dugan, F., Landry, E. and Hu, J., 2018. Ascochyta blight of faba bean. *WSU Extension Bulletin*, pp.1-4.
- Dugan, F.M., and C.A. Strausbaugh. 2019. Catalog of *Penicillium* spp. causing blue mold of bulbs, roots, and tubers. *Mycotaxon* 134: 197-213.
- Dugan, F.M., S.L. Lupien, and B.C. Hellier. 2019. Infection by *Fusarium proliferatum* in aerial garlic bulbils is strongly reduced compared to rates in seed cloves when both originate from infected bulbs. *Crop Protection* 116:43-48.
- Garcia, R.O. L.I. Rivera-Vargas, R. Ploetz, J.C. Correll and B.M. Irish. 2018. Characterization of *Fusarium* spp. isolates recovered from bananas (*Musa* spp.) affected by Fusarium wilt in Puerto Rico. Doi: 10.1007/s10658-018-1503-y
- Hawkins, C. and Yu, L.X., 2018. Recent progress in alfalfa (*Medicago sativa* L.) genomics and genomic selection. *The Crop Journal*, 6(6), pp.565-575.
<https://doi.org/10.1016/j.cj.2018.01.006>.
- Hellier, B.C. 2018. Practical considerations for increasing seed samples of wild species. In: Greene S.L., Williams K.A., Khoury C.K., Kantar M.B., and Marek L.F., eds., *North American Crop Wild Relatives, Volume 1* (pp. 281-309). Springer, Cham.
- Landry, E.J. and Hu, J., 2019. Increasing pre-acclimation temperature reduces the freezing tolerance of winter-type faba bean (*Vicia faba* L.). *Journal of Agronomy and Crop Science*, 205(1), pp.46-53.
- Liu, X.P., Hawkins, C., Peel, M.D. and Yu, L.X., 2019. Genetic loci associated with salt tolerance in advanced breeding populations of tetraploid alfalfa using genome-wide association studies. *The Plant Genome*, 12(1). doi:10.3835/plantgenome2018.05.0026.
- Mugabe, D., Coyne, C.J., Piaskowski, J., Zheng, P., Ma, Y., Landry, E., McGee, R., Main, D., Vandemark, G., Zhang, H. and Abbo, S., 2019. Quantitative trait loci for cold tolerance in chickpea. *Crop Science*. In press.
- Strausbaugh, C.A., Hellier, B.C. 2018. Beet curly top resistance in USDA-ARS plant introduction lines, 2017. *Plant Disease Management Reports*. 12:CF001.

- Strausbaugh, C.A., Hellier, B.C. 2018. Rhizomania and storage rot resistance in USDA-ARS plant introduction lines evaluated in Idaho, 2017. Plant Disease Management Reports. 12:CF155.
- Trněný O., J. Brus, I. Hradilová, A. Rathore, R. Das, P. Kopecký, C. Coyne, P. Reeves, C. Richards, P. Smýkal. 2018. Molecular evidence for two domestication events in the pea crop. Genes 9:535. doi:10.3390/genes9110535.
- van-Oss R.P., A. G.Z. Kerem, A. Sherman, H. Zhang, G. Vandemark G, C.J. Coyne, O. Reany, S. Abbo. 2018. The relationship between seed free tryptophan and vernalization response in chickpea. Plant Breeding 137:290-300.

Appendix 1

Western Regional Plant Introduction Station Current Staffing List as of December 31, 2018

Position	Name	Federal or State	Position type
Pullman			
Research Leader/Station Coordinator	Jinguo Hu	Fed	PFT
Program Support Assistant	Vacant	Fed	PFT
IT Specialist	Bo Gao	Fed	PFT
Biological Science Technician	Lisa Taylor	Fed	PFT
Seed Storage/Database Manager	Vacant	Fed	PFT
Plant Technician	Jacqueline Cruver	State	PFT
Plant Technician	Julianna Gothard	State	PFT
Farm Manager, Pullman	Charles Golob	State	PFT
Plant Technician	Saber Jewell	State	PFT
Plant Technician	Julie Christian	State	PFT
Farm Manager, Central Ferry	Kurt Tetrick	Fed	PFT
Plant Technician	Jennifer Morris	Fed	TFT
Research Plant Pathologist	Vacant	Fed	PFT
Biological Science Technician	Shari Lupien	Fed	PFT
Agronomy and Safflower Curator	Vacant	Fed	PFT
Biological Science Technician	Jessy McGowan	Fed	TFT
Plant Biologist	Michael Cashman	Fed	TFT
Biological Science Technician	Bob Guenther	Fed	PFT
Cool Season Food Legumes Curator	Clarice Coyne	Fed	PFT
Biological Science Technician	Britton Bourland	Fed	PFT
Horticultural Crops Curator	Barbara Hellier	Fed	PFT
Biological Science Technician	William Luna	Fed	PFT
Biological Science Technician	Alex Cornwall	Fed	TFT
Biological Science Technician	Marie Pavelka	Fed	PFT
Phaseolus Beans Curator	Theodore Kisha	Fed	PFT
Biological Science Technician	Dawn Tachell	Fed	PFT

Prosser

Temperate-adapted Forage Legume				
Curator	Brian Irish	Fed	PFT	
Biological Science				
Technician	Estela Cervantes	Fed	PFT	
Farm Tech 2	Jesus Prieto	State	TPT	
Research Geneticist	Long-Xi Yu	Fed	PFT	
Biological Science				
Technician	Vacant	Fed	PFT	
Biological Science				
Technician	Martha Rivera	Fed	PFT	

Appendix 2

Research, Service and Outreach Activities

- January 12-15: Long-Xi Yu participated and gave presentation on “Genomic Architecture and Phenotypic Plasticity of Forage Quality in Response to Water Deficit in Alfalfa (*Medicago sativa* L.)” at the 2018 International Plant and Animal Genome Conference (PAG XXVIII), San Diego, CA
- January 14-18: Clarice Coyne co-organized a workshop Genomics of Genebanks and presented research on “KASP assays for powdery mildew resistance breeding in pea” at the 2018 International Plant and Animal Genome Conference (PAG XXVIII), San Diego, CA
- January 14-18: Jinguo Hu co-organized the Plant Molecular Breeding Workshop at the 2018 International Plant and Animal Genome Conference (PAG XXVIII), San Diego, CA
- January 17-18: Brian Irish participated in the Washington State Hay Growers Association Meeting held in Kennewick, WA
- January 24-25: Brian Irish hosted Dr. Mark Smith of S&W Seed company (alfalfa) for site visit
- January 27-30: Brian Irish participated and presented posters at the Western Seed Growers Association Meeting held in San Antonio, TX
- January 30/February 1: Ted Kisha gave a tour of greenhouse facilities and seed storage to the WSU class members of HORT 202
- January 30/February 1: Barbara Hellier provided tours of Seed Storage to 4 sections WSU Hort 202 lab.
- January 5: Ted Kisha participated as a graduate committee member with the thesis defense of M.S. Graduate student Danielle Guzman from the Department of Horticultural Science.
- February 14-16: Jinguo Hu attended the 9th Organic Seed Growers Conference and met stakeholders in the organic farming community.
- February 19-20: Clarice Coyne attended and presented at the Pulse Crop Working Group meeting and USAPLC Research Review, Bozeman, MT.
- February 21-March 1: Brian Irish traveled to Liberia, Costa Rica to aid in characterizing cotton germplasm with a team of USDA-ARS NPGS scientist from College Station, TX.
- February 22: Barbara Hellier provided information on cold tolerant lettuce accessions to a stakeholder.
- February 23: Barbara Hellier provided *Papaver orientale* leaf tissue for pigment flavonoid analysis to a stakeholder.
- March 7-8: Jinguo Hu participated an USDA-ARS RPES panel meeting and visited the NPO in Beltsville, MD.

March 27-29: Jinguo Hu attended the California Leafy Greens Research Annual Meeting visited the garlic germplasm and faba bean breeding line plots at USDA-ARS Parlier, CA and visit collaborator on faba bean research at Lundberg Family Farms.

April 13: Barbara Hellier provided locality data on Beta species collected in Northern California to a stake holder.

April 19: Barbara Hellier attended an USDA-ARS-Sugarbeet Research webinar.

April 24-26: Clarice Coyne attended a NIFA-sponsored workshop on “Strategies for Training the Next Generation of U.S. Plant Genebank Managers” at the National Center for Plant and Animal Genetic Resource Preservation, Fort Collins, CO.

April 29-May 10: Ted Kisha hosted a visiting scientist and legume curator from the Smithsonian Institution.

May 24: Barbara Hellier attended an USDA-ARS-Sugarbeet Research webinar.

May 6-8: Clarice Coyne presented plenary talk “Harvesting Legume Genomes: Plant Genetic Resources” at the 7th International Food Legume Research Conference, Marrakech, Morocco.

May 6-8: Jinguo Hu presented a talk entitled “Enhancing faba bean (*Vicia faba* L.) germplasm for resilience to temperature extremes” at the 7th International Food Legume Research Conference, Marrakech, Morocco.

May 9-11: Clarice Coyne presented invited talk “Genetic diversity and test GWAS of an ICARDA lentil (*Lens culinaris* Medik.) reference plus collection using genotyping by sequencing (GBS)” at the 4th American Moroccan Agricultural Sciences Conference, Meknes, Morocco.

May 9-11: Jinguo Hu presented a talk entitled “Enhancing faba bean (*Vicia faba* L.) germplasm for increased resilience to temperature extremes and improved nutrition quality” at the 4th American Moroccan Agricultural Sciences Conference, Meknes, Morocco.

June 3: Clarice Coyne participated in the Agronomy Society of America, Crop Science Society of America, American Public Gardens Association conference planning workshop, “Celebrating Crop Diversity” at the University of California, Riverside Botanic Garden, Riverside, CA.

June 4-6: Charles Hawkins participated and presented oral presentation on Genomic selection in alfalfa at The North American Alfalfa Improvement Conference. Logan, Utah.

June 4-6: Long-Xi Yu participated and presented oral presentation on “Developing Molecular Markers for Enhancing Resistance to Drought and High Salinity in Alfalfa” and “Developing Functional Markers for Verticillium Wilt Resistance in Alfalfa” at The North American Alfalfa Improvement Conference. Logan, UT.

June 4-6: Brian Irish helped organize and host the Alfalfa Crop Germplasm Committee meeting during the 2018 North American Alfalfa Improvement Conference in Logan, UT

June 4-6: Brian Irish and National Program Leader, Dr. Peter Bretting, gave a joint presentation on the NPGS and forage genetic resources of the WRPIS to the audience of the North American Alfalfa Improvement Conference in Logan, UT

June 13: Clarice Coyne hosted field tour of the cool season food legume regeneration and research project for Thomas Stefaniak, North Dakota State University food legume breeder, Pullman, WA.

June 18-June 22: Barbara Hellier attended the Plant Germplasm Operations Committee meeting, Washington D.C.

June 19-21: Clarice Coyne participated in the USDA Plant Germplasm Operating Committee's annual meeting/curator workshop and presented a volunteered talk "Variant Call Format: Handling SNP Data", Beltsville, MD.

June 19-21: Brian Irish participated and provided and update presentation on the Seeds of Success program at the Plant Germplasm Operations Committee meeting in Washington DC (Vice-Chair)

June 20: Barbara Hellier presented a talk on the cost and details of producing an outreach video the NPGS- PGO meeting.

June 25: Ted Kisha attended the W-6 Meeting via internet.

June 25-26: Jinguo Hu, Brian Irish and Dave Stout attended the W6 Technical Advisory Committee in Corvallis, OR.

July 1-31: Ted Kisha hosted a summer intern with the Washington Upward Bound Program.

July 9: Barbara Hellier attended Narrative Training by Randy Olson.

July 12: Brian Irish hosted a DNA barcoding of Temperate-adapted forage legume germplasm webinar with project collaborators (8 participants)

July 29-August 4: Barbara Hellier attended the American Society of Horticultural Science annual conference, Washington DC.

July 30-Aug 3: Ted Kisha attended the annual conference of the American Society for Horticultural Science at the Sheraton, Washington DC. He served as the Chair of the Genetics and Germplasm (GG) Professional Interest Group, moderated the session on Genetics and Germplasm, and presented "Examination of Extractable Phenolics and Non-extractable Proanthocyanidins from a Selection of "Red" and "Black" Market Class Accessions of Beans (*Phaseolus vulgaris*) from the National Plant Germplasm System. He organized and chaired the workshop Using the GRIN-Global Database as a Research and Breeding Tool.

July 30-August 3: Jinguo Hu attended the American Society of Horticultural Science annual conference, Washington DC and the Herbaceous Ornamental CGC meeting.

July 30: Barbara Hellier attended the Herbaceous Ornamental CGC meeting and presented a collection status report.

July 30-31: Clarice Coyne hosted Professor Shahal Abbo, Hebrew University of Jerusalem, Faculty of Agriculture, Food & Environment, Revohot, Israel for field tour, group meeting, faculty meetings and seminar, Pullman, WA.

August 22: Ted Kisha toured the greenhouse and seed storage with Faith Price, Director of WSU Native American Programs and Tony Brave, the Native American Outreach Coordinator.

August 16-24: Brian Irish, traveled and served on a hiring committee for the USDA-ARS Pacific Basin Area Research Center's Curator/Horticulturist position, Hilo, HI (four interviews).

August 23: Barbara Hellier presented an overview of the NPGS Sugarbeet collection at the USDA-ARS-Sugarbeet Research webinar.

September 12-20: Ted Kisha collected seed and plant material from populations of *Phaseolus polystachios*, the North American Wild Kidney Bean from Kentucky and Tennessee.

September 15-22: Long-Xi Yu visited Qinghai Academy of Agricultural and Forestry Sciences and gave presentation on "Developing functional markers for disease resistance in alfalfa and wheat". Xining, China.

September 22-28: Long-Xi Yu visited North West Agricultural University and gave presentation on "Genomics-Assisted Breeding for Enhancing Resistance to Biotic and Abiotic Stresses in Autotetraploid Alfalfa". Yanglin, China.

September 23: Barbara Hellier attended the New Crops CGC meeting via phone and presented a collection status report.

October 26: Ted Kisha led a tour of the greenhouse and seed storage for the EXCEL camp, bringing around 20 Native American High School juniors and seniors for a visit to the USDA at WSU.

October 5-December 31: Clarice Coyne hosted visiting scholar, Naser Rasheed, from University of Agriculture, Faisalabad, Pakistan.

November 11-14: Long-Xi Yu presented a poster on "Identification of Genetic Loci Associated with Resistance to Drought and High Salinity in Alfalfa Using Genome-Wide Sequencing and Association Studies" at the 2nd World Alfalfa Congress. Córdoba, Argentina.

November 11-14: Brian Irish presented a poster entitled "Managing the USDA-ARS National Plant Germplasm System's temperate-adapted forage legume genetic resources' at the 2nd World Alfalfa Congress in Cordoba, Argentina

November 4-7: Clarice Coyne attended and presented posters "Towards developing a resource for genomic selection in chickpea" and "Association mapping of yield and other agronomic traits in the USDA lentil core collection" at the ASA, CSSA Annual Meeting, Baltimore, MD.

December 12: Ted Kisha attended the meeting of the Western Pulse Growers Association in Moscow, Idaho. Ted presented a poster "The Nuña Bean (The Peruvian "Popping" Bean) as a nutritious Niche Crop with Added Value.

December 12: Clarice Coyne attended the annual meeting of the Western Pulse Growers Association, Moscow, ID.

December 11: Barbara Hellier attended the Root and Bulb CGC meeting via ZOOM and presented a collection status report.

December 5: Jinguo Hu and Barbara Hellier hosted visiting scientist Haiping Wang of the Institute of Vegetables and Flowers, Chinese Academy of Agricultural Sciences, Beijing, China. We discussed garlic germplasm evaluation, toured seed storage, garlic storage, the Pullman farm, and WSU labs.

Appendix 3

Meeting Minutes of the W-6 Technical Committee Meeting (pending approval)

Date: Monday, June 25, 2018

Location: Conference Room at the National Clonal Germplasm Repository, Corvallis, OR

Officers:

Chair – Carol Miles

Vice Chair – Ian Ray (call in)

Secretary – Joe Kuhl

2018 W6 TAC participants:

In person (Conference Room at the National Clonal Germplasm Repository, Corvallis, OR):

Carol Miles, Washington State University, Mount Vernon, WA, email: milesc@wsu.edu;

Joseph Kuhl, University of Idaho, Moscow, ID, Email: jkuhl@uidaho.edu;

Scot Hulbert, Washington State University, Pullman, WA, email: scot_hulbert@wsu.edu;

Jinguo Hu, USDA-ARS WRPIS, Pullman, WA, email: jinguo.hu@ars.usda.gov;

Dave Stout, USDA-ARS WRPIS, Pullman, WA, email: Dave.Stout@ars.usda.gov;

Brian Irish, USDA-ARS WRPIS, Pullman, WA, email: Brian.irish@ars.usda.gov;

Joseph Postman, USDA-ARS NCGR, Corvallis, OR, email: Joseph.Postman@ars.usda.gov;

Kevin Jensen, USDA-ARS FRR, UT, email: Kevin.Jensen@ars.usda.gov;

Pat Byrne, Colorado State University, email: Patrick.byrne@colostate.edu;

Ali Missaoui, University of Georgia, email: cssamm@uag.edu;

Dan Parfitt, University of California, Davis, CA, email: fzparfit@plantsciences.ucdavis.edu;

Gary Kinard, USDA-ARS NGRL, Beltsville, MD, email: Gary.Kinard@ars.usda.gov;

Melinda Yerka, University of Nevada Reno, Reno, NV, email: myerka@unl.edu;

Kim Hummer, USDA-ARS NCGR, Corvallis, OR, email: Kim.Hummer@ars.usda.gov;

Called In:

Ian Ray, New Mexico State University, Las Cruces, NM, email: iaray@nmsu.edu;

Peter Bretting, National Program Leader, email: Peter.Bretting@ars.usda.gov;

Ann-Marie Thro, National Program Leader, email: athro@nifa.usda.gov;

Harold Bockelman, USDA-ARS NSGC, Aberdeen, ID, email:

Harold.Bockelman@ars.usda.gov;

John Preece, USDA-ARS NCGR, Davis, CA, and USDA-ARS NALPGR, Parlier, CA, email: John.Preece@ars.usda.gov;

Roger Chetelat, University of California - Davis, Davis, CA, email: trchetelat@ucdavis.edu;

Stephanie Greene, USDA-ARS NLGRP, Ft. Collins, CO, email:

Stephanie.Greene@ars.usda.gov;

Tracie Matsumoto, USDA-ARS TPGRDR, Hilo, HI, email: tracie.matsumoto@ars.usda.gov;

Marylou Polek, USDA-ARS NCGRCD, Riverside, CA, email:

Marylou.Polek@ars.usda.gov;

Michael Giroux, Montana State University, Bozeman, MT, email: mgiroux@montana.edu;

Opening remarks:

The meeting was called to order by Chair Carol Miles at 8:35am. There were brief opening remarks regarding agenda and procedure.

2017 Minutes were introduced, moved and seconded to approved without changes, unanimously approved.

Resolutions committee was discussed: Kim Hummer and Dan Parfitt agreed to co-chair. Brian Irish possible member?

Administrative Advisor report (Scot Hulbert):

Dr. Scott Hulbert is replacing Dr. Jim Moyer, and is serving on five multi-state meetings. W6 5-year plan was renewed in 2016. Five-year plan reviews were very good. TAC reports need to emphasize impacts, in particular economic/commercial impacts, use bullets and keep short. The proposed FY 2019 budget of \$446,257 looks appropriate. It was noted that in the proposed budget, USDA-ARS appropriations, were flat year to year, while MRF funding increased 2.3% annually. Kevin Jensen moved with Dan Parfitt second to approve the FY 2019 budget. Motion passed.

It was also noted that no money was included to move alfalfa germplasm production from Prosser to Central Ferry, which is estimated to cost ~\$3 million. The idea was that by moving alfalfa germplasm grow-out from Prosser to Central Ferry, the grow-out would not be exposed to potential pollen drift from GE alfalfa, which is widespread around the Prosser site. There are approximately 4-5,000 accessions could be contaminated with genetically engineered transgenes. After much discussion it was evident that since commercial alfalfa fields are within 5 miles of Central Ferry it might not be a satisfactory solution. Brian Irish commented that currently guidelines are in place and are being followed for seed production using isolation protocols (insect-proof cages).

Significant costs are associated with managing genetically engineered crops within germplasm management groups, and the private sector needs to recognize this issue, especially as it related to the federal germplasm program. A report on GE and Organic crops was presented to secretary of agriculture Tom Vilsack. It was noted that for the private sector GE represents a public relations issue, while for public germplasm groups it was a matter of integrity. The American Seed Trade Association (ASTA) might be willing to speak up on behalf of germplasm users. Collections that might be contaminated with GE transgenes might include: alfalfa, cotton, and sugar beet. Within USDA this contamination is referred to as Adventitious Presence (AP). It was noted that unless one or more stakeholders voice concern about this issue it is unlikely to attract much attention. It was suggested that a resolution could be created to address this issue.

Additional comments were made regarding W6 budget related issues.

Due to an airport expansion W6 will loss 28.5 acres. State and Federal authorities are working to resolve the loss of acres, however new land may cost ~\$100/acre, ~\$3,000 increase to budget. Some land being discussed is too steep for the desired use. W6 will also need to adapt to moving equipment longer distances than they have in the past. Farm managers are working on solutions to moving farm equipment around.

Short break.

ARS National Program Office report (Peter Bretting):

Dr. Bretting presented PowerPoint slides summarizing the status, prospects and challenges facing the National Plant Germplasm System in 2018. Successes include state/federal partnerships. The number of accessions has gradually increased over the last 10 years. Germplasm distribution has remained relatively constant over the last 10 years, around 250,000 accessions disturbed annually. The USDA-ARS National Plant Germplasm System budget peaked in 2012 and has been flat since 2014. Staff retirements are projected at 30% over the next five years. Retirement include John Wiersema (USDA-ARS-Beltsville), Dave Stout (USDA-ARS-Pullman), and Jack Peters (USDA-ARS-Corvallis). New hires include Ben Gutierrez (USDA-ARS-Geneva). With the recent hiring freeze lifted, additional staff are expected to be hired in the near future. Currently, no formal, comprehensive program exists for training new Plant Genetic Resource (PGR) managers. Gayle Volk and Pat Byrne secured a USDA/NIFA planning grant for a workshop in Fort Collins in April 2018 to discuss designing and developing a training program. The workshop generated numerous insights and another grant (Higher Education Challenge) has already been submitted to extend concepts and ideas from the workshop.

National Program leader Plant Systems-Production NIFA update (Ann-Marie Thro):

Dr. Thro presented PowerPoint slides summarizing management and utilization of plant genetic resources and associated information. In her talk, Dr. Thro highlighted two types of funds: Capacity funds and Competitive funds. Within Competitive funds Dr. Thro mentioned that a new AFRI program with a separate RFA will be released October 10, 2018 called Sustainable Agricultural Systems (SAS). This new program seeks large projects for correspondingly large grants. She noted that it is very difficult to find competitive funding for maintenance and distribution of plant germplasm.

Business meeting, NPGS Station Reports:

National Small Grains Collection, Aberdeen, ID (Harold Bockelman):

The National Small Grains Collection (NSGC) presently holds 146,225 accessions of the small grains (wheat, barley, oat, rye, triticale, rice, and related wild species). This number includes more than 10,000 accessions of mapping populations with GSHO (Genetic Stock – *Hordeum*) and GSTR (Genetic Stock – *Triticum*) numbers, which will not be maintained for perpetuity. NSGC distributed 36,868 accession samples in 727 separate requests in the past 12 months. Approximately 30% of the distributions were to foreign scientists. NSGC provided back-up samples to NLGRP totaling 470 accessions. Almost 99% of NSGC accessions have been backed-up. NSGC has prepared a total of 12,400 samples to be sent to Svalbard in the next shipment. More than 60,000 accessions will then be backed-up at Svalbard.

NSGC is continuing efforts to capture voucher images of spikes, panicles, and seeds. The images and characterization data provides valuable information to both the germplasm user and for NSGC curation. The “Accession-Inventory Attach” function was completed in GRIN-Global in late 2017. Since that time more than 36,800 images have been added.

Evaluations of NSGC wheat landrace accessions are continuing for reaction to the Ug99 stem rust race in Kenya. We continue to coordinate the assembly of the Stem Rust Nursery in Kenya in cooperation with the Kenya Agricultural & Livestock Research Organization, CIMMYT, and wheat and barley breeders in public and private programs throughout the U.S. The latest shipment in May included more than 3,800 entries from U.S. public and private breeders and researchers. An Agronomist position has been vacant since January, 2017.

National Germplasm Resources Laboratory, Beltsville, MD (Gary Kinard):

The Plant Exchange Office (PEO) supports the collection of germplasm for the NPGS through the management of a Plant Exploration and Exchange Program. Guidelines for developing plant exploration and exchange proposals will be distributed to CGC chairs in January 2018. Proposals must be endorsed by the appropriate CGC or other crop experts. The deadline for submitting proposals for explorations or exchanges to be conducted in FY 2019 is July 20, 2018.

Collaboration on Crop Wild Relatives in the U.S.:

In 2016, USDA-ARS and the U.S. Forest Service established a new agreement to foster collaboration on conservation of crop wild relatives on U.S. National Forests. A pilot project on complementary (*in situ* and *ex situ*) conservation of CWR of the genetic resources of wild cranberry (*Vaccinium macrocarpon* and *V. oxycoccos*) in National Forests is underway. In 2017, leaves and germplasm of *V. oxycoccos* were collected from wild populations in National Forests in Oregon and Washington. Germplasm was sent to the National Clonal Germplasm Repository in Corvallis, Oregon. Leaf samples were sent to the USDA-ARS Vegetable Crops Research Unit at the University of Wisconsin for genetic analysis. This analysis and other factors will be used to determine which sites should be designated as *in situ* reserves.

Discovery and Documentation of Historical Plant Introductions:

A project to identify historical plant introductions (PIs) that are not in the NPGS continues. In 2017, 35 historical PIs were located at the former Cheyenne (Wyoming) Horticultural Station. The information on the PIs was distributed to curators for their input on the need to acquire samples of the germplasm.

GRIN Taxonomy for Plants:

Since 2008, a project to provide thorough coverage of wild relatives of all major and minor crops in GRIN-Taxonomy has been underway. We have completed our initial work on 190 major and minor crops from 111 genera, and an interface to query these data in various ways will be available as part of the first 2018 update of the GRIN-Global public website (test version at <https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysearchcwr.aspx>).

Facilitation of Germplasm Exchange:

The PEO helps expedite the distribution of germplasm from the NPGS to foreign scientists and other international genebanks through a long-standing collaboration with USDA-APHIS at

Building 580, BARC-East. In 2017, 640 public orders containing a total of 55,912 samples of NPGS accessions were shipped from Beltsville to individuals in 69 countries around the world for research and education. In addition, PEO facilitated the agricultural inspection of arriving germplasm shipments containing accessions from numerous foreign countries for researchers and curators at NPGS sites.

GRIN and GRIN-Global:

At the beginning of 2018, the GRIN-Global plant database included the following:

584,449 active accessions representing 15,720 species and 2,533 genera

3,023,069 inventory records

1,973,427 germination records

8,192,598 characteristic/evaluation records

410,476 digitized images

These numbers increase almost daily.

The U.S. NPGS made the transition from GRIN for plants to GRIN-Global on November 30, 2015. The GRIN-Global Development Team initiated improvements and enhancements to both the Curator Tool and Public Website, and corrected any bugs that were reported in 2017. Current information about the project, including user documentation and release notes from each version of the software, can be found on the project website at <https://www.grin-global.org/>.

National Clonal Germplasm Repository, Corvallis, OR (Joseph Postman):

Stakeholder/Service Accomplishments:

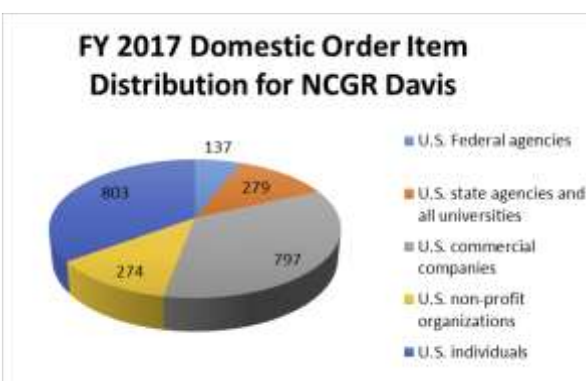
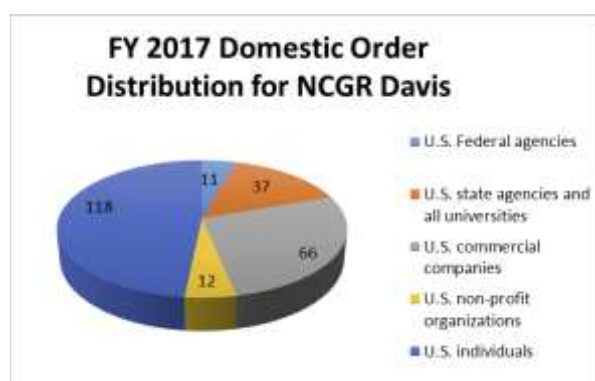
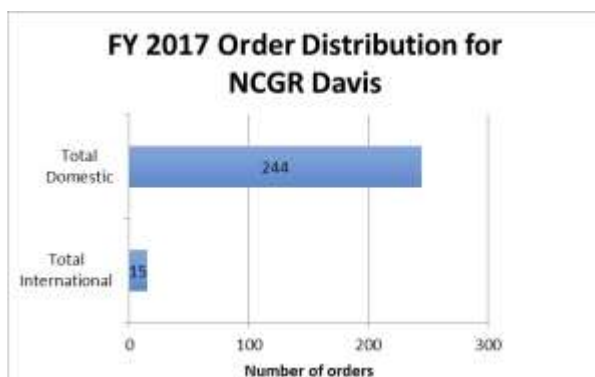
- 12,443 accessions, 73 genera and 774 taxa of 677 species of temperate fruit, nut, and specialty crops were conserved.
- Managed > 3,600 accessions of fruit tree and nut crops on 22 acres of orchard.
- Obtained a total of 80 new accessions and 290 new inventory items in CY 2017.
- Received 1,202 order requests and shipped 5,789 items.
- Collaborated with NLGRP, Ft. Collins, CO, on cryopreservation protocols of dormant blueberry, hazelnut, pear, currant and gooseberry.
- Collaborated with staff of NCGR-Davis to backup genetic resources of hazelnuts in Parlier, and butternuts and kiwifruit in Corvallis, Oregon.
- Trained visiting scientists from the Netherlands, China, and the U.S.
- Participated on Governing Board for USDA National Clean Plant Network.
- Participated as Science Editor of the ISHS Proceedings and Journals.
- Provided tissue culture assistance to hop breeders for a hop mutation breeding project.
- Collaborated with Forest Service scientists and USDA botanist and geneticist on *in situ* conservation of cranberry within National Forests of eastern US.
- Implemented dormant bud cryopreservation as one of several backup strategies for woody clonal germplasm accessions.
- Expanded potted greenhouse backup collections of *Pyrus* and *Cydonia* for accessions represented by a single tree and at risk of loss due to disease susceptibility, lack of hardiness or small tree size.

- Trained two high school student recruited through the Apprenticeship in Science and Engineering Program in field and molecular evaluation of blueberry, blackberry, red and black raspberry plants.
- Trained visiting graduate student in evaluating sequence variation possibly associated with powdery mildew resistance in red raspberry.
- Provided DNA testing expertise in blueberry to the Federal Bureau of Investigation to assist in solving a murder mystery.
- Enabled marker assisted seedling selection for black raspberry aphid resistance, perennial flowering in strawberry, and aromatics profile in the USDA-ARS, Corvallis, the University of Florida and University of New Hampshire small fruit breeding programs.

Research Accomplishments

- Determined and published on susceptibility/resistance to egg laying of spotted wing drosophila in fruit of *Vaccinium* species.
- Screened strawberry crop wild relatives for perennial blooming in screenhouses in Corvallis, Oregon, and published list of accessions with photoperiod-insensitive flowers.
- Determined phylogenetic relationships in *Rubus* species based on target enrichment DNA sequencing.
- Detected Black currant reversion virus infection in several black currant (*Ribes nigrum*) collection; worked with APHIS to develop a national response plan for this disease.
- Used chloroplast DNA sequence data to differentiate pear species groups, and to identify genetic relationships between pears and other related crops in collaboration with NLGRP, Fort Collins.
- Used interstem grafts to evaluate pear germplasm for dwarfing potential. Correlated pear mother tree architecture traits with dwarfing potential.
- Developed a high-density SNP array for large-scale genotyping of pear germplasm for marker assisted breeding and germplasm collection diversity analysis in collaboration with University California, Davis.
- Analyzed genetic diversity and population structure of American wild southeastern blueberry germplasm in the NCGR collection- Identified true-to-type Florida-4B using parentage analysis and provided evidence of its hybrid status (*V. darrowii* and *V. fuscatum*).
- Demonstrated the diagnostic potential of a current marker for *Phytophthora* crown rot in the University of Florida breeding program but not in other diverse germplasm preserved at the NCGR.
- Demonstrated the usefulness of a bioinformatics pipeline in identifying subgenomes of the octoploid strawberry.
- Discovered a potentially novel gene for black spot resistance in rose.
- Identified *Vaccinium* germplasm that is slow to become infected with, and potentially resistant to Blueberry shock virus.

National Clonal Germplasm Repository, Davis, CA (John Preece):



New Acquisitions:

In recent years, explorations were conducted in the Caucasus and Central Asian centers of diversity to fill gaps, especially in crop wild relatives. This new germplasm is clearing quarantine and will add significant diversity annually for the next five years and beyond. During the past year, 32 new *Prunus* accessions were received from APHIS. These include 10 species collected from 6 countries.

C.M. Rick Tomato Genetics Resource Center, Davis, CA (Roger Chetelat):

Acquisitions. The TGRC acquired 444 new accessions this year, including a large set of backcross inbred lines (BILs) from *S. pennellii* LA0716 in cv. M82, as well as an accession of *S. pennellii* used for genome sequencing, and an introgression line with a segment of *S. lycopersoides* chromosome 12. Obsolete or redundant accessions were dropped. The current total of number of accessions maintained by the TGRC is 4,360.

Maintenance and Evaluation. A total of 1,576 cultures were grown for various purposes, of which 974 were for seed increase, including 53 wild species accessions. Germination tests were run on 655 seed lots. Progeny tests were performed on 89 stocks of male-steriles, trisomics, and other segregating lines or accessions with unexpected phenotypes. 175 stocks were grown for introgression of the *S. sitiens* genome. Other stocks were grown for research on interspecific reproductive barriers. All plants grown for seed regeneration were tested twice for PSTVd; no positive plants were found. Newly regenerated seed lots were split, with one sample stored at 5° C to use for filling seed requests, the other stored in sealed pouches at -18° C to better maintain long term seed viability. For backup storage, 93 seed samples were sent to the USDA-NLGRP and 26 samples were sent to the Svalbard Global Seed Vault.

Distribution and Utilization. A total of 5,978 seed samples representing 2,241 different accessions were distributed in response to 330 requests from 275 researchers and breeders in 31 countries; at least 17 purely informational requests were also answered. The overall utilization rate (i.e. the number of samples distributed relative to the number of accessions available) was 137%. Information provided by recipients indicates our stocks continue to be used to support a wide variety of research and breeding projects. Our annual literature search uncovered 115 publications that mention use of our stocks.

Documentation. On our website we added a ‘comments’ page to facilitate user feedback, and we removed most contact information on users to protect their privacy. Additional images of mutants and wild species were uploaded. Passport data on new accessions was added. Seed request records and passport information on seed samples submitted for off-site back up were provided to the USDA- NLGRP for uploading to their GRIN-Global database.

Research. The TGRC continued research on the mechanisms of interspecific reproductive barriers and on introgression of the *S. sitiens* genome. We published a paper on natural variation for pollen incompatibility genes in *S. arcanum*, *S. chmielewskii*, and *S. neorickii*. We further advanced a set of breeding lines representing the genome of *S. sitiens* in a cultivated tomato background. The goal of this project is to develop a set of ‘introgression lines’ – prebred stocks containing defined chromosome segments from the donor genome – that will provide the first breeder friendly germplasm resources for this wild species. We contributed to a paper reporting a second reference genome sequence for *S. pennellii*. We also participated in collaborative research to evaluate methods for creating doubled haploids by manipulation of centromere histone proteins.

Noon to 1:20pm, Working lunch

Special topic: Kimm Hummer presented “Doomsday vaults, clonal style”

Business meeting, NPGS Station Reports: continued

National Laboratory for Genetic Resource Preservation Ft Collins, CO (Stephanie Greene):

Plant and Animal Genetic Resources Preservation Unit

Plant Preservation Group- safety backup of plant and microbe collections (NPGS and other designated collections)

Clonal CNPGS collection backed up: 84% - seed; 18% - clonal

Plant Germplasm Preservation Research Unit

Developing state-of-art tools to improve gene bank management

Status of the Base Seed Collection:

150,000 base samples have at least one monitor test

2014-2017- focused on monitoring vulnerable base samples

- conducted 22,000 monitor tests

71%- viability changed (\pm) < 20 percentage points

23%- viability declined > 20 percentage points

- 2885 base samples (335 taxa) have declined more then 20% since initially tested.

- Yet to be assessed - decline of base samples with monitor tests prior to 2014 (128,000 samples)

Highlights 2018

Svalbard 10th Anniversary

Sent 13,000 accessions representing 280 taxa. 60% comprised of wheat, barley and soybeans. Our lab receives seed from NPGS active sites around the country, repackages and consolidates into a single shipment. This is the first time we are shipping our seed in plastic totes.

Tropical Plant Genetic Resources and Disease Research, Hilo, HI (Tracie Matsumoto):

The Tropical Fruit & Nut Germplasm Repository in Hilo, HI will start the recruitment process for a new Curator within the next few months.

At the Hilo repository, we maintain 13 designated clonal germplasm collections with 1200 accessions representing 61 genera and 145 species in 33 acres of fields, greenhouses and a tissue culture laboratory. Forty-five accessions of papaya and *Vasconcellea* have been regenerated (7000 gm seed) from Hilo, Paauilo and Lalamilo fields. Forty-eight accessions of guava seed were collected (1100 gm). In vitro back-up of breadfruit (20), *Vasconcellea* (11), pineapple (25), ginger (3) starfruit, litchi (2), macadamia (4), guava (3) and passiflora were initiated. Working closely with the USDA-ARS, germplasm repository in Miami we are continuing transfer of the avocado to Hilo through Fort Detrick with eighty-one accessions. Working closely with the USDA-ARS, germplasm repositories in Puerto Rico and Miami we are continuing transfer of the cacao germplasm with fifty-six accessions. Field trials of cacao are being established to evaluate select varieties. Observations have been collected for pineapple plant (9604), flower (2852) and fruit (3708), titratable acid (447), longan fruit (380), peach palm fruit (85), litchi fruit (5580), papaya fruit (450), breadfruit fruit (464), breadfruit plant (672), pilinut (1284), guava fruit (290), rambutan fruit (240), litchi & longan flower (462). GRIN-Global allows researchers to search characterization records, accession and history information available globally within NPGS system and cooperator's collections for specific traits. Entered 14 photos, 53 cooperator, 175 orders, 1661 order items, 66 accession, 127 inventory, 12 narrative, and 7536 observations records and updated 24 environments. 249 requests were filled with 1675 items. Different propagation methods are being explored for breadfruit and once established will be used to expand our collection from the accessions at the National Tropical Botanical Garden, Kahanu, Maui. Tissue cultured pineapple plants are being tested for pineapple mealybug wilt viruses in preparation of being sent to Fort Collins NLGRP for development of cryogenic storage, seeds from 8 papaya accessions have already been sent. Rejuvenation of guava, rambutan, and breadfruit plantings are substantially complete. Air-layers of older trees are field planted or potted for back-up. In addition, cacao, breadfruit, guava, macadamia, rambutan, litchi, longan, and starfruit are pruned for size control and to stimulate new growth. 1061 pineapples replanted. The *Vasconcellea* collection is rejuvenated, 12 accessions representing nine species was moved to different greenhouse to avoid infection by various viruses. Peach palm planting was thinned of 80 trees to stimulate new growth from the roots of the old tall trees.

We also continue to serve as a backup for the USDA-ARS germplasm repositories in Miami, Florida, and Mayaguez, Puerto Rico. This year, seven new accessions of avocado were introduced to Hilo from Miami, Florida, through Fort Detrick, Maryland, after scions were tested for both Avocado Sun Blotch Viroid and Laurel Wilt disease in Miami, Fort Detrick and Hilo. Avocado sunblotch viroid (ASBVd) and laurel wilt (*Raffaelea lauricola*) testing protocols have been established at Hilo repository. We hosted Barbara Freeman from the Miami laboratory to

show us how to conduct the assays and thus far all shipped material as well as existing avocation on the station is free of ASBVd.

National Arid Land Plant Genetic Resources Unit, Parlier, CA (John Preece)

Distributions from NALPGRU are in the form of seed, green cuttings/propagules, tissue or rooted plants depending on the crop and the nature of the request, and are filled and shipped year-round. The trend in distributions from NALPGRU is flat after a decrease due to a change in policy regarding distributions to home gardeners. In FY 2017, 80.5% of orders were sent to domestic co-operators, and these were splits equally between federal agencies, universities, and unaffiliated individuals.



Service Regenerations

A significant component of the NALPGRU mission is seed regenerations of accessions from other NPGS sites that require a long growing season and/or dry conditions. NALPGRU staff work closely with curators at the home sites to coordinate planting, data collection, and harvest. The following accessions were increased at Parlier during the 2017 season:

Site	Crop	# accessions harvested
W6	Allium	253
W6	Lactuca	3
W6	Vicia faba	1
NSGC	Triticum/Hordeum/Secale	1366
S9	Capsicum	36
S9	Vigna	43
S9	Citrullus	18
NC7	Helianthus	39
NC7	Cumin	1

Acquisitions

NALPGRU was approved for funding through the Plant Exploration Office and the New Crops CGC for a collection trip targeting *Parthenium* in southwest Texas. The trip is being planned for late summer 2018. Three new accessions of wild *Cucurbita foetidissima* were donated from an NPGS collection trip to Oklahoma.

Collection maintenance and propagation

The NALPGRU performs routine regenerations of their seed crops, and manages the rest as clonal accessions with periodic replanting. The backup *Corylus* block was removed in spring 2017 to allow space for a new, more comprehensive planting. The first 55 trees were planted in

the new block in summer 2017. The next set of trees has been propagated by Corvallis staff and is awaiting shipment to Parlier for planting.

Evaluation and Research

Grants focused on the collections at NALPGRU: USDA-NIFA, \$7 million “Sustainable Bioeconomy for Arid Regions (SBAR)” includes replicated field trials of NALPGRU *Parthenium* collection, 2017-2020; California State University Agricultural Research Institute, \$150,000 (evaluation of NALPGRU guayule accessions for drought, salt and boron tolerance, 2016-2018); CGC evaluation funding, \$30,000 (developing an in-vitro screen for rubber content in *Parthenium*, in collaboration with Colleen McMahan USDA-ARS Albany).

Temperate-adapted Forage Legume germplasm collection, Prosser, WA (Brian Irish)

- Personnel: A full-time Curator (Geneticist) is responsible for overall project implementation and for design of service and research activities. Project is also supported by a full-time USDA-ARS Biological Science Technician and one ½ time USDA/WSU Technician/Farmer as well part time Laborers throughout the year.
- Late 2017/early 2018 a ‘new’ Project Plan was developed and submitted for OSQR peer-review. This Project Plan is specific to the Temperate-adapted Forage Legume germplasm collection and outlines activities proposed for the next 5-year program cycle. Plan received a ‘minor revisions’ score and was certified on January 29, 2018. Project intends to focus resources on maintenance, documentation and distributions. As resources permit, possibilities exist to target germplasm for acquisition as well as several research objectives.
- As part of the newly drafted project plan, collaborations were set up with several scientists at Arizona State University Polytechnic (Dr. Steele – *Medicago* spp.) and Loyola University Chicago (Dr. Laten – *Trifolium* spp.) and the University of Puerto Rico (Dr. Siritunga – *Lotus* spp.) to correctly voucher species and to examine possible mislabeling and/or misidentification in TFL germplasm using DNA barcoding. Dr. Melanie Schori, USDA-ARS systematist, is also aiding this collaborative effort.
- During the 2017 summer regeneration period, alfalfa (*M. sativa* subsp. *sativa* ‘Vernal’) sentinel plots (½ covered and ½ uncovered) were established around germplasm regeneration field plots to monitor adventitious presence of genetically engineered (GE) glyphosate trait in alfalfa germplasm. Using a glyphosate-amended seedling germination assay and a seed grinding technique more than 140,000 seed was tested from 13 plots. No AP was detected from any covered (insect proof cage covers) sentinel plots, however AP was detected in five of the uncovered plots. AP detection in uncovered sentinel plots suggests transgenic gene flow to regeneration field site and extreme care must be taken to ensure timely placement of cage covers for alfalfa regenerations.
- Low seed number and low viability inventories continue to accumulate, especially for wild clover species and some accessions have been lost. These difficult to regenerate accessions are being targeted systematically for regeneration utilizing an in vitro germination procedure followed by clonal propagation in greenhouses. The idea is to increase the low number of plants germinating in the laboratory to the optimal (100) needed for field establishment. Personnel understands that genetic erosion might be occurring due to the less-than-ideal effective population size, but must do everything possible to avoid losing accessions.
- A recent systematic review of the *Lotus* genus has reclassified former native North American *Lotus* species into two new genera: *Acmispon* and *Hosackia*. Therefore, the TFL project

gained 19 *Acmispon* species with 63 accessions and 6 *Hosackia* species with 14 accessions. The number of *Lotus* species/accessions was adjusted correspondingly.

- Project coordinated the field planting and harvest (regeneration) of 184 *Medicago*, *Trifolium*, *Lotus* (*Acmispon*/*Hosackia*) germplasm accessions during the 2017 growing season. Additionally, 50 *Medicago*, *Trifolium* and *Lotus* species germplasm accessions were planted in the fall to be overwintered and regenerated CY 2018. The regeneration field site also included 10 sentinel plots and one faba bean (*Vicia faba*) accession.
- Project personnel were involved in the collection and scanning of 143 flower images for accessions being regenerated in 2017 as well as 173 seed and 109 pod voucher images for 2016 regenerated accessions. These images will be included in the GRIN-Global database and associated with corresponding accessions.
- During FY 2017 project coordinated the distribution of a total of 180 (1742) requests from 154 (142) cooperators (135 U.S./19 Int.). The number of unique accessions distributed was 3,222 (2,052) and total number of items distributed was 4,407 (3,243).
- Significant distributions during the FY were made to National and International requestors associated with Governmental, Private and Non-profit organizations. These genetic resources were used mostly in breeding and varietal development using traditional and genomic techniques, screening for disease resistance and abiotic stresses, screening for use as a cover crop, companion or in rotation, chemical analyses, phylogenetics, phytoremediation, class instruction and basic research (especially for model species - e.g., *M. truncatula*).

Western Regional Plant Introduction Station, Pullman, WA (Jinguo Hu):

2017 highlights:

- On December 31, 2017, there were 98,405 accessions belonging to 1,060 genera, 4,769 species (5,447 taxa) in the WRPIS collection.
- We acquired 1,499 new accessions including 1,384 native plant accessions collected by the Seeds of Success (SOS) project and 807 accessions from various sources.
- We distributed a total of 42,484 packets of seed samples to 1,060 requestors with addresses in each of the 50 domestic states and 46 foreign countries. Sixty percent (25,913 packets) were distributed to the U.S. and 40% (16,571 packets) were distributed to foreign countries. Requestors in each of the 50 domestic states received germplasm samples from WRPIS in the Year of 2017. A total of 9,682 packets from WRPIS went to the 13 Western states.
- We uploaded 17,006 observation data points on 3,515 accessions into the Germplasm Resources Information Network (GRIN)-Global database. These data points are on 97 established descriptors for 13 different crop species. Our collaborators contributed 7% and WRPIS staff provided 93% of the evaluation data. The database is accessible by researchers worldwide via the internet.
- We entered 2,314 seed viability records into GRIN-Global in 2017. The WRPIS tested 985, the National Laboratory for Genetic Resource Preservation (NLGRP), Fort Collins, CO tested 1,329 accessions.
- We packed and stored 1,772 newly regenerated/harvested inventories of a broad range of plant species. We determined seed quantities of 6,513 inventories.
- We shipped 1,573 seed inventories to the National Laboratory for Genetic Resource Preservation (NLGRP), Fort Collins, CO and 602 inventories to the Svalbard Global Seed Vault, Svalbard, Norway for secured backup.

- With the partial support by a germplasm evaluation grant from the NPGS Root & Bulb Crop Germplasm Committee, we demonstrated the potential for dramatically lowering *Fusarium proliferatum* infestation by planting bulbils instead of seed cloves for regeneration of garlic and reported the result at the American Phytopathological Society conference.
- We evaluated 100 faba bean accessions with replicated small plots under organic environment on the Lundberg Family Farms, Richvale, California with the support of a grant from the Food Legume Crop Germplasm Committee. Evaluation data, such as biomass, plant height, days to flower and seed yield, were collected and uploaded into our GRIN-Global database.
- Our genome-wide association study identified SNP markers that were significantly associated with Verticillium wilt (VW) resistance in two alfalfa populations, that were developed for mapping the disease resistance genes. Six significant markers on chromosome 8 explain 40% of the total phenotypic variation and represent novel loci associated with VW resistance. Candidate genes closely linked to the resistance loci were identified. These markers are useful for selecting alfalfa lines with improved VW resistance.
- In collaboration with USDA-ARS NWISRL, Kimberly ID, we described *Penicillium cellarum* sp. nov., a pathogen of stored sugar beet roots, together with demonstrating its pathogenicity and environmental preferences.

National Clonal Germplasm Repository for Citrus and Dates, Riverside, CA (MaryLou Polek):

- In CY 2017, 17 additional accessions were cryoprocessed in Riverside. However, due to the Hold Order placed on the repository when the HLB quarantine was implemented (see section on Distributions), these have not been sent to Ft Collins at the time of this writing. It is expected that they will be sent in June or July, 2018.
- NCGRCD acquired 3 new citrus accessions in CY 2017: Okitsu wase X Maltese ovale (RSD 2017002), *Micromelum minutum* (RSD 2017001), and TI (Rush) (RRUT 545). RSD 2017002 was a controlled pollination specifically intended for use at NLGRP and will not be maintained as an accession. RSD 2017001 did not establish. RRUT 545 was received as sanitized budwood from the Citrus Clonal Protection Program (CCPP).
- In CY 2017, NCGRCD completed sanitation of 17 accessions that were released from State and Federal quarantine in November of 2017.
- During the period 2016 – 2017, sixteen germplasm accessions were laboratory tested and indexed. Release is pending dsRNA analysis on 10 of the 16. Note: The dsRNA analysis has become difficult to carry out because the resin (CF-11) used in the classical protocol has been discontinued. Identification of an alternative or modification of the current dsRNA assay is in progress in collaboration with the Vidalakis lab.
- Seventeen accessions were tested in the laboratory in CY 2017 and are in the process of being biologically indexed. Pending tests for quarantine release include sPAGE, stubborn culture, and dsRNA. Both the proceeding and the following should be released in CY 2018.
- During CY 2017, a total of 7988 laboratory tests were performed in support of distributions, therapy items, CVC backup and SH CTV.
- Distribution of citrus germplasm was greatly reduced in CY 2017 due to phytosanitary restrictions implemented by USDA-APHIS and CDFA after HLB was detected approximately 3 miles from the UCR Agricultural Operations area in July. This resulted in the NCGRCD, CVC, and CCPP being within the 5-mile radius quarantine zone. Within 24

hours of confirmation, APHIS instilled a Hold Order on the repository. As a result, material from the SH cannot be distributed until sampled twice at 6-month intervals by a certified laboratory (specifically, the CDFA diagnostic laboratory).

- The quarantine and other associated regulations have also limited the types of seeds that can be moved domestically. USDA-APHIS formerly restricted all seeds of Aurantioideae. The restriction on *Citrus* spp and *Poncirus* spp was removed in 2017, but not restrictions on other types, including *Citrus* X *Poncirus* hybrids, the most common rootstocks. Interstate movement of pollen, leaves, and other germplasm is also restricted; but most of these can be moved if the appropriate permits are in place.
- In CY 2017, NCGRCD distributed 262 items to 99 requestors. All but 6 items were citrus or related taxa, the remaining 6 being date palm materials. In recent years there was a high number of requests for date palm accessions from scientists conducting genomic research. This project is nearing completion and therefore, the number of date palm distributions has decreased.
- CY 2017 Propagations: there were 283 total propagations made from 170 genotypes

Critical Issues

- The Crop Germplasm Committee needs to be made aware of critical issues threatening the future of the NCGRCD. These include:
- Budgetary shortfalls: The annual NCGRCD budget allotment has remained stagnant for the past several years while the cost of operations has significantly increased. In particular these include but are not limited to; increased lease assessment (\$2,250/yr), the new levy of municipal fees (\$20,000/yr), UC greenhouse bench rent (15% increase for 3 consecutive years), janitorial services (almost doubled in 2017).
- Laboratory equipment is aging and will be needing replacement soon; the cost of service agreements are unsustainable.
- Protective Screenhouse is almost at capacity; expansion is vital.
- Impact of HLB Quarantine
- Threat of palm weevils to the CVARS field collection
- Personnel Issues: the Unit lacks genetic, data management, and tissue culture expertise; anticipated retirements within the next 5 years, term (temporary) positions need to be converted to permanent.

Business meeting, State Reports:

TAC members summarized their written state reports.

California state report (Dan Parfitt)

624 requests for plant introductions from California users were filled by the NPGS in 2017, very similar to the 676 from last year, representing 341 different users, almost identical to the 342 from last year. The request level for this year was similar to last year.

Collection of germplasm information: The collection methodology was the same as used in the last few years. 320 queries were sent by e-mail. 1.3% of the e-mail addresses were not received, an even lower % than last year. This is an exceptionally low number, much less than in prior years. 45 recipients sent reports, for a 14 % response rate, almost identical to last year. Comments from the respondents are provided below.

The distributed germplasm was used for plant breeding research, testing in home gardens, and propagation of both clonal and seed propagated species. Several respondents used the germplasm for demonstration projects in school settings, though not as much as in prior years. Several researchers used materials as reference materials or checks in their experiments. Some germplasm was used as archeological reference material, similar to the last several years. Germination of the samples is not needed for this application. Much of the germplasm continues to be used for commercial breeding research (private, university or USDA) and examination of the distribution list suggests that this category is highly under-reported, especially from private companies. This is not surprising as these companies are competing with each other and are in the business to release proprietary intellectual property. There seems to be less interest to use the collections for molecular/biochemical studies. This is a continuing trend. Several members of the California Rare Fruit Growers requested materials for evaluation and distribution to their members as in past years.

Colorado state report (Patrick Byrne):

Orders for germplasm from the NPGS included delivery of accessions from both clonal repositories and Plant Introduction Stations. A total of 2,450 accessions were delivered in Colorado, constituting 123 orders. This represented an increase in shipments from the previous year (1,661 accessions and 96 orders in 2016), but is similar to the numbers for 2015 (2,312 accessions and 140 orders). Orders were shipped from the following locations in 2017: COR, DAV, GEN, HILO, NC7, NE 9, NR6, NSGC, NSSL, OPGC, S9, SOY, TGRC, and W6.

Idaho state report (Joe Kuhl):

In 2017, 3,024 accessions were requested in Idaho from the National Plant Germplasm System. The total number of accessions were down from 2016 and 2015 when 5,709 and 7,533 accessions were requested, respectively. A total of 83 orders were placed from Idaho in 2017, down from 107 orders in 2016, but similar to 73 orders in 2015. As observed in past years orders were fairly evenly divided among state, federal and private groups, 31, 20, and 32 orders, respectively. The major user groups (assessed by the number of accessions requested) in 2017 were USDA scientists (primarily based in Aberdeen, Idaho) accounting for 66% of total accessions, while state entities accounted for 25% of total accessions, together accounting for ~91% of the total accessions requested in Idaho. University researcher requests made up the vast majority of requests from state agencies. While the number of private orders placed in 2017, 32, were only slightly down from 35 placed in 2016, the total accessions requested dropped significantly with 276 accessions requested in 2017 compared to 703 accessions in 2016. The top two private requests were from companies, Crookham Company with 67 accessions and Mountain River Kirby, 52 accessions. A breakdown of accessions requested in 2017 by genus and species was not available.

Montana state report (Michael Giroux):

Thirty-three recipients received 1941 plant germplasm accessions in Montana during 2016. Twenty of the recipients responded to inquiry. About 1/3 of the accessions were for *Triticum* species (bread or durum wheat), 1/3 for *Hordeum* species (barley) and 1/3 for pulse crop accessions. The biggest increase over previous years was for barley and pulse crop accessions which reflects the fact that Montana State hired a pulse crop breeder (Kevin McPhee) who began work at Montana State in January 2017 and several years ago hired a new barley

breeder (Jamie Sherman) who is screening barley accessions for traits of interest. We also continue to have a number of individuals requesting accessions of various species including tree fruit to screen for those that may tolerate MT winters.

New Mexico state report (Ian Ray):

Twenty-five individuals from New Mexico placed 52 orders and received 945 accessions from the NPGS in 2017. In general, these materials were utilized for agronomy, botany, genetics, physiology, taxonomy, and plant pathology research (51%); educational and demonstration programs (29%), varietal development (10%), and undeclared use (10%).

Nevada state report (Melinda Yerka):

Ten individuals from Nevada placed 17 orders and received 91 accessions from the NPGS in 2017. Plant materials were used for chemistry/molecular genetics (40%), plant pathology (18%), anthropology (3%), breeding/varietal development (10%), public educational (19%), and undeclared (11%) efforts. Researchers at the University of Nevada, Reno (UNR) continue to be the primary users (54%), which accounts for the significant reduction in requests made in 2017 as opposed to previous years (large projects are initiated when new plant science faculty are hired or obtain significant grant funding). Users reported that materials would be used for research (70%), education (19%), or other/unspecified (11%) use.

Oregon state report (Present by Carol Miles in place of Shawn Mehlenbacher):

Oregonians continue to use the PI system extensively. Users include state and federal researchers as well as private seed companies and private individuals. Oregon is a major user in the western region, along with California and Washington. 23 publications utilizing NPGS germplasm were published in 2017 and the first part of 2018.

Utah state report (Kevin Jensen):

Dr. Kevin Jensen sent out three rounds of emails to 2017 germplasm users. Their responses are documented in the 2017 Utah report.

Washington State report (Carol Miles):

In 2017, 126 Washington State residents requested a total of 6,032 germplasm samples from the National Plant Germplasm System (NPGS). Recipients were with universities (37, 32 at WSU), USDA (17), private research groups (10), commercial firms, seed companies and nurseries (27), and non-profit organizations (8), as well as 27 private individuals. Recipients received germplasm (in the form of seeds and cuttings) from 17 NPGS repositories or stations in 239 orders. Of the 126 recipients, 2 had no contact information and 7 email addresses were invalid, so 117 recipients received our notice to report their results, and a follow-up notice was sent to those who did not initially respond. Of these, 29 (25%) provided feedback regarding the germplasm they received.

The germplasm material was used in diverse scientific disciplines such as agronomy, anthropology, archaeology, botany, genetics, horticulture, plant pathology, entomology, and soil science, and contributed significantly to scholastic and economic activity in the State of Washington.

The utilization of the germplasm material from the NPGS in 2017 included exploring and utilizing genetic diversity in the USDA Pea Single Plant Plus collection (C. Coyne); a study of

the mechanism of C4 photosynthesis, a process which enables plants to effectively assimilate CO₂ in warm climates, with high water use efficiency (G. Edwards); checking and confirming pathogen phenotypes (W. Chen); and collecting flower volatiles for attraction studies of paper wasp with new plants (A. Kenny Chapman). Germplasm material was used by private research firms (Adaptive Symbiotic Technologies, Battelle-USDOE, GeneShifters LLC, Green *Apis* Evaluations, KWIAHT – Center for Historic Ecology of the Salish Sea, Phase Genomics, Phytelligence Inc., Seattle Indian Health Board), and for commercial nursery and seed propagation and distribution (Alta Rosa Farm, Bear Creek Farm, Bell Mountain Fruit, Brady's Orchard, Callison's, Crites Seed Inc., Dogfairy Ranch, Feil Orchards Inc., Hawley Farms LLC, Highland Specialty Grains, Landmark Turf & Native Seed, Laz R Us LLC, M & A Farm, Northwest Meadows LLC, NWT Seeds, Osborne Seed, Peaceful Acres Natural Habitat, Pure Line Seeds, Inc., Raintree Nursery, Renaissance Orchards, S.S. Steiner Inc., Sundquist Farm, Tonnemaker Hill Farm, Topcliffe Farm, Tortoise Garden, Watershed Garden Works). Individuals and civic organizations requested material for evaluation and testing of *Phaseolus* spp. and *Vicia faba* for local production [D. Borman, K. Wilkins (Orcas Island Seed Bank)], and propagation of optimal *Malus* spp. for home orchards (Western Cascade Fruit Society, Olympic Orchard Society) and community co-op orchards (J. Shannon, Shaw Island). Several recipients stressed the importance of the NPGS service, and mentioned in particular the value of NPGS as a system for acquiring material for research work. Some wrote of the increasing difficulty of obtaining germplasm for breeding uses from private sources, so that the NPGS is globally important for the development of new breeding programs. One recipient noted that the availability of unique and rare varieties has allowed growers to begin the process of re-establishing viable local commercial farms that can compete at a very small scale. Another described it as “an invaluable resource.”

In general, material requested arrived in good condition and grew well, but a few instances were noted in which seed exhibited poor or no germination. One recipient of scionwood from the Geneva repository noted that the rubber bands around the samples were too tight and dented the scionwood. One serious complaint was registered from a request to W6 repository for material to use in “replanting / restoring abandoned irrigation canals, ponds and dry areas”. The requester received no material and “a rather insulting email” stating that the germplasm was not available for home gardening. Such a response reflects poorly on the NPGS as a whole and potentially damages good relations with future requestors/recipients.

Alaska, Arizona, Hawaii and Wyoming do not have state representatives. Dave Stout collected and summarized the information from these states.

Alaska State report (Dave Stout):

During 2017 NPGS there shipped 14 orders with a total of 102 order items (18 from WRPIS) to 10 people in Alaska. Eleven orders were submitted over the GRIN-Global Website and others were through emails or other means. We received three responses to our email questionnaire from requestors.

Arizona state report (Dave Stout):

During 2017 NPGS there shipped 62 orders with a total of 1,936 order items (83 from WRPIS) to 41 people in Arizona. Fifty-three orders were submitted over the GRIN-Global Website and

others were through emails or other means. We received eight responses to our email questionnaire from requestors.

Hawaii state report (Dave Stout):

During 2017 NPGS there shipped 28 orders with a total of 320 order items (only one from WRPIS) to 19 people in Hawaii. Sixteen orders were submitted over the GRIN-Global Website and others were through emails or other means. We received four responses to the questionnaire from Rebecca Canevali, Priscilla Carbajal, Ken Love and Nancy Redfeather, respectively.

Wyoming state report (Dave Stout):

During 2017 NPGS shipped 38 orders with a total of 886 order items (494 from WRPIS) to 10 people in Wyoming. All the orders were submitted over the GRIN-Global Website. Only one person, Saleh Osama, responded to my email questionnaire.

Open discussion:

The W6 TAC has discussed how state representative prepare state reports over the years. This year the topic came up and there was interest in possibly coordinating the questions asked to germplasm users. A standardize set of questions might be agreed upon by all members so that there is greater uniformity between state reports and increased ability to summarize all state reports into a single annual review. It was also discussed how to address the issue that many germplasm users that request germplasm in the previous year do not necessarily have results in time for the report, and in many cases the impact of germplasm use may not be realized for many years after received. How many years back should germplasm use be assessed? How do we get an accurate assessment of germplasm use when it may take years to collect results and determine utilization?

A brief discussion revised the issue of GM traits contaminating alfalfa germplasm.

A motion to adjourned was made and seconded, unanimously approved.

W6 TAC Secretary: Joe Kuhl

Meeting Minutes of the W-6 Technical Committee Meeting - Continued

Date: Tuesday, June 26, 2018

Location: Conference Room at the National Clonal Germplasm Repository, Corvallis, OR

In person:

Kim Hummer, Jinguo Hu, Dan Parfitt, Brian Irish, Pat Byrne, Dave Stout, Kevin Jensen, Carol Miles

Called In:

Anne-Marie Thro and Ian Ray on conference call,

Challenges of the W-6 Station (Jinguo Hu)

Farmland issue – WRPIS lost 4 parcels of land, 28.5 acres, when Pullman Airport expanded; 5 yr rotation needed to rotate by crop species, disease cycle and hard-seeded issue

Central Ferry 60 miles away, chickpeas appeared to grow well there last year with good seed size, but when seed was sent to Colorado State for back up, germination test was 30%, temperature was too high during final seed set

May be able to use 1/3-2/3 of NRCS farm (7 acres) that is right next to current buildings

Cup Farm is the private commercial farm on the other side of current buildings, and Scot said he could contact the farmer to see if he might be interested in a long-term lease

Kevin: is WSU obligated to provide land?

Jinguo and Kim: not sure, but excellent relationship between WSU and WRPIS so no need to be concerned, and Scot said yesterday WSU has land available for WRPIS

Action item: The tac wrote a resolution to request this issue is resolved by 2019

Central Ferry and alfalfa issue – at Central Ferry 37 acres WSU and 100 A long-term lease to USDA-ARS from local coop; 3 acres per year is all that is needed, plus a 5-yr rotation, so 15 A total currently needed; so plenty of land to accommodate the alfalfa program

Commercial private alfalfa planting 1 mile down river and across the other side of the river; farmer has agreed not to grow GE alfalfa, but no signed/official agreement

Co-existence strategy is 5 mi separation

Constructing new building to house alfalfa program \$1.3 mil; Pullman has office space but not greenhouse space

Brian will plant sentinel plots without cages to see if there is any contamination

Action item: Jinguo and Brian plan to meet to discuss and decide if move is viable, report back to the group next year

The greenhouse is being constructed at Central Ferry, should be ready by winter, for *Phaseolus* program

Staff – technician resigned, WSU position, 3 months until rehire is complete

Dave Stout's position in process of being refilled, position description is complete, will be advertised soon

Vicky Bradley retired last week, may be 1 yr until rehire; Jesse acting curator temporarily for now, working well

Impact (Pat) – we have to demonstrate impact for what we are doing, good anecdotal reports in state reports

Create a narrative of 1-2 success stories for each state; economic impact good to show but hard to demonstrate

Kevin: Oregon hazel nuts and Shawn's work a big impact story, so is Utah wheat breeding

Anne-Marie: each state create a table highlighting impacts

Can we coordinate efforts with other regions?

Every few years a meeting of the 4 regions, we can discuss then, last meeting was in CO 2 years ago

Action item: Form a subgroup of the tac to: determine what is done with the state reports and W6 annual report; ask other regions what they are doing ; ask each state representative in W6 to share annual request letter; maybe we need to ask recipients who received germplasm

several/3 years ago (Kevin); subgroup volunteers: Pat, Kevin, Carol, others let Pat know if you are interested

More states participated this year than in the past (Dan), how do we keep state representatives engaged?

Charley Brummer identified as a replacement for Dan (CA), need to make sure if Charley agrees

Distribution of germplasm (Kim) – need to restrict distribution next year due to lack of resources (budget is not adequate to maintain current samples or ship requests)

Dan: it's a quandary, we are promoting importance of NRGs to public, so public wants to use it

Kevin: exposure is good, there is a genetic diversity movement

Missy: they have a letter letting people know they won't receive material, could update it so people understand the lack of resources

Are cultural practices included with each order, so people know how to plant/grow the material they receive? No, we assume if they order a stick or a tissue culture plantlet, the recipient knows what to do with it. Could this be a screen to limit orders, that is, if they are made aware these are not 'plants' would they not order

Kim: some people are asking for germplasm so they can sell it, can recognize some names and screen them out

Missy: people asking for hops germplasm (a few 100) so they can start a commercial production operation

Kevin: create a core set of germplasm for general requesters?

Kim: homeowners would see a small set in GRIN, scientists see whole set

Brian: GRIN data used by many people who don't request germplasm

Kevin: could still make data available but mark germplasm unavailable to limit requests; primary function of NPGS is preservation not distribution

Dave: each order is reviewed by staff and decision is made to fill order

Dan: requester submit experimental plan with each order and also a propagation plan to validate they know how to handle the material, could eliminate some requests

Brian: he reviews each order and decides which orders to fill

Dan and Brian: grant projects could include funds for orders, and especially shipping and handling; USDA-ARS not able to accept funds

Kevin: he has a Suspense account, a federal/ARS account, needs to be renewed every 5 years, charges for stock/foundation seed sales, restricted use for funds such as no travel, but funds used to pay land lease for seed production, personnel who work with seed production, bags and other seed production supplies, 40-50K annual amount in the account

Kim: has an account with Friends of NCGR, up to 10K, when they fill orders they ask for a donation of \$10-100 depending on amount of material requested/shipped

Carol: has a WSU Service account where funds from fruit sales are placed, no restricted use

Kevin: can't give away/sell government property, make sure charging for NPGS services is OK

Action item: 2019 annual meeting will be hosted by W6-WRPIS in Pullman in mid-June, will have a webinar connection with WebEx; 2020 annual meeting tentatively to be held in Logan UT

Resolutions:

Resolution 1. The W-6 Technical Advisory Committee thanks Dr. Kim Hummer, Joseph Postman and the staff of the USDA-ARS National Clonal Germplasm Repository in Corvallis for their efforts in organizing and hosting the 2018 W-6 meeting with teleconference options.

Resolution 2. The W-6 Technical Advisory Committee thanks Dr. Jim Moyer for his many years of service as Administrative Advisor for the W-6 Regional Technical Advisory Committee.

Resolution 3. The W-6 Technical Advisory Committee thanks Dave Stout and Vicki Bradley for their many years of service at the W-6 station and their contributions to NPGS.

Motion to adjourn the meeting by Kevin, Dan seconded, passed unanimously

Meeting minutes for Tuesday, June 26, 2018 recorded by Carol Miles.