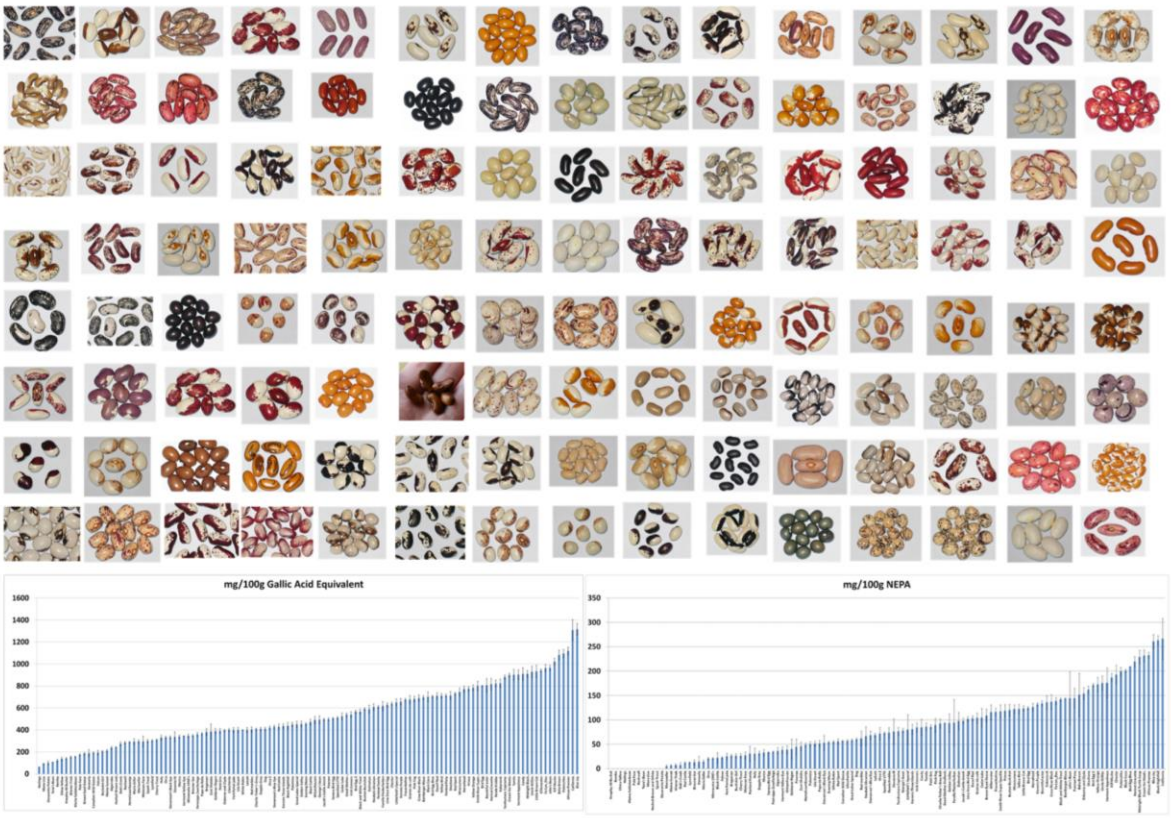
Annual Report for Calendar Year 2017

USDA-Agricultural Research Service
Plant Germplasm Introduction and Testing Research Unit
Western Regional Plant Introduction Station (WRPIS)
59 Johnson Hall, Washington State University
Pullman, WA

Phone: (509) 335-1502 Fax: (509) 335-6654
Jinguo.hu@ars.usda.gov



June 2017

Table of Contents

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 plant species 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 at Pullman, WA, on the Pullman campus of the Washington State University (WSU). Two of the projects (the National Temperate-adapted Forage Legume (TFL) Germplasm Project and the Alfalfa Genetics Research Project) are located on an ARS worksite at 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 (approximately 12% of the total operation budget) funding which covers the salary and fringe benefits of six full-time state employees working for the WRPIS, as well as partial cost of land, equipment 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 scientists also actively collaborate 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 2017, we shipped out a record high number of 42,484 packets of seed samples to 894 requestors residing in each of the 50 domestic states and 47 foreign countries. WRPIS scientists made 19 poster or oral presentations at various regional, national and international conferences, and published 19 research papers in peer-reviewed scientific journals.

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 2016. 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 (Figure 10) of stored sugar beet roots, together with demonstrating its pathogenicity and environmental preferences.

Cover story: There is strong evidence that consumption of pulses (dry beans, pea, chickpea and lentil) has substantial health benefits such as reducing cardiovascular disease, preventing diabetes and even preventing certain types of cancer. Scientific research demonstrated that these benefits are associated with the antioxidant activity of an array of phytochemicals including polyphenolic compounds. However, there is little information on the variation of polyphenolic compounds among the accessions of “heirloom” beans in the WRPIS’ collection. To generate the needed information, we analyzed extractable and non-extractable phenolics in 120 heirloom bean accessions exhibiting a wide array of colors and patterns. Surprisingly, phenolic content was not strictly correlated with pigments such as black or red beans. The highest levels were also found among light brown beans, 'California' and 'Beka Brown'. The data will be uploaded into our GRIN-Global database for breeders to select desirable parental accession in developing varieties with the optimal polyphenolic compound contents for consumers.

Upper: the colors and patterns of the heirloom bean accessions used in the laboratory analysis; Lower: the distribution of extractable (left) and non-extractable (right) phenolics among the accessions (Cover story prepared by Dr. Theodore Kisha, Curator for *Phaseolus* Germplasm).

REPORT

ADMINISTRATION

Jim Moyer (Administrative Advisor)
Ann Marie Thro (NIFA Representative)
Michael Fitzner (NIFA Representative)
Peter Bretting (ARS National Program Staff)
Robert Matteri (ARS PWA Area Director)
Jinguo Hu (ARS Research Leader and Station Coordinator)
James Dann (ARS Program Support Assistant)

PERSONNEL

One critical vacancy was filled during the period of departmental hiring freeze. After the retirement of the Unit's Information Technology Specialist Ms. Gwen Pentecost in May 2016, we were allowed to advertise for the position. We interviewed a qualified applicant, Mr. Bo Gao, and made a tentative offer in January 2017. However, the position was held up for several additional months due to the Government-wide hiring freeze. Mr. Gao was officially hired August 2017 as the Information Technology Specialist. Mr. Gao earned a Master of Science degree in Computer Science from Middle Tennessee University and a Bachelor of Science degree in Computer Science from Northwest Normal University in Changchun, China. Mr. Gao has extensive experience in database management and has secured an Oracle database certificate. In addition to providing IT support to the staff, Bo will share responsibility in managing the Unit's plant germplasm data in the GRIN-Global Database. We truly appreciate the support of our Area Office and Headquarters for the approval and aid infilling this critical vacancy. Mr. Bill Boge, a Biological Science Technician in the Alfalfa Genetics research program at Prosser, retired in May 2017 after more than 30 years of service. This vacancy won't be filled advertised to be filled until the hiring freeze has been lifted.

Our seed storage and database manager Mr**.** Dave Stout retired on March 17, 2018 after working almost 48 years for the WRPIS. Dave, as he is known to his friends and coworkers, started to work for WRPIS when he was attending Washington State University (WSU), Pullman in 1970. He was hired by WSU as a Seed Curator to work at the station with a wide range of responsibilities from germplasm regeneration, characterization, seed cleaning, germination and seed storage as well as database management. Dave retired from WSU and joined UDSA-ARS in 2004 as the Seed Storage and Database Manager. He is one of the original group individuals who started the Germplasm Resources Information Network (GRIN) database and contributed substantially to the recent upgrade of GRIN to GRIN-Global. Dave continues to help the Unit by working half-time after officially retiring from the federal government. Dave is currently serving as a member of the NPGS GRIN-Global Advisory Committee representing the WRPIS. We greatly appreciate Dave's dedication to managing the many agriculturally important plant genetic resources at the WRPIS. Recruitment to fill this critical position is under way.
Changes relating to WSU/State personnel include a Plant Technician vacancy in the farm crew was filled by Ms. Julianna Gothard, who works part-time in helping the Seed Cleaning Technician and other activities on the farm. Mr. Jesus Prieto was hired as a two-year term technician to help the Temperate-Adapted Forage Legume Germplasm program at Prosser. The Pullman Farm Manager, Mr. Sean Vail, resigned in November 2017. The WSU Department of Crop and Soil Sciences was able to move Mr. Charles Golob to work half-time as the Acting Farm Manager and oversee the farm operations. WSU Human Resource Services and the WSU

Department of Crop and Soil Sciences decided to hire Mr. Golob as the WRPIS Pullman Farm Manager.

RESEARCH PROJECT

From January of 2017, curators and scientists have been working on the new project plans for the next five-year cycle (2018-2023) since the two project plans, “Management of Plant Genetic Resources and Associated Information" and "Temperate-adapted Forage Legume Genetic Resource Management, Characterization, and Evaluation" for Pullman and Prosser respectively, would end in April 2018. Two new project plans, entitled “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”, went through internal and external reviews and was certified by the Scientific Quality Review Officer, Office of Scientific Quality Review and were enacted in April 2018. It is worth mentioning that both project plans received overall quality ratings of “No Revision Required” and the Pullman project plan received a perfect score of 8.0. This was the result of the collective effort of all SYs in the Unit! These two projects are relevant to the Agricultural Research Service’s National Program 301 Plant Genetic Resources, Genomics, and Genetic Improvement.

The alfalfa research project being executed at the Prosser worksite entitled “Enhancing Resistance to Biotic and Abiotic Stresses in Alfalfa” is relevant to the Agricultural Research Service’s National Program 215 Pasture, Forage, and Rangeland System and will expire in March 2019. The new project plan will be developed and reviewed in the year 2018.

The current USDA-NIFA Multistate Research Project W-6 entitled “Management and Utilization of Plant Genetic Resources and Associated Information” is in its second year of the five-year cycle.

FUNDING

The total ARS budget for our programs was $2,931,800 with $2,293,754 for plant germplasm service and research at Pullman, WA, and $ 254,724 for the Temperate-adapted Forage legume germplasm at Prosser, WA, and $438,292 for the alfalfa research at Prosser, WA. The discretionary dollar per SY was $33,182. The ‘in kind’ support from a NIFA Multistate Research Project W-6, through Washington State University was $435,900.

In addition, the Grasses, Safflower and Native Plants Curator Vicki Bradley received a $138,000 grant from BLM (Bureau of Land Management) to support the project entitled “Management, Evaluation, Acquisition, and Distribution of Native Plant Germplasm for Research and Restoration”; Ms. Bradley also received a $10,800 grant from US Forest Service to conduct a research project entitled “Conservation, Adaptation and Seed Zones for Key Great Basin Species”. The above two grants support a collaborator, two temporary employees (one full-time supporting scientist, and one part-time technician), other seasonal help, supplies and travel. Research Geneticist Dr. Long-Xi Yu successfully obtained a research grant from Alforex, a leading alfalfa seed company in the U.S. for marker assisted breeding in elite alfalfa germplasm to enhance biomass productivity during drought. As a co-PI for this collaborative project with New Mexico State University, Dr. Yu will receive $186,887 to his proposed research project entitled “Marker assisted breeding in elite alfalfa germplasm to enhance biomass productivity

during drought" to be carried out at Prosser, from 2017-2021. Dr. Yu also received two NIFA-AFRP grants on collaborative projects to be conducted during 2017-2019: $55,000 for "Determining genetic factors that influence forage quality in alfalfa" and $34,536 for "Bacterial stem blight of alfalfa: Connection with frost damage, development of resistant germplasm, and mapping resistance genes". These grants are supporting a Postdoctoral Research Associate, Dr. Charles Hawkins, who started in October 2016 and has been working on bioinformatics and quantitative genetics for improvement of alfalfa with resistance to disease and abiotic stress. Cool Season Food Legume Germplasm Curator Dr. Clarice Coyne, together with two other collaborators, received a $35,000 research grant from the USA Dry Pea and Lentil Council and $35,000 from Association of Northern Pulse Growers to support applied pea and lentil genomics research, respectively. Dr. Coyne served as the Co-PI on a chickpea disease evaluation grant of $15,000, the Co-PI on the US-Israeli Binational Science Foundation drought study in wild pea of $180K and the Co-PI on a WA State Specialty Crops disease resistance in lentil of $199K. These grants support Dr. Yu Ma, a Postdoctoral Research Associate. Horticultural Crops Germplasm Curator Ms. Barbara Hellier obtained $8,000 from the Beet Sugar Development Foundation to support *Beta* germplasm conservation and regeneration.

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. Washington State University) and 157.3 acres of farm land (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). We have been waiting for paper work to set up the purchased greenhouse (35' x 100') kit from the Winandy Greenhouse Company to replace the 40-year-old greenhouse currently in use for *Phaseolus* beans germplasm regeneration at our Central Ferry Farm. The existing transformer bank was upgraded and a new single phase transformer was installed by the Inland Power and Light Company for ensuring power supplies to the new greenhouse and other facilities on the farm. The 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.

Proper crop rotation is necessary to produce quality seeds for distribution to worldwide researchers who request samples from WRPIS. For this reason, WRPIS needs adequate farm land to replace the 28.5 acres recently lost due to the Pullman-Moscow Regional Airport Expansion project. This farmland was assigned to WRPIS by WSU for germplasm regeneration and research purposes. The WSU land management team has been working hard with staff to find suitable replacement land in the area. Three options are available and all of them would 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 farm land. As of May 23, 2018, there is no final words from WSU authorities as to where the replacement farmland will be. It is our hope that the WSU will satisfy this need 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 adventitious appearance (AP) of transgene in the NPGS alfalfa germplasm collection. After the deregulation of the genetically-engineered Roundup Ready Alfalfa (RRA) and the low-lignin trait, necessary

measures such as using new insect-proof cage covers over the regeneration plots were taken to reduce the chance of AP in the alfalfa germplasm regeneration. 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 better to relocate the germplasm operation to the Central Ferry Farm that is more isolated from RRA 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 is not possible to make the move. A combined effort of 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 1 shows the number of accessions for major crop groups maintained at WRPIS. We are second among the four regional PI stations and third among the 28 NPGS sites/collections in terms of number of accessions managed (https://npgsdev.ars-grin.gov/gringlobal/query/accessionsbysite.aspx). As of June 12, 2018, the WRPIS holds 100,471 accessions. This is approximately 17% of the total NPGS holdings of 591,679 accessions. As for numbers of plant taxa, WRPIS ranks number one among all NPGS sites since WRPIS holds 25.8% of the genera and 27.5% of the 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 s few vegetables, grasses and ornamentals).

The Agronomy and Native Plants Program (Vicki Bradley) 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. **The Cool Season Food Legumes Program** (Clarice Coyne) curates a total of 22,789 accessions of pea, chickpea, lentil, faba bean, and lupine. **The *Phaseolus* Beans Program** (Ted Kisha) manages a collection of 17,566 accessions, all belonging to the *Phaseolus* genus. **The Temperate-adapted Forage Legumes Program** (Brian Irish, located in Prosser, WA) manages the alfalfa, clover, trefoil and their wild relatives with a total of 13,343 accessions. **The Horticulture Crops Program** (Barbara Hellier) manages 12,890 accessions of sugar beet, lettuce, garlic, and many miscellaneous species that have potential use for ornamental or medicinal purposes.

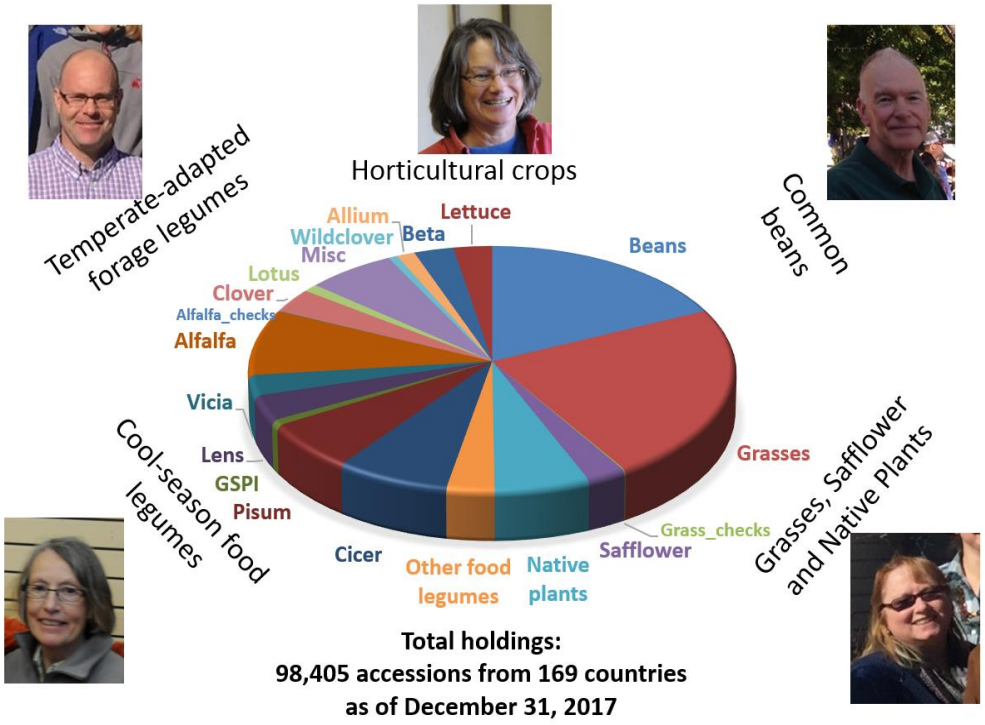


Figure 1. The five curators and their assigned major crop groups maintained at WRPIS.

Germplasm Acquisition

During the 2017 calendar year, there were 1,225 new accessions added to our collection including 1,133 native plant accessions from the SOS project, 48 accessions (mostly perennial clovers [*Trifolium* spp.]) from the Griffin, GA repository. The clovers were cultivars and crop wild relatives donated by now retired USDA-ARS Scientist and clover breeder, Dr. Gary Pederson. In addition, 39 grasses, 17 *Beta*, eight pea, seven *Phaseolus* beans and a few others were incorporated. As of December 31, 2017, there were 98,405 accessions belonging to 1,041 genera, 4,706 species and 5,381 taxa in the WRPIS collection. The value of these collections continues to grow as international access to germplasm is increasingly limited by the changing political environments.

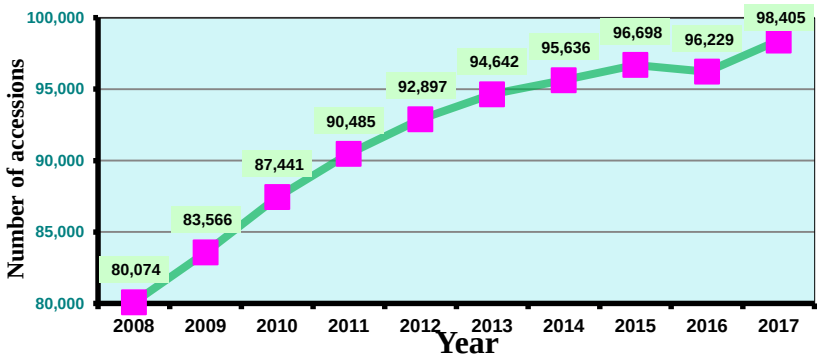


Figure 2. Total number of accessions managed by WRPIS since 2008 (numbers recorded at the end of each calendar year).

Germplasm conservation

In 2017, WRPIS curators regenerated 1,772 inventories by following the established, labor-intensive procedures and protocols for maintaining the genetic integrity and health of all germplasm collections. These included physical isolation, hand planting and transplanting, controlled hand and insect pollination, hand harvesting, cleaning and packaging for storage and distribution.

A total of 2,386 seed viability records were entered into the GRIN-Global database. WRPIS tested 773 inventories, the WRPIS Horticultural Crops program tested 73 inventories and NLGRP in Fort Collins, CO tested 1,540. Seed quantities of 6,513 inventories in our storage were updated by weighing and converting to number of seeds per inventory.

For security backup, we sent 1,573 inventories to NCGRP at Fort Collins, CO and 602 inventories to the Svalbard Global Seed Vault, Longyearbyen, Svalbard, Norway through the NCGRP during 2017.

Germplasm evaluation and characterization

In 2017, a total of 13,825 observation data records were entered into the GRIN-Global database. These included 98 descriptors on 11 different crop species. Ninety-four percent of the data were collected by WRPIS staff and the remaining 6% came from cooperators.

With partial support of a germplasm evaluation grant from USDA-ARS NPGS Root & Bulb Crop Germplasm Committee, Horticultural Crops Germplasm Curator Barbara Hellier and Research Plant Pathologist Frank Dugan completed research demonstrating that bulbils of *Allium sativum* have a lower infection rate from *Fusarium proliferatum* than do seed cloves, when both the bulbils and the cloves originate from the same infested bulbs. The result was presented at the 2017 annual meeting of the American Phytopathological Society. A survey of *F. proliferatum* in WRPIS *Allium* germplasm (99 of approximately 400 accessions sampled) is completed.

In collaboration with the Department of Food Science and Human Nutrition at WSU, our *Phaseolus* Curator Ted Kisha analyzed 120 heirloom bean accessions for protein, extractable phenolics and non-extractable proanthocyanidins. There were 2 to 3-fold differences even within market classes of Red and Black beans. Some of the data has been entered into our GRIN-Global database.

Cool Season Food Legume Curator Clarice Coyne participated in a collaborative project on genomic diversity and the macro-ecology of the crop wild relatives of domesticated pea. Legumes play an important role in human health, sustainable food production, global food security, and the resilience of current agricultural systems. Pea belongs to the ancient set of cultivated plants of the Near East domestication center and remains an important crop today. Based on genome-wide analysis, *P. fulvum* was identified as a well-supported species, while the diversity of wild *P. sativum* subsp. *elatius* was structured into five geographically positioned clusters. The spatial and environmental patterns of two progenitor species of domesticated pea in the Mediterranean Basin and in the Fertile Crescent in relation to the past and current climate was explored. These findings help set research and discussion priorities and provide geographical and ecological information for germplasm-collecting missions, as well as for the preservation of extant diversity in ex-situ collections.

Germplasm distribution

Figure 3 shows the annual number of seed packets distributed for each of the past ten years. This year's distribution of 42,484 packets to 1,060 requestors, was the highest on record for WRPIS, with an increase of almost 27% from the previous year. This indicates a high interest of the germplasm user community in WRPIS' collection. Among the distributed packets, 60% or 25,913 packets were sent to addresses covering each of the 50 U.S. domestic states and 40% or 16,571 packets were sent to requestors from 46 foreign countries. The most requested plant groups were grasses (6,165 packets) and cool season food legumes (6,002 packets), followed by *Phaseolus* bean (3,856 packets), temperate-adapted forage legumes (3,782 packets), horticultural crops (3,764 packets) and native plants (780 packets).

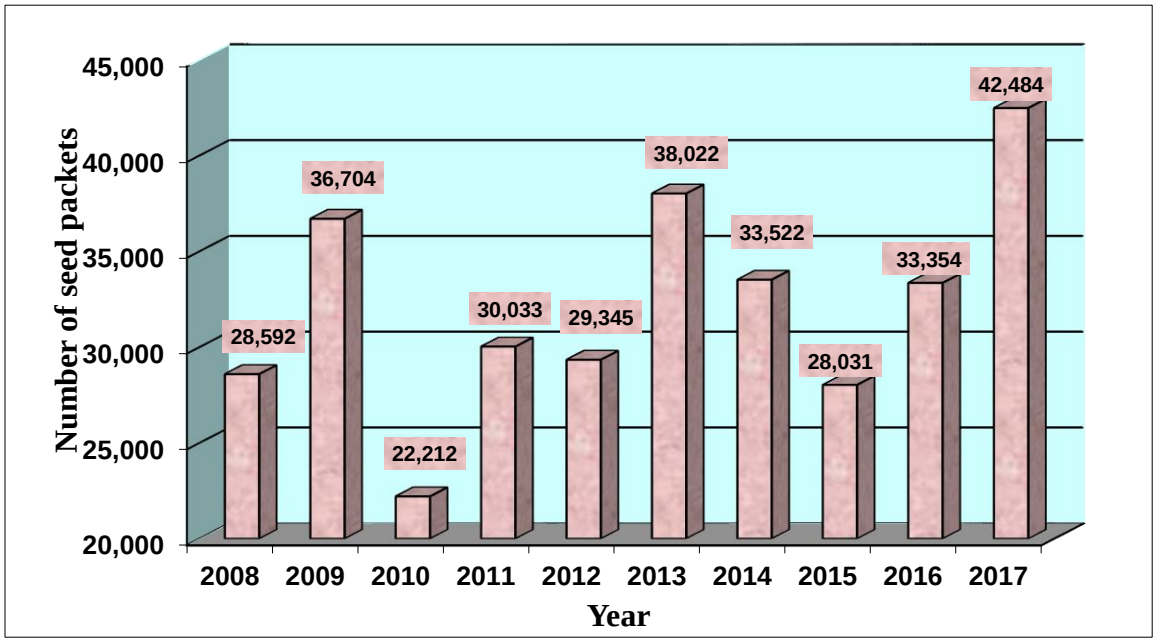


Figure 3. Number of seed packets distributed annually by WRPIS from 2008 to 2017**.**

Germplasm utilization in the 13 Western States

According to data generated by Dave Stout, WRPIS Seed Storage and Database Manager at Pullman, the 13 Western states (AK, AZ, CA, CO, HI, ID, MT, NV, NM, OR, UT, WA, and WY) germplasm user received 32,144 from all NPGS genebanks/repositories in 2017. Among them 9,682 packets were distributed by WRPIS. The germplasm usage in the Western 13 States accounted for 30% of NPGS' and 37.4% 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 accessions distributed in 2017 to each of the 13 Western States by the NPGS and the WRPIS, respectively. The number received by each state varied from 1 (Hawaii) to 3,051 (Washington) from the WRPIS and from 81 (Nevada) to 9,750 (California)

Table 1. Numbers of plant germplasm accessions distributed in 2017 to each of the 13 Western States by the NPGS and the WRPIS (data provided by Dave Stout).

States	Number of packets distributed		
	From NPGS	From WRPIS	% from WRPIS
Washington	5,835	3,050	0.52
Utah	2,948	2,353	0.80
California	9,750	1,204	0.12
Oregon	2,102	1,194	0.57
Montana	1,867	685	0.37
Wyoming	886	494	0.56
Colorado	2,453	237	0.10
Idaho	2,975	209	0.07
New Mexico	745	140	0.19
Arizona	1,936	83	0.04
Alaska	102	18	0.18
Nevada	81	14	0.17
Hawaii	320	1	0.00

from the NPGS. Washington, Utah, California, and Idaho were the top four in terms of receiving germplasm from WRPIS in 2017. The WRPIS distributed more than half of the accessions received by germplasm users in the following four western states (Washington, Utah, Oregon and Wyoming). It is noteworthy that 80% of the germplasm accessions received by users in the state of Utah were from WRPIS.

Summary of individual curatorial programs

1. **The Agronomy and Native Plants Program**
   Curator: Vicki Bradley (full-time)
   Technician: Bob Guenthner (full-time)
   Technician: Jessica McGowan (full-time)
   Plant Biologist: 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. **Grass** - Seeds of 1061 *Lolium* accessions were photographed for uploading to GRIN Global (GG). Two hundred and forty-six grass accessions were selected and planted for regeneration considering quality, viability, and quantity of seed, and isolation requirements. Of these, 56 accessions required special germination techniques such as scarification, stratification, or germinating in the dark.

B. **Safflower** - Data for 11 descriptors and photos of plots and heads were collected on 50 accessions of safflower in the summer of 2017. These data and images were uploaded to GG. A project to analyze oil and fatty acid content (linoleic acid, oleic acid, palmitic acid, and stearic acid) in 492 safflower accessions for which the data are not in GG continued. To date, 96 accessions have been analyzed (56 in the period 10/1/17 – 4/15/18).

C. **Safflower Genetic Resources Website**-This website has been managed by this program through Washington State University. We recently arranged for migration of the older http format to the WordPress format for ease of editing and adding information to the site. The new look of the Safflower Genetic Resources Website is shown in Figure 4.

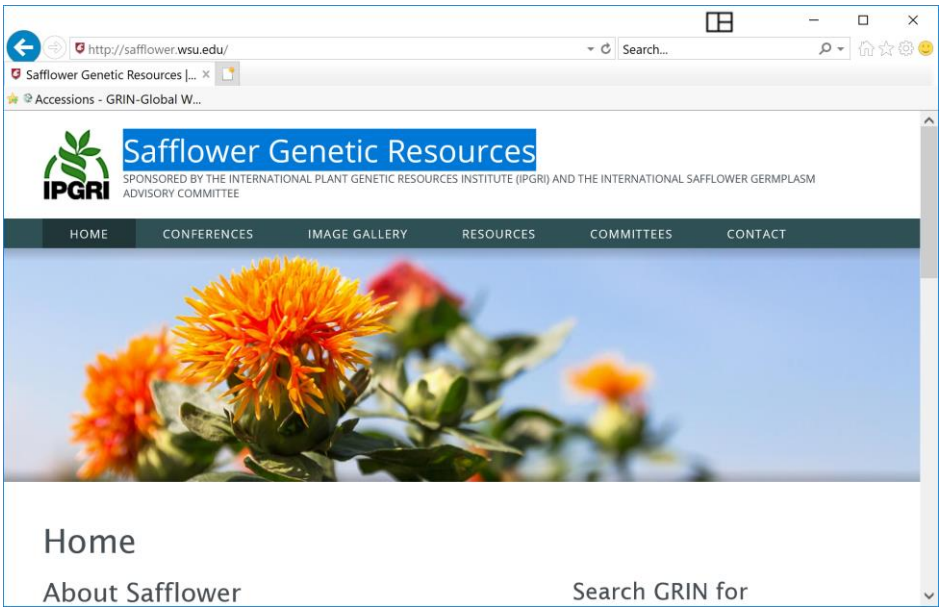


Figure 4. The screenshot of the Safflower Genetic Resources webpage.

D. **Native Plants** - We continued to collaborate with Bureau of Land Management (BLM) to manage the native plant seeds collected by the Seed of Success (SOS) program from public lands in the U.S. We enter the passport data for each sample into the GRIN-Global database. The seed samples are backed up in the NLPGP as well as being stored and distributed from the WRPIS to germplasm users for research and development of native plant materials to facilitate conservation for the lands administered by the BLM. In 2017 we added 1,133 native plant accessions to the WRPIS's collection and distributed 780 packets to native plant germplasm users.

2. The Cool Season Food Legumes Program

Curator: Clarice J Coyne (full-time)
Technician: Britton Bourland (full-time)
Post-Doctoral Scientist: Dr. Yu Ma (Supported by grants from the USA Dry Pea and Lentil Council and the Northern Pulse Growers Association)

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 646 accessions for regeneration of low quantity or low germination or for security backup. Included were 40 accessions of wild *Cicer reticulatum*, crossable to cultivated chickpea, newly collected and donated from Turkey. Trait data of 6,721 observations was collected on each accession under regeneration and additional descriptor data of 30,014 observations was taken on accessions in 3,600 plots of replicated evaluation experiments. Notable was the participation in an international (USA, Canada, Morocco, Spain, Italy, India, Bangladesh) Genome Canada project of phenotyping a collection of 324 accessions (3 reps) genotyped using a lentil exome capture assay.

Figure 5. Hand planting faba bean regeneration plots at the Pullman Farm on April 25, 2018.

A. Lentil production acreage in the U.S. is increasing in recent years in responding to the export market demand. A Washington State University Ph.D. graduate student, Md Nurul Amin, native of Bangladesh, received training in this program and completed a Genome-wide Association Study (GWAS) with the USDA lentil core collection as a part of his Ph.D. dissertation. He used the genotypic data of 10,052 SNPs generated by genotyping by sequencing, the phenotypic data collected at two locations and in two years and identified SNP markers significantly associated with important agronomic traits (Figure 6).

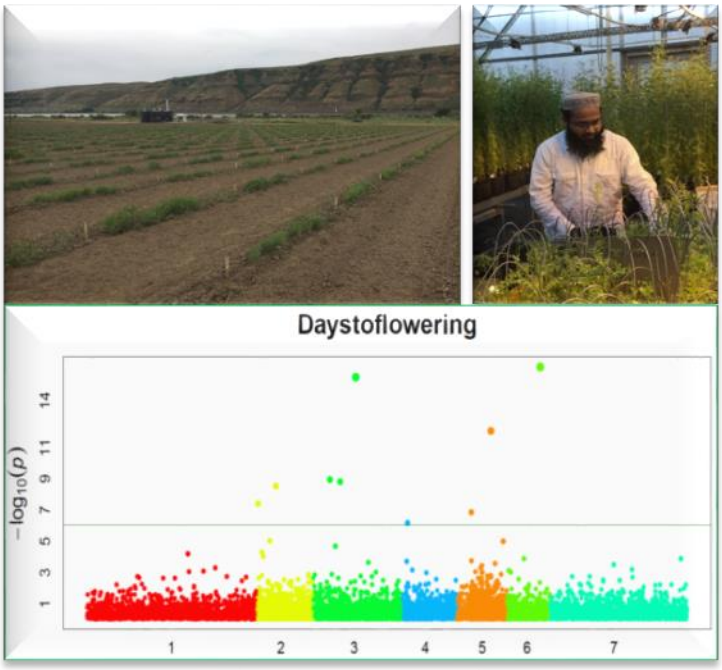


Figure 6. Upper: Nurul working in the greenhouse and his field evaluation plots at our Central Ferry Farm. Lower: A Manhattan plot showing SNP markers on Chromosomes 3 and 6 that are significantly associated with days to flower of lentils.

B. 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. **The Temperate-adapted Forage Legumes Program**
Curator: Dr. Brian M. Irish (full-time)
Technician: Estella Cervantes (full-time)
Time Slips: Jesus 'Jesse' Prieto (WSU –full-time)
Pathways Intern: Christos Galanopoulos (part of year)

The Temperate-adapted Forage Legume (TFL) genetic resources program is an important component of the Plant Germplasm Introduction and Testing Research Unit in Pullman, Washington and operates at the USDA-ARS worksite in Prosser, Washington. The project focuses on acquiring, maintaining, characterizing, evaluating and distributing alfalfa, clover, trefoil and their wild relative germplasm accessions.

A. A recent taxonomic revision of the taxa in the *Lotus* genus has resulted in the reclassification of North American native *Lotus* spp. as *Acmispon* spp. This reclassification has impacted the project which now manages 63 accessions belonging to 19 species in the *Acmispon* genus. The same number of accessions (63) was reduced from the *Lotus* ssp. genus inventories.
B. For the 2017 growing season a total of 196 accessions were field established for regeneration including 80 *Medicago* species, 65 *Trifolium* species and 41 *Lotus* species and ten sentinel alfalfa plots for adventitious presence transgene detection. Due to low seed recovery from the 2016 regeneration efforts 22 accessions were carried over for a second-year increase. In addition, a group of 50 cold-hardy (mostly *Trifolium* spp.) accessions were planted in the fall (September) of 2016 and were overwintered to be increased and harvested early during the 2017 summer season. 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 2017 calendar year a total of 4,460 alfalfa, clover, trefoil and their crop wild relative accessions were distributed in 183 orders to 164 cooperators. Just over 16% of the order requests, and subsequent shipments, were from/to international cooperators.
D. All threshed, cleaned and chalcid-free seed from 2016 increases was submitted to Seed Storage Manager to be included in the Pullman cold storage unit and made available for distribution late in the calendar year. An average of close to 300 grams of seed per accession/plot was achieved for seed cleaned for the 2016 growing season (vs. 129 grams/plot for 2015). All passport and associated information as well as germinations to determine baseline viability (125 accessions tested) and voucher images (373) were provided to technical personnel for loading into the Germplasm Resource Information Network (GRIN) Global database.
E. A pilot study was implemented during the calendar year to begin regenerating a backlog of low viability (<50%) and low seed number (<100) accessions in the collection. This was an effort conducted in the laboratory where seed was germinated in vitro using incubators. The low numbers (~10) of germinating plants were carefully monitored, and as they grew, were transplanted to greenhouse pots. There plants were clonally propagated by rooted cuttings or crown division to reach an optimal number of plants (100) to be taken to the field. Project personnel understand that this might cause a reduction in genetic diversity due to a 'bottleneck' effect, but it is the only way to keep accessions alive.
F. The threat of transgenic gene flow into 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. Therefore, ten sentinel plots were included in the regeneration field in 2017. These plots are located on each of the regeneration field corners centrally and are of the 'Vernal' alfalfa variety. In 2017, 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 five covered 2016 'Vernal' alfalfa variety sentinel plots around regeneration fields which were tested in 2017, more than 50,000 seed were tested and no AP was detected. These efforts relate to the continued monitoring for adventitious presence of transgenes in the germplasm being regenerated at the Prosser, WA worksite.

G. In 2017, The TFL Curator participated and presented research/reports at the Crop Science Society of America and the Clover and Special Purpose Legume Crop Germplasm Committee meetings held in Tampa, FL; at the Washington State Hay Growers Association Meeting held in Kennewick, WA; at the Western Seed Growers Association Meeting held in Las Vegas, NV. In addition, the project hosted visiting scientists from the Land Institute in Salina, KS; as well as a delegation of Chinese Agricultural Scientists and personnel from the USDA Risk Management Agency.

ARS scientists in Prosser, hosted a Pathways intern student from Virginia State University, a Historically Black College/University during the 2017 spring semester. The student was funded through USDA's Office of Outreach and Diversity, Equal Opportunity. The students learned about day-to-day operations of the project by being exposed to all the service and research work. The hope is that the students return after graduate school to possibly join technical staff at the Western Regional Plant Introduction Station.

4. The Horticulture Crops Program
Curator: Barbara Hellier (full-time)
Technicians: Marie Pavelka (full-time)
Technicians: Alex Cornwell (full-time)

The Horticulture Crops program focused on regeneration, collection maintenance and distribution. In 2017 this program focused on regeneration, maintenance and distribution. We maintained the clonal Allium (garlic and miscellaneous Allium species) and rhubarb collections (367 accessions), planted and harvested 74 accessions of *Lactuca,* 12 accessions of Beta, and 81 accessions in the following genera: *Amorpha, Anthyllis, Artemisia, Astragalus, Chamaecytisus, Crepis, Epilobium, Erigeron, Eriogonum, Glycyrrhiza, Hedysarum, Krascheninnikovia, Lomelosia, Marubium, Nigella, Onobrychis, Oxytropis, Papaver, Plantago, Purshia, Salvia, Sanguisorba, Satureja, Scabiosa, Scorpiurus, Silphium, Taraxacum, Teucrium, Thermopsis,* and *Urtica*. We provided total seed yield and 100 seed weights for the increased accessions for entry into GRIN-Global and descriptor data for 1018 accessions of A*stragalus, Beta,* and *Lactuca* on 11 descriptor traits.

In addition to collection management activities, the curator led the Unit effort to restructure our seed distribution activities to prepare for our Seed storage manager's retirement. She worked with current curators and the seed storage manager and staff to identify common seed distribution tasks and develop Standard Operating Procedures along with regularly meeting with seed storage staff to identify needs, problems and worked to find solutions.

We are trying the solar powered fans to improve seed quality of the Beta plants in the pollen-proof regeneration cages. The system has a 10 watt, 12 v solar panel with a dc connection to power a 12-inch high velocity fan (Figure 7). The air circulation by the solar powered fan in beet pollen proof regeneration cages can alleviate flower stalk tip die-back and hence improve the seed quality and quantity. We used this system at our Pullman Farm for the 2017 field season and will continue to use it in the future.

Figure 7. The solar powered fan system used in the pollen-proof regeneration cages for the *Beta* regeneration.

5. The *Phaseolus* Bean Program
Curator: Ted Kisha (full-time)
Technician: Dawn Tachell (full-time)

The *Phaseolus* Beans Program manages a collection of 17,549 accessions, all belonging to the *Phaseolus* genus.

A. We analyzed 120 Heirloom Beans for protein, extractable phenolics and non-extractable proanthocyanidins. There were 2 to 3-fold differences even within market classes of Red and Black beans. We also analyzed protein, sugars, and phenolic compounds in 35 nuña beans (Peruvian Popping Beans) and compared the results with 8 common Market Class dry beans. These new descriptors in GRIN will assist breeders in developing more nutritious bean varieties.
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 mite, 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.

   The original biocontrol agents included some spider mite destroyers (*Stethorus punctillium*) and spider mite predators (*Phytoseiulus persimilis*, *Neoseiulus californicus*, and *Mesoseiulus longipes*) which were relatively expensive, but the spider mite problem was very bad and we wanted to get them under control fast. Late on, we put out green lacewing eggs (*Chrysopa rufilabris*) and "Double Death" nematode predators (*Steinernema carpocapsae* and *Heterorhabtditis 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 from

planting. We're hoping that we can eventually keep the life cycle of the green lacewings going. We put out a few plant of safflower and lupines, which serve as the food the green lacewing adults, but so far we haven't seen any live green lacewings adults in the greenhouse. As an experiment, I took one tag home and put it on a houseplant and, within a month, I had green lacewings flying around inside. There must be a way to keep the cycle going if we can figure out the proper conditions in the greenhouse. We plan to extend the green lacewings using to Greenhouse #44 and that at Central Ferry research farm where the spider mites were terrible.

The biocontrol agents are relatively more expensive than that of pesticides. However, the benefit of working in a pesticide-free greenhouse is not something that can be measured in dollars. In addition, using biocontrol agents can eliminate pesticide applications that could sometimes injure plants being grown in the greenhouse.

MISSION-RELATED RESEARCH PROGRAMS

1. Alfalfa Genetics Research Program

Research Geneticist Long-Xi Yu (full-time)
Technicians: Martha Rivera (full-time); Bill Boge (retired in April 2017)
Post-Doctoral Associate: Dr. Charles Hawkins (Supported by grants from USDA-NIFA AFRP program and a collaboration project with Alforex Seeds and New Mexico State University)

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

A. Verticillium wilt (VW) is one of the most serious diseases of alfalfa worldwide. Two alfalfa populations, the FGI population (developed by Forage Genetics International) and the Pioneer population (developed by Pioneer Hi-Bred International and the alfalfa business was sold to the S&W Seed Company recently), were used for mapping the disease resistance genes. Markers associated with VW were identified by marker-trait association using the mixed linear models. Eleven markers were significantly associated with VW resistance in the FGI population and they were located on three chromosomal regions in the alfalfa genome. Six significant markers on chromosome 8 explain 40% of the total phenotypic variation and represent novel loci associated with VW resistance. Additional markers associated with VW resistance were also identified on chromosomes 2 and 7, and they co-located with regions of VW resistance loci reported in barrel medic, a distantly related wild relative of alfalfa. Most significant markers associated with VW in the Pioneer population were located on chromosome 6. Candidate genes closely linked to the resistance loci 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 resistance and water use efficiency of alfalfa is important to meet the challenges of finite available water resource. We developed advanced alfalfa breeding populations in collaboration with scientists from ARS and universities and selected from more than 3,000 plants for evaluating for drought and salt resistance in the field. We

collected evaluation data on agronomic, physiological and quality traits as well as an integrated drought resistance index (DRI). Of these, eight new lines had a higher level of drought resistance than the known resistant control and are being used in alfalfa breeding. Our study of marker-trait association also identified genetic loci associated with drought and salt tolerance. Most loci associated with drought and salt resistance in this work overlap with the previously reported quantitative trait loci (QTL) associated with biomass under drought in alfalfa. Additional significant markers were clustered in several contigs with unknown chromosomal locations. A Basic Local Alignment Search Tool (BLAST) search (using their flanking sequences) revealed homology to several annotated genes with functions in stress tolerance. With further validation, these markers may be useful for marker-assisted breeding of new alfalfa varieties with drought resistance and improved water use efficiency. The results have been reported at professional conferences and published in peer-reviewed journals.

2. Pulse Genetics Research Program
Research Geneticist: Jinguo Hu
Technician: Lisa Taylor (full-time)
Post-Doctoral Scientist: Erik Landry (resigned in September, 2017)

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. Our germplasm enhancement of winter hardy faba bean for pulse and cover crop development progressed well in the past year. Figure 8 shows the high percentage survival of the selected lines after the harsh winter in Pullman. Promising breeding materials have been distributed under standard plant evaluation agreements between researchers across various winter hardiness zones to identify suitable populations for distinctive agro-ecologies for public release.

Figure 8. High percentage survival of the enhanced winter hardy faba bean lines on the WRPIS' Pullman farm. The plots were planted on October 25, 2016 and the picture was taken on

February 10, 2017. Almost all the seedlings in the adjacent plots died during the winter months. The lowest temperature recorded on site were -10.5 °F (-23.6 °C) on December 17, 2016 and -6.2 °F (-21 °C) on January 5, 2017.

B. Supported by a grant from the CGIAR-U.S. University Linkages Program, we collaborated with the International Center for Agricultural Research in the Dry Areas, Terbol, Lebanon and collected data for eight agronomic traits on a Generation Challenge Program (GCP) reference set of 140 faba bean accessions grown under high temperature at different locations in Lebanon and U.S. We also genotyped the reference set with the genotyping by sequencing (GBS) technique which produced approximately 4 million reads per genotype on an Illumina HiSeq 2500 Sequencer. The single nucleotide polymorphism (SNP) marker calling pipeline UNEAK (Universal Network Enabled Analysis Kit) found 10,950 variant loci from the sequence data. After fileting SNPs with missing rate over 60% and minor allele frequency less than 5%, 2,632 SNPs were obtained for final analyses. The final dataset contained 131 accessions with SNP call rate above 70%. The missing SNPs were imputed by LinkImpute. The SNP genotype data discriminated the 140 entries from each other (Figure 9). Genome-Wide Association Study (GWAS) was performed using the program BLINK (Bayesian-information and Linkage-disequilibrium Iteratively Nested Keyway) and four SNPs were identified to significantly associated with plant height (2 SNPs) and 100 seeds weight (2 SNPs).

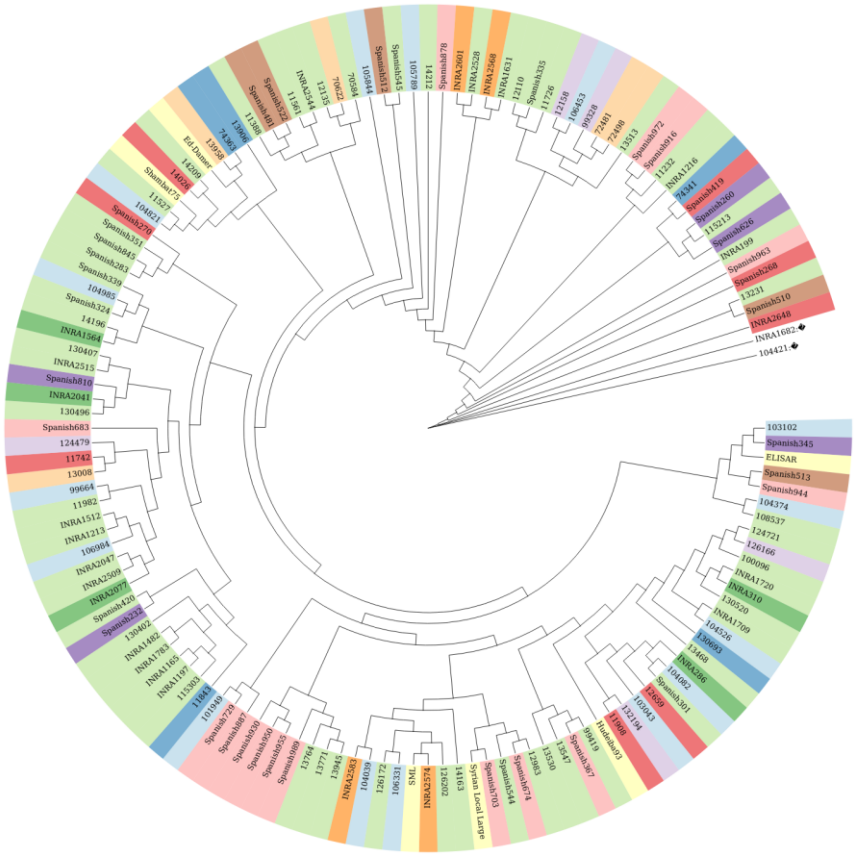


Figure 9. A neighbor-joining tree based on 1,862 SNP markers (each marker is with <10% data points missing).

C. 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. Researchers worldwide can access the database and identify genetic resources for breeding cover crops with potential under their organic farming systems.

3. Plant Pathology Research Program
Research Plant Pathologist: Frank Dugan
Technician: Shari Lupien (full-time)
Doctoral Student: Gretchen Freed

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. *Fusarium proliferatum* is an aggressive pathogen of Allium spp. and other crops. Eradication from garlic seed cloves by chemical treatment is problematic. When both cloves and bulbils originated from the same infected bulbs, infection rates in bulbils were consistently only a small percentage of those from cloves. Funded partially by a germplasm evaluation grant from the NPGS Root and Bulb Crop Germplasm Committee, we demonstrated the potential for dramatically lowering *F. proliferatum* infestation by planting bulbils instead of seed cloves for regeneration of garlic and reported the result at an APS conference (abstract can be found at https://www.apsnet.org/Documents/2017APS-ProgBk-Online.pdf).

B. *Penicillium cellarum* is one of a growing number of fungi documented as deteriorating stored sugar beets. Initial steps in implementing practical management strategies are determining the identity of the causal agents of rot and the environmental parameters most conducive to product deterioration. In collaboration with USDA-ARS NWISRL, Kimberly ID, we described *P. cellarum* sp. nov., a pathogen (Figure 10) of stored sugar beet roots, together with demonstrating its pathogenicity and environmental preferences.

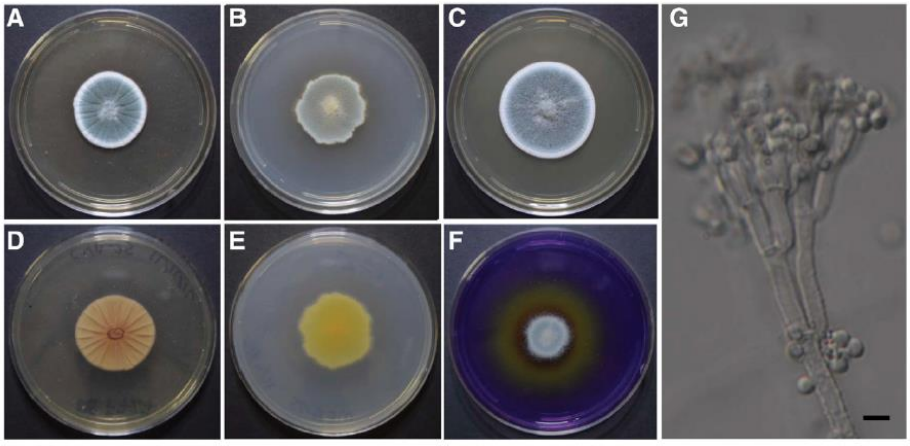


Figure 10. Growth of *Penicillium cellarum* sp. nov., isolate F727 (holotype) at 25°C after 7 days on A, Czapek yeast autolysate agar (CYA), B, malt extract agar (MEA), C, yeast extract sucrose agar, D, CYA reverse, E, MEA reverse, and F, Creatine sucrose agar. Yellow hallow indicates moderate acid production. Penicillus (G), bar = 5 μm. (Published in Plant Disease 101: 1781-1787).

C. One of Dr. Dugan's recently published books *Hidden Histories and Ancient Mysteries of Witches, Plants, and Fungi* was recognized by an interview with Brian C. Clark. "The writings on 'climate change, invasive species, crop shortages, hunger, and even famine' are nothing new and we might learn something from the way people in the past have responded to threats to survival." (The people's plants, Washington State Magazine, Fall 2017).

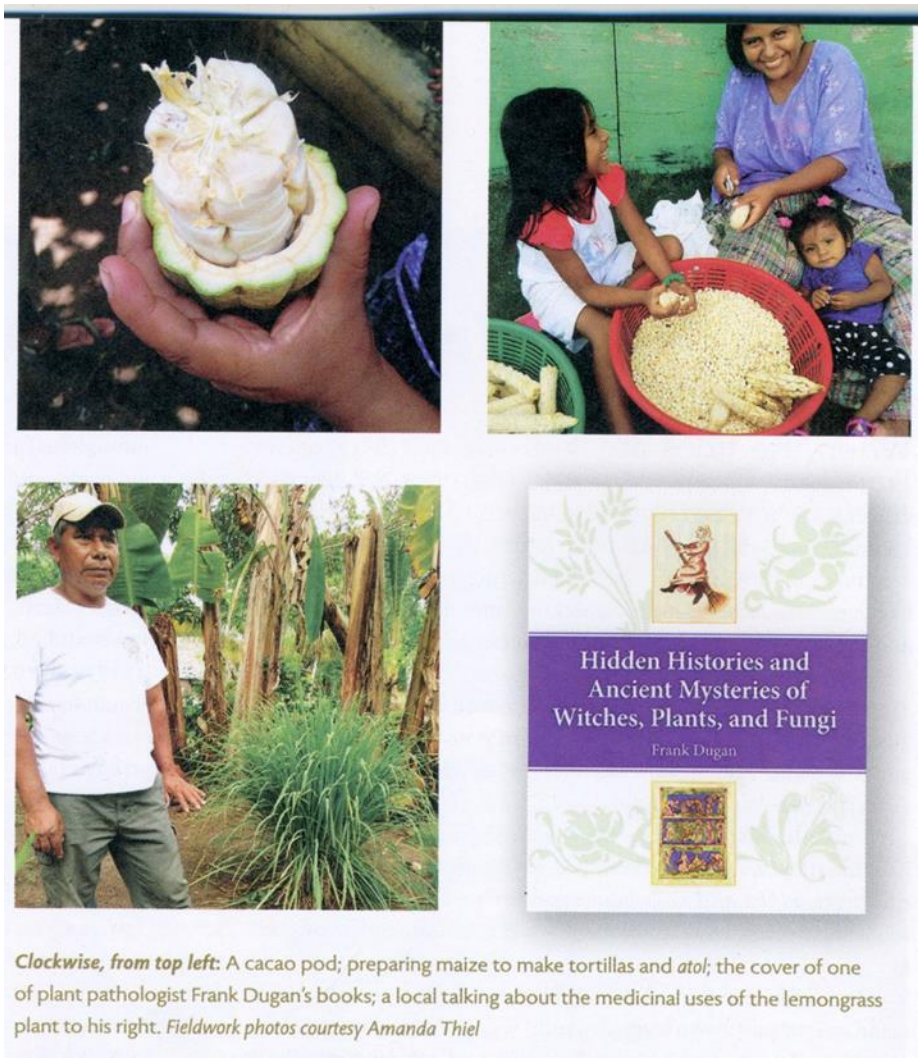


Figure 11. A figure from the Washington State Magazine, Fall 2017.

Committees, Presentations and Other Services

During 2017 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 serves 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 PhD student at University of Idaho, and chairs the graduate committee for one PhD student in WSU Department of Plant Pathology. In 2016, 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 and Department of Plant Pathology. He serves as member of The 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, Washington State University. He serves as a member in the Plant Germplasm Operations Committee and in various Crop Germplasm Committees 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 **Vicki Bradley** is 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 is also an Adjunct scientist with the Department of Crop and Soil Science at WSU. Vicki is a member of the Plant Germplasm Operations Committee, serving on the *in situ* and the Crop Wild Relatives subcommittees. She is a member of the ARS Pullman Location EEO and Outreach Committee, and is 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 serving on two Ph.D. Graduate Student committees at Washington State University. She co-supervised one post-doctoral research associate at Washington State University and is serving *ex officio* on three Crop Germplasm Committees: *Pisum*, Food Legume, and Clover and Special Purpose Legumes. 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, North American Pulse Improvement Association. Serving on Crop Science Editorial Board, CSSA Technical Editor, Div. C-1, C-8. She 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. 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, a member of the American Society of Sugarbeet Technologists and a member of the WSU Land Use Committee. *Phaseolus* Curator **Theodore Kisha** continued his service as a member and the vice-chair of the Genetics and Germplasm Working Group of the American Society for Horticultural Science and a member of the "Center for Research on Invasive Species and Small Populations (CRISSP)" at the University of Idaho. 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 19 oral or poster presentations at either scientific or general public meetings, contributed two book chapters, and published 19 peer reviewed scientific journal papers in 2017. 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 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, 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 2017

Peer reviewed journal articles (19):

1. Carpenter M.A., M Shaw, R. Cooper, T.J. Frew, R.C. Butler, S.R. Murray, L. Moya, **C.J. Coyne**, G.M Timmerman-Vaughan. 2017. Association mapping of variation in starch chain length distribution in pea (*Pisum sativum* L.) using carbohydrate and starch metabolism candidate genes. BMC Plant Biology 17:132. DOI 10.1186/s12870-017-1080-9
2. **Dugan, F.M**., **E.J. Landry**, and **J. Hu**. Ascochyta blight of faba bean. Washington State University Cooperative Extension Fact Sheet.
3. **Dugan, F.M**., S.L. Lupien, and J. Hu. 2017. Fungal plant pathogens associated with emerging crops in North America: A challenge for plant health professionals. Plant Health Progress 18: 221-229.
4. **Dugan, F.M**., S.L. Lupien, C.M. Vahling-Armstrong, G.A. Chastagner, and B.K. Schroeder. 2017. Host ranges of Penicillium species causing blue mold of bulb crops in Washington State and Idaho. Crop Protection 96: 265-272.
5. Holdsworth W.L., E. Gazave, P. Cheng, J. Myers, M.A. Gore, **C.J. Coyne**, R.J. McGee, M. Mazourek. 2017. A Community Resource for Exploring and Utilizing Genetic Diversity in the USDA Pea Single Plant Plus Collection. Horticulture Research 4;17017; doi:10.1038/hortres.2017.17.
6. Kim, W., J.-J. Park, **F.M. Dugan**, T.L. Peever, D.R. Gang, G. Vandemark, and W. Chen. 2017. Production of the antibiotic secondary metabolite solanapyrone A by the fungal plant pathogen *Ascochyta rabiei* during fruiting body formation in saprobic growth. Environmental Microbiology 19: 1822-1835.
7. **Landry E., C.J. Coyne**, R. J. McGee and **J. Hu**. 2017. A modified mass selection scheme for creating winter-hardy faba bean (*Vicia faba* L.) lines with a broad genetic base. Euphytica 213: 72. doi:10.1007/s10681-017-1843-2
8. Liu X-P, **Yu L-X** (2017) Genome-wide association mapping of loci associated with plant growth and forage production under salt stress in alfalfa (*Medicago sativa* L.). Front. Plant Sci. doi: 10.3389/fpls.2017.00853.
9. **Lupien, S.L., F.M. Dugan**, K.M. Ward, and K. O'Donnell. 2017. Wilt, crown and root rot of common rose mallow (*Hibiscus moscheutos*) caused by a novel Fusarium sp. Plant Disease 101: 354-358.
10. Ma, Y., **Coyne, C.J.**, Grusak, M.A., Mazourek, M., Cheng, P., Main, D. and McGee, R.J., 2017. Genome-wide SNP identification, linkage map construction and QTL mapping for seed mineral concentrations and contents in pea (*Pisum sativum* L.). BMC Plant Biology, 17:43. DOI: 10.1186/s12870-016-0956-4
11. Ruas, M ., Guignon, V., Sempere, G., Sardos, J., Hueber, Y., Duverhey, H., Andrieu, A., Chase, R., Jenny, C., Hazekamp, T., Jelali, K., Adeka, J., Ayala Silva, T., Chao, C., Daniels, J., Dowlya, B., Effa Effa, B., Gueco, L., Kempenaers, E., Herradura, L., Ibobondji, L., **Irish, B.M.**, Kilangi, J., Muhangi, S., Ngo Xuan, P., Paofa, J., Pavis, C., Sandoval Jorge, Sutanto, A., Thiemele, D., Tossou, C., Vangu Paka, G., Ganjun, Y., Van Den Houwe, I., Roux, N., Rouard, M. 2017. MGIS: Managing banana (*Musa* spp.)

genetic resources information and high-throughput genotyping data. Database: The Journal of Biological Databases and Curation. doi:10.1093/database/bax046.

12. Smýkal P., R. Varshney, V. Singh, **C.J. Coyne**, C. Domoney, E. Kejnovský, T. Warkentin. 2016. From Mendel's discovery on pea to today´s plant genetics and breeding. Theoretical and Applied Genetics 129: 2267-2280.
13. Strausbaugh, C.A., and **F.M. Dugan**. 2017. A novel *Penicillium* sp. causes rot in stored sugar beet roots in Idaho. Plant Disease 101: 1781-1787.
14. Thavarajah D., A. Abare, I. Mapa, **C.J. Coyne,** S. Kumar, P. Thavarajah. 2017. Selecting lentil accessions for global selenium biofortification. Plants 6 (3), p.34.
15. Wang, M.L., **Irish, B.M.**, Tonnis, B.D., Pinnow, D.L., Davis, J., Hotchkiss, M.W., Harrison, M.L. 2017. Exploring bamboo leaf nutrient value in the US NPGS germplasm collection. Austin Food Sciences. 2(1):1030.
16. Wang, M.L., Harrison, M.L., Tonnis, B.D., Pinnow, D.L., Davis, J., **Irish, B.M.** 2017. Total leaf crude protein, amino acid composition and elemental content in the USDA-ARS bamboo germplasm collection. Plant Genetic Resources. doi: 10.1017/S1479262117000053.
17. **Yu L-X** (2017) Identification of single-nucleotide polymorphic markers associated with biomass yield under water deficit in alfalfa (*Medicago sativa* L.) using genome-wide sequencing and association mapping. Front Plant Sci. doi: 10.3389/fpls.2017.01152.
18. **Yu L-X,** Chao S, Singh PR, Sorrells EM. (2017) Identification and validation of single nucleotide polymorphic markers linked to Ug99 stem rust resistance in spring wheat. PLoS ONE 12 (2): e0171963. doi:10.1371/journal.pone.0171963.
19. Zhang F, Zhang T, Long R-C, Lv H, Wang Z, **Yu L-X**, Kang J, Yang Q (2017). Genome-wide association study identifies loci associated with early-flowering in autotetraploid alfalfa (*Medicago sativa* L.) using genotyping-by-sequencing. Submitted to peer-reviewed journal.

Appendix 1

Western Regional Plant Introduction Station
Current Staffing List as of May 20, 2017

Position	Name	Federal or State	Position type
Pullman			
Research Leader/Station Coordinator	Jinguo Hu	Fed	PFT
Program Support Assistant	James Dann	Fed	PFT
IT Specialist	Bo Gao	Fed	PFT
Biological Science Technician	Lisa Taylor	Fed	PFT
Seed Manager/Computer Specialist	Dave Stout (retired)	Fed	PFT
Plant Technician	Jacqueline Cruver	Sta	PFT
Plant Technician	Julianna Gothard	Sta	PFT
Farm Manager, Pullman	Charles Golob	Sta	PFT
Plant Technician	Saber Jewell	Sta	PFT
Plant Technician	Scott McGee	Sta	PFT
Farm Manager, Central Ferry	Kurt Tetrick	Fed	PFT
Plant Technician	Jennifer Morris	Fed	TFT
Research Plant Pathologist	Frank Dugan	Fed	PFT
Biological Science Technician	Shari Lupien	Fed	PFT
Agronomy and Native Plants Curator	Vicki Bradley	Fed	PFT
Biological Science Technician	Jessy McGowan	Fed	TFT
Plant Biologist	Michael Cashman	Fed	TFT
Biological Science Technician	Bob Guenthner	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
	Plant Technician	Jesus Prieto	Sta	TPT
	Research Geneticist	Long-Xi Yu	Fed	PFT
	Biological Science Technician	Vacant since May 2017	Fed	PFT
	Biological Science Technician	Martha Rivera	Fed	PFT

Appendix 2

Research, Service and Outreach Activities

January 12, Barbara Hellier provided information on fodder beets to a stakeholder.

January 13, Vicki Bradley met with Orlin Reinbold (Landmark Turf & Native Seed) and Michael Neff (WSU) to discuss their interest in selecting accessions for low input turf applications.

January 14-18, Clarice Coyne organized a workshop Genomics of Genebanks, attended workshops on "Interest Group for Applying Genetic Information to Plant Genetic Resource (PGR) Management within the National Plant Germplasm System (NPGS)" and "International Consortium to Sequence the Pea Genome" at the 2017 International Plant and Animal Genome Conference (PAG XXV), San Diego, CA.

January 14-18, Long-Xi Yu participated and gave oral presentation in the Molecular Breeding Workshop at the 2017 International Plant and Animal Genome Conference (PAG XXV), San Diego, CA.

January 14-18, Jinguo Hu attended the 25th International Plant and Animal Genome Conference (PAG XXV) and co-organized the Molecular Breeding Workshop, San Diego, CA.

January 17-18, Brian Irish participated in the 2017 Washington Hay Expo held in Kennewick, WA.

January 17-18, Charles Hawkins participated and gave oral presentation on genomic selection in alfalfa during the 2017 Washington Hay Expo held in Kennewick, WA.

January 20, Jinguo Hu visited the faba bean evaluation plots at the Lundberg Family Farms, Richvale, CA.

January 26, William Luna attended a Wilbur-Ellis Professional Technical Seminar, Spokane, WA.

January 27, Vicki Bradley and Bob Guenthner met with WSU IT personnel for training on editing the Safflower Genetic Resources webpage in Wordpress.

January 27-February 1, Clarice Coyne presented an invited talk "Winter-hardiness in chickpea" at Indo-US Bilateral Workshop "Genomic Approaches for Yield Enhancement and Biological Nitrogen Fixation in Chickpea", New Delhi, India.

January 29-31, Brian Irish attended the Western Alfalfa Seed Growers Association meeting in Las Vegas, NV.

February 2-5, Jinguo Hu attended the Organicology Conference, Portland, OR.

February 13-14, Clarice Coyne co-organized a meeting of the Pulse Crop Working Group and presented a talk "Genetic resources for trait/gene discovery in pulse crops", Pullman, WA. Frank Dugan also attended.

February 15, Clarice Coyne presented three research proposals to the USA Dry Pea & Lentil Council and Northern Pulse Growers Research Review Committee.

February 16, Barbara Hellier provided images of *Beta vulgaris* ssp. *maritima* to American Seed Trade Association for a display at Walt Disney World Resort, Epcot Center.

February 24, Brian Irish gave a webinar presentation to the Tropical/Sub-Tropical forum entitled, "*Musa*: untapped genetic diversity".

February 26 to 27, Barbara Hellier attended the ARS-Sugarbeet Industry listening session and the Sugarbeet Crop Germplasm Committee meeting, Greenville, SC.

February 26 to 27, William Luna attended Washington State Agriculture Pesticide License Recertification training, Pullman, WA.

February 26-27, Jinguo Hu attend the Sugar Beet Crop Germplasm Committee meeting and the 39th Biennial Meeting of American Society of Sugar Beet Technologists in Greenville, SC.

March 6, Ted Kisha spoke with the Moscow Charter School Science class about the NPGS, beans, and nutrition

March 13-14, Jinguo Hu visited ARS-Parlier, CA and attended the 2017 California Leafygreen research meeting in Pismo Beach, CA.

March 15, Jinguo Hu visited the faba bean evaluation plots at the Lundberg Family Farms, Richvale, CA.

March 17, Ted Kisha attended the WSU 1ST Annual Du Pont Plant Symposium on Diversity in Agriculture

March 15, Vicki Bradley gave a tour of seed storage and the Pullman Farm to Michael Neff, Charles Golob, and Cody Gyllenberg.

March 30, Vicki Bradley, Ted Kisha, Jessy McGowan, Dawn Tachell, and Lisa Taylor volunteered as judges at the Jefferson Elementary School Science Fair in Pullman, WA.

March 31, Ted Kisha attended the WSU Academic Showcase Celebrating the research, scholarship, and creative activities of faculty, staff, and graduate and professional students.

March 7, Long-Xi Yu was invited to present "Genomic-assisted breeding for enhancing resistance to biotic and abiotic stresses in alfalfa: a progress report" at the Washington Alfalfa Seed Commission, Pasco, WA.

March 7, the annual Food, Fun, and Fact Fest was held and a representative from each WRPIS programs presented a summary of the year's work and future plans.

March 20, Barbara Hellier provided information to the Organic Seed Alliance, WA on lettuce disease resistance.

March 22, Barbara Hellier provided information on a garlic cultivar to a stakeholder.

March 30, Barbara Hellier submitted an annual report to the Beet Sugar Development Foundation on the status of the *Beta* collection and grant funding use.

April 7, Barbara Hellier provided *Allium* collection statistics to a stakeholder.

April 11 Ted Kisha gave a tour of the *Phaseolus* Greenhouse and Seed Storage facility to the WSU Integrated Plant Sciences class.

April 13, Vicki Bradley met with Jim Wallis of the WSU Browse lab to discuss fatty acid analysis in safflower seed.

May 11-19, Clarice Coyne presented an invited talk "Abiotic stress tolerance in chickpea" at CropSym: Crop abiotic stress workshop and participate in a Binational Research Foundation funded project collaboration meeting at the Hebrew University of Jerusalem, Rehovot, Israel.

May 8-12, Long-Xi Yu visited Sichuan Agricultural University and served as committee member of a Ph.D. student, Xinchun Liu, who worked as a visiting scholar in Dr. Yu's lab and conducted part of his thesis study.

May 17-23, Brian Irish traveled to Mayaguez, Puerto Rico to wrap up research at the Tropical Agriculture Research Station as well as to participate, present research and received award in the 2nd Annual Chocolate Festival.

May 25, Barbara Hellier provided information on *Papaver* seed storage longevity to a stakeholder.

June 15-September 10, WRPIS hosted a Chinese visiting scientist, Dr. Deming Jin, Professor of College of Plant Science and Technology, Huazhong (Central China) Agricultural University, Wuhan, China. Professor Jin participated in an international collaborative research project on heat tolerance of faba bean, an agreement of the USAID Linkage Program under CRP-Grain Legumes-between Jinguo Hu and ICARDA (International Center for Agricultural Research in the Dry Areas).

June 19-25, WRPIS hosted Drs. Xuxiao Zong, Chief Scientist, and Tao Yang, Geneticist, Pulse Crop Research Unit, Institute of Crop Science, Chinese Academy of Agricultural Sciences, Beijing, China. They met with Todd Scholz, Vice President of Research & Member Services, USA Dry Pea & Lentil Council in Moscow, ID on June 20. They also toured the seed storage facility, individual curatorial program and research farms at Pullman and Central Ferry. They also spent one day with the Research Leader Dr. George Vandemark, Research Geneticist Dr. Rebecca McGee and Research Plant Pathologist Dr. Weidong Chen of the ARS Grain Legume Genetics and Physiology Research Unit.

June 19-20, Brian Irish hosted in Prosser, WA visiting scientist and perennial Legume Breeder Dr. Brandon Schlautman from the Land Institute in Salina, Kansas.

June 23, Brian Irish and technical staff hosted a team of visiting Chinese agricultural scientists.

June 21, Vicki Bradley, Jinguo Hu and Frank Dugan attended the W6 Technical Advisory Committee meeting.

June 21, Barbara Hellier was visited by Brandon Schlautman, Perennial Legume Breeder, The Land Institute to discuss potential forage legumes in the W6 Miscellaneous collection. Several field nurseries with taxa of interest were toured.

June 23-27, Long-Xi Yu participated American Society for Plant Biologists and presented a poster entitled "Identification of loci associated with resistance to root-rot diseases in autotetraploid alfalfa using genome-wide sequencing and association mapping" in Honolulu, HI.

July 3-27, Ted Kisha was a mentor to a summer intern (Shelly Brice) with the Washington Upward Bound Program.

July 4-5, Clarice Coyne hosted visiting scientist Betsy Alford from the University of California, Davis to assist on collection of chickpea field production field soil samples for a *Rhizobium* survey.

July 14, Barbara Hellier virtually attended the Herbaceous Ornamental Crop Germplasm Committee meeting and submitted a collection status report.

August 5-9, Frank Dugan attended the American Phytopathological Society Annual Meeting and presented one poster (Infection rate by *Fusarium proliferatum* in aerial garlic bulbils is reduced compared to rate in seed cloves when both originate from infected bulbs) and was coauthor on another (Mycobiome study reveals pathogens of *Camassia* in the Pacific Northwest), San Antonio, TX.

August 8, Barbara Hellier provided information on seed harvest pollination bags to a stakeholder.

August 9-10, Clarice Coyne participated in a meeting of collaborators of the Genome Canada project Application of Genomics to Improve the Lentil Economy (AGILE) and gave a presentation "AGILE field phenotyping in the Palouse region of Washington State, Saskatoon, Canada.

August 11, Barbara Hellier provided a tour of Seed Storage and *Beta* regeneration plots to Imad Eujayl, ARS molecular biologist, Kimberly, ID.

August 14, Barbara Hellier provided information on *Beta vulgaris* accession disease resistance to a stakeholder.

August 18-22, Ted Kisha attended the annual conference of the American Society for Horticultural Science at the Hilton Waikaloa in Hawaii. Served as the Vice Chair of the Genetics and Germplasm (GG) Working Group, Organized and attended the Precision Breeding Workshop, presented "Relationship between seed coat colors and patterns with phenolic content and antioxidant activity in a collection of 120 heirloom accessions of beans (*Phaseolus vulgaris*) from the National Plant Germplasm System", and co-authored "Characterization of sugar concentration among edible podded accessions in the USDA *Phaseolus vulgaris* germplasm collection".

August 22-25, Clarice Coyne attended a Variant Calling Bioinformatics Workshop at University of California, Davis, CA.

September 1, Barbara Hellier provided table beet accession evaluation data to a stakeholder.

September 1, Barbara Hellier provided freeze dried rhubarb leaf tissue for a stakeholder's use in a molecular marker study.

September 10-16, Jinguo Hu was invited to attend an onsite workshop of collaborative research on pulse crop breeding, genomics and germplasm and give a presentation entitled "Enhancing faba bean germplasm for resilience to temperature extremes", in Kunming, China.

September 14, Barbara Hellier provided information on potential ornamental taxa to a stakeholder.

September 15, Barbara Hellier provided *Allium sativum* topset data to a stakeholder.

September 17 to 23, Barbara Hellier attended the American Society of Horticultural Science annual conference and the Leafy Vegetable Crop Germplasm Committee meeting where she presented a *Lactuca* collection status report. Waikoloa, HI.

September 19-23, Jinguo Hu attended the 2017 ASHS Annual Conference, attended the Leafy Vegetable Crop Germplasm Committee (CGC) and the Root and Bulb CGC meetings, and give an oral presentation entitled "A crimson flowered vegetable type faba bean germplasm line", Waikoloa, HI.

September 28, Barbara Hellier provided table beet flesh color data to a stakeholder.

October 6, Barbara Hellier delivered a presentation on USDA-ARS, National Plant Germplasm System, ARS-Pacific West Area, ARS-Pullman location and WRPIS organizational structure to the W6 Unit.

October 8-19, Ted Kisha collected the North American wild kidney bean (*Phaseolus polystachios*) in KY and TN funded by a grant from the Plant Collection Office.

October 19, Barbara Hellier provided a collection status report for the Special Purpose and Clover Crop Germplasm Committee meeting in Tampa, FL.

October 21-22, Clarice Coyne gave an invited talk "Crop wild relatives at USDA: Ancient legumes pea, chickpea and lentil" at American Society of Agronomy, Crop Science Society of America, American Public Gardens Association Core Planning Committee Meeting, Tampa, FL.

October 23-25, Clarice Coyne presented research "Yield components in the USDA pea core collection" and "Genetically-enhanced winter-hardy faba bean (*Vicia faba* L.) germplasm for cover crop cultivar development" at the ASA-CSSA-SSSA Annual Meeting, Tampa, FL.

October 23-25, Jinguo Hu attended the ASA-CSSA-SSSA Annual Meeting and presented a poster entitled "Genetically-enhanced winter-hardy faba bean (*Vicia faba* L.) germplasm for cover crop cultivar development" at Tampa, FL.

October 23-25, Brian Irish attended the ASA-CSSA-SSSA Annual Meeting and presented report to the Clover and Special Purpose Legume Crop Germplasm Committee (CGC) in Tampa, FL.

October 30 – November 3, Ted Kisha attended the meetings of the Bean Improvement Cooperative, North American Pulse Improvement Association, the W-3150 (Breeding Common Bean (*Phaseolus vulgaris* L.) for Resistance to Abiotic and Biotic Stresses, Sustainable Production, and Enhanced Nutrition), and the *Phaseolus* Crop Germplasm Committee at Michigan State University in East Lansing, MI.

November 1, Clarice Coyne co-organized the 7th International Legume Root Diseases Workshop and co-authored the presentation "Seventeen years of research on genetics of resistance to *Aphanomyces* root rot of pea", East Lansing, MI.

November 13-17, Long-Xi Yu hosted visiting scientist, Ian Ray from New Mexico State University and trained him for the high-throughput SNP genotyping and genome-wide association studies in enhancing resistance to biotic and abiotic stresses in alfalfa.

November 2-3, Clarice Coyne co-authored a presentation "Identification of quantitative trait loci (QTL) controlling cold tolerance in chickpea recombinant RIL population rom *Cicer arietinum* L. x *C. reticulatum*." At North American Pulse Improvement Association and presented Curator Reports to the Pea Crop Germplasm Committee (CGC) and the Food Legume CGC, East Lansing, MI.

November 15, Barbara Hellier virtually attended the Root and Bulb Crop Germplasm Committee meeting and presented an *Allium* and table beet collection status report.

November 29, Barbara Hellier provided collection proposal reviews for the Plant Exchange Office.

December 13, Clare Coyne and Ted Kisha attended the Annual Pulse Grower's Meeting of the Western Pulse Growers Association that was organized by the USA Dry Pea and Lentil Council. Clare presented posters from the NAPIA and ASA-CSSA-SSSA Annual meeting, and Ted presented a poster on the nutritional components of heirloom beans, Moscow, ID.

Appendix 3

Meeting Minutes of the 2017 W-6 TAC Meeting (pending approval)

Date: Wednesday, June 21, 2017

Location: Hulbert Hall, Room 323J, WSU Pullman Campus

Officers:

Chair – Joe Kuhl

Vice Chair – Carol Miles

Secretary – Jack Martin

2017 W6 TAC Teleconference participants:

In person (Hulbert Hall, Room 323J, Washington State University, Pullman Campus):
Joseph Kuhl, University of Idaho, Moscow, ID, Email: jkuhl@uidaho.edu;
Jim Moyer, Washington State University, Pullman, WA, email: j.moyer@wsu.edu;
Jinguo Hu, ARS WRPIS, Pullman, WA, email: jinguo.hu@ars.usda.gov;
Frank Dugan, ARS WRPIS, Pullman, WA, email: frank.dugan@ars.usda.gov;
Ted Kisha, ARS WRPIS, Pullman, WA, email: theodore.kisha@ars.usda.gov;
Vicki Bradley, ARS WRPIS, Pullman, WA, email: vicki.bradley@ars.usda.gov;
Dave Stout, ARS WRPIS, Pullman, WA, email: Dave.Stout@ars.usda.gov;

Called In:
Edward Kaleikau, USDA NIFA, Washington, DC, email: EKALEIKAU@nifa.usda.gov;
Hao Tran, ARS PWA, Albany, CA, email: Hao.Tran@ars.usda.gov;
Gary Kinard, ARS NGRL, Beltsville, MD, email: Gary.Kinard@ars.usda.gov;
Harold Bockelman, ARS NSGC, Aberdeen, ID, email: Harold.Bockelman@ars.usda.gov;
Joseph Postman, ARS NCGR, Corvallis, OR, email: Joseph.Postman@ars.usda.gov;
John Preece, ARS NCGR, Davis, CA, and ARS NALPGR, Parlier, CA, email: John.Preece@ars.usda.gov;
Stephanie Greene, ARS NLGRP, Ft. Collins, CO, email: Stephanie.Greene@ars.usda.gov;
Marylou Polek, ARS NCGRCD, Riverside, CA, email: Marylou.Polek@ars.usda.gov;
Dan Parfitt, University of California, Davis, CA, email: fzparfit@plantsciences.ucdavis.edu;
Mark Brick, Colorado State University Fort Collins, CO, email: Mark.Brick@ColoState.EDU;
Melinda Yerka, University of Nevada Reno, Reno, NV, email: myerka@unl.edu;
Ian Ray, New Mexico State University, Las Cruces, NM, email: iaray@nmsu.edu;
Edward Scheenstra, Washington State University, Mount Vernon, WA, email: escheenstra@wsu.edu;
Jacqueline King, Washington State University, Mount Vernon, WA, kingjack@wsu.edu;
Kevin Jensen, ARS FRR, UT, email: Kevin.Jensen@ars.usda.gov;
Jack Martin, Montana State University, Bozeman, MT, email: jmmartin@montana.edu;
Shawn Mehlenbacher, Oregon State University, email: shawn.mehlenbacher@oregonstate.edu
Barbara Hellier, ARS WRPIS, Pullman, WA, email: Barbara.Hellier@ars.usda.gov;
Brian Irish, ARS WRPIS, Pullman, WA, email: Brian.irish@ars.usda.gov;

Meeting was called to order by Chair Joe Kuhl at 8:30am. There were brief opening remarks regarding agenda and procedure.

Administrative Advisor report (Jim Moyer):

Dr. Moyer summarized the recent National Plant Germplasm Committee meeting held in Geneva, NY. There has been some movement on treaties. The plant germplasm community will want to continue follow these developments. There is increasing focus on documenting impact of the germplasm collections and the accessions distributed to users. There was discussion on how state reports would be tailored to reflect impact rather than just a log of accessions that were distributed. A key point is to try to link germplasm to commerce. Budgets continue to be an issue. As for W6, the project is now back on a 5-year cycle. Many universities have a close working relationship with USDA-ARS. WSU is no exception. For example there may be a state employee supervised by a USDA scientist. These relationships may prove to be more problematic in the future. The proposed W6 FY2018 budget is $435,940. See below for budget discussion.

ARS National Program Office report (Peter Bretting):

Dr. Bretting was not present due to schedule conflict. Power point slides were submitted as a summary of National Program Office activities.

National Program Leader Plant Systems-Production NIFA update (Ed Kaleikau):

Congress has increased appropriations for several competitive grant programs above their 2016 levels. Plant breeding for agricultural production will be a Foundational program within AFRI in 2017. Funding opportunities will include research grants and conference grants. The research grants will target pre-breeding and germplasm enhancement, selection theory, applied quantitative genetics and participatory breeding. The 2014 Farm Bill enables eligible state and national commodity boards to submit topics for research supported through AFRI. Topics must relate to AFRI's priorities. Once topics are approved proposals follow normal peer review process. Plant breeding remains a priority and funding has increased over past few years.

USDA-ARS Pacific West Area Office report (Hao Tran):

Staffing changes were mentioned. Dr. Tran pointed out that 7 out of 20 USDA-ARS locations in the Pacific West Area are plant germplasm sites.

TAC meeting minutes, budget and discussion:

It was noted that the copy of the minutes that was distributed had a sentence that should be removed.

Dan Parfitt moved and Jack Martin Seconded a motion that the 2016 W6 TAC meeting minutes be approved. Motion passed.

The FY2018 budget was discussed. The proposed FY18 budget in $435,940. This is an increase over the FY2017 budget of $10,520. The increases were in salary and fringe benefits.

The Pullman regional airport expansion will take about 30 acres of WPPIS land. Dr. Hu is working with WSU administration to find alternative land. A tentative plan has WRPIS renting land from WSU for ~$100 per acre. The hope is to secure a long term rental agreement. The alternative land would require additional costs in terms of time and travel. Dr. Hu expects to have a final agreement in the near future.

Shawn Mehlenbacher moved with Kevin Jensen second to approve the FY2018 budget. Motion passed.

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

The lab provides many functions to serve the National Genetic Resources Program. The Laboratory is comprised of the Plant Exchange Office (PEO), the Database Management Unit (DBMU), and the Plant Disease Research Unit (PDRU). A new botanist, Dr. Melanie Schori, was hired this past year. GRIN-Global has been implemented for about 1.5 year. The system seems to be working well but is constantly undergoing small fixes. Other gene banks have expressed interest in collaborating with GRIN-Global.

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

The National Small Grains Collection (NSGC) presently holds 143,893 accessions of the small grains.

The 'Wild Barley Diversity Collection' was recently assigned PI numbers. It consists of 318 accessions of Hordeum vulgare subsp. spontaneum, the primary genepool wild relative of cultivated barley, representing the entire geographic range of this important CWR. It was donated by Brian Steffenson, Univ. of Minnesota, through collaborations with ICARDA.

They are continuing their efforts to capture voucher images of spikes, panicles, and seeds.

Evaluation of NSGC wheat landrace accessions is continuing for reaction to the Ug99 stem rust race in Kenya.

As for staff changes, Charles Erickson, Agronomist with NSGC, retired. The plan is to re-fill the position when hiring freeze ends.

The 2016 Fall nursery had to be terminated due to the severe winter. This is a set-back for evaluation efforts for the winter cereals.

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

Staff changes include Jill Bushakra a former postdoc was hired as Rubus/Ribes Crop Manager, and Barbara Gilmore was hired as field farm manager.

Screenhouses and greenhouses are being upgraded.

The bacterium Xylella fastidiosa was identified in a few pear trees at the Corvallis site. The pathogen can cause a chronic leaf -scorching disease in many different species of woody landscape shrubs and shade trees. This suspended shipment of Pyrus scions and cuttings temporarily.

Collaborated with staff of NCGR-Davis to backup genetic resources of hazelnuts in Parlier, CA. This is especially important because Eastern Filbert blight has been found in Corvallis.

Research highlights:

- Developed a multiplexed 14-SSR fingerprinting set as a tool for quick and economic identity verification for hazelnut.
- Developed DNA test for aphid resistance in raspberry.
- Determined the northern limits and distribution of Fragaria cascadensis in Oregon.
- Observed enneaploid (9x) hybrids where F. cascadensis is sympatric with F. virginiana ssp. Platypetala.

National Clonal Germplasm Repository, Davis, CA and National Arid Land Plant Genetic Resources Unit, Parlier, CA (John Preece):

The Davis facility receives, collects, preserves, evaluates, and distributes genetic resources of Mediterranean fruit and nut crops. The Parlier facility is a work site that serves as important germplasm regeneration center for other (NPGS) sites that have species and accessions that require long frost-free seasons or arid conditions for seed production or regeneration of vegetative propagules

The facility is fully staffed. A research technician was hired to work with pistachio tissue culture procedures.

The number of items shipped declined in 2016 because the facility stopped shipping orders to the general public. Requests for plant material from the general public are being taken care of by California Rare Fruit Growers. The details of this agreement with California Rare Fruit Growers was discussed.

It was noted the size of the collection has grown ~25% in the past three years (from 7,000 to 8,732 accessions). The increase is mainly due to the addition of crop wild relative accessions.

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

The facility has developed their new 5 year plan which is now in review.

There are currently 5 staff vacancies. But some staffing needs have been met by bringing in 2 pathways interns and 2 Letter of Authorization (L/A) Appointments.

They processed 18,201 seed samples during FY2016.

Percent of W6 collections backed up at NLGRP was noted. This ranged from <90% for safflower to 30% for onion.

Svalbard gene bank in Norway has received attention in the popular press because water had surrounded the entrance to the seed vault. It was noted that no water actually entered the seed vaults themselves and it remains a safe and secure from water damage. As an extra precaution, NLGRP will send seed to the Svalbard gene bank in plastic rather than cardboard containers.

Western Regional Plant Introduction Station (Jinguo Hu):

Number of accessions totalled 96,229 accessions belonging to 986 genera, 5,159 species (taxa) as of 12/31/2016.

They acquired 3,524 new accessions including 1,353 Phaseolus beans from the International Center for Tropical Agriculture (CIAT) in Colombia, 1,249 native plant accessions collected by the Seeds of Success (SOS) project and 174 Lupinus from Germany.

They distributed 33,354 packets of seed samples to 1,364 requestors with addresses in each of the 50 domestic states and 46 foreign countries. Seventy-four percent (24,772 packets) were distributed to the U.S. and 26% (8,582 packets) were distributed to foreign countries. Requestors in each of the 50 domestic states received germplasm samples from WRPIS in 2016. A total of 10,990 packets from WRPIS went to the 13 Western states.

They uploaded 45,092 observation data points on 9,876 accessions into the Germplasm Resources Information Network (GRIN)-Global database. These data points are on 168 established descriptors for 20 different crop species. Collaborators contributed 6% and WRPIS staff provided 94% of the evaluation data. The database is accessible by researchers worldwide via the internet.

Coordinated a domestic wild bean collection trip and collected 17 North American wild kidney bean or thicket bean, which is a perennial vine related to the lima bean in Virginia and North and South Carolina.

Research highlights:

A research project on determining the genetic diversity of cultivated lentil was completed and published. The project interrogated 352 lentil accessions with 1,194 polymorphic single nucleotide polymorphism (SNP) markers and identified three agro-ecological zones.

A research project studying the adaptation of autumn-sown faba bean germplasm to South-eastern Washington was completed and results were published in Agronomy Journal. Promising breeding populations have been distributed under ARS Plant Evaluation Agreements to researchers across various winter hardiness zones in the U.S.

Staff changes:

Dr. R. C. Johnson retired in 2016, and the position will not be re-filled. Gwen Pentecost (IT specialist) retired during 2016. The goal is to re-fill the position.

Dr. Brian Irish was hired as the Curator/Geneticist of the Temperate-adapted Forage Legume (TFL) genetic resources program at the ARS worksite in Prosser, WA.

The Pullman facility is nearing its seed storage capacity. The hope is to have a long term capital improvement plan to increase storage capacity.

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

Because of pathogens and other exotic pests germplasm facilities are being proactive to back up their collections. This point came up repeatedly in reports. The NCGRCD at Riverside has

an ongoing program to secure citrus genetic resources by establishing them in cryopreservation at NLGRP in Fort Collins, CO. In CY2016 an additional 209 accessions were sent to NLGRP for processing and preservation. This has brought the total number of accessions from the screenhouse in cryopreservation to 401, with approximately 78 remaining.

There is concern about Huanglongbing (HLB), or citrus greening disease in California. They are taking precautions to prevent its occurrence. The precautions and laboratory screening are having an impact on budget.

Methods for detection of HLB were mentioned. APHIS technique uses quantitative PCR. But it does not detect it early enough. Methods for early detection are being developed.

Business meeting and State Reports:

TAC members summarized their written state reports.

California state report (Dr. Dan Parfitt)

Highlights of submitted report:

- There were 676 requests for plant introductions representing 342 different users
- A mango from Pakistan that does not produce fruit in Florida did produce excellent fruit in Southern California.
- Zea mays accessions used for educational purposes.
- Cowpea (Vigna unguiculata) lines were used in screening for resistance to Cowpea mosaic virus (CPMV).
- Seeds from NPGS were used as reference specimens to identify seeds from archaeological records.

Colorado state report (Mark Brick for Pat Byrne):

Highlights of submitted report:

- There were 1,661 accessions delivered in Colorado, constituting 96 orders.
- Maize accessions are being used to research xylem functionality, repair, and overall robustness.
- Photographs were obtained using NPGS accessions to use in noxious weed identification tool.
- Beta vulgaris accessions are being evaluated for resistance to Rhizoctonia in a field nursery.
- Historical spring wheat varieties were evaluated for their response to additions of compost to the soil in a greenhouse study

Idaho state report (Joe Kuhl):

Highlights of submitted report:

- There were 5,709 accessions requested from 107 orders.
- Large numbers of Tritucum accessions are being used in public and private breeding programs.
- Solanum and Lupinus accessions are being evaluated as trap crops for Globodera pallida (pale cyst nematode).

- Phaseolis accessions are being used for virus propagation and identification.

Montana state report (Jack Martin):

Highlights of submitted report:
- Twenty-seven recipients received 874 plant germplasm accessions
- Wheat accessions are being used to identify additional sources of resistance to the wheat stem sawfly.
- Apple accessions are being used as reference standards to identify historical apple varieties.

Nevada state report (Melinda Yerka):

Highlights of submitted report:
- Twenty-two orders were placed for a total of 109 plant accessions.
- Artemisia tridentate sbsp are being used to develop genetic markers to help identify and ensure the correct species of sage brush is planted for sage grouse habitat.
- Plant materials from NPGS are being used for identification and analysis of archaeological materials.

New Mexico state report (Ian Ray):

Highlights of submitted report:
- Twenty-three individuals placed 35 orders and received 895 accessions.
- Maize accessions primarily representing older southwestern U.S. maize landraces or heirloom varieties are being evaluated for drought and salinity tolerance to be used as potential donors of abiotic stress tolerance in modern hybrids.
- Diploid alfalfa accessions are being evaluated under low water conditions. Promising accessions will be mated with tetraploid alfalfa to determine if diploid alfalfa can contribute useful alleles to cultivated alfalfa.
- Peanut accessions are being evaluated for resistance to Sclerotinia disease. Promising lines have been identified to be used as parent lines in the breeding program to produce new cultivars with improved resistance to Sclerotinia disease.

Oregon state report (Shawn Mehlenbacher):

Highlights of submitted report:
- Hazelnut accessions with high resistance to Eastern Filbert blight (EFB) have been identified.
- Large numerous new simple sequence repeat (SSR) markers were developed for hazelnut. These will be useful for future breeding and genetic studies.
- Several taxa from the NPGS system are being used as reference specimens for identifying ancient plant remains in archaeological sites, primarily on the Channel Islands off southern California.
- NPGS accessions were used to construct the first genome sequence for Mentha. This was accomplished using M. longifolia which is a diploid species ancestral to cultivated peppermint and spearmint.
- Twenty-two publications were reported.

Utah state report (Kevin Jensen):

Highlights of submitted report:

- Maize line B96 was shown to be resistant to some, though not all, spider mites that are pests to maize and other grasses.
- NPGS accessions is being used to study pollinator diversity. The knowledge gained will inform future Seeds of Success target species designations.
- Wheat accessions were used for phenotypic evaluation for dwarf bunt resistance.
- Several maize accessions (inbreds and populations) are being test for use in breeding program to develop improved inbreds to be used in hybrids for irrigated organic production in the inter-mountain region.

Washington State report (Jacqueline King and Edward Scheenstra for Carol Miles):

Highlights of submitted report:

- About two thirds of the plant germplasm recipients were from universities or USDA.
- The uses and utilization germplasm were varied. Some included DNA extraction and molecular marker analysis of Malus domestica, taxonomic identifications of archaeological and ethnobotanical materials, SNP genotyping and screening of Lens and Pisum spp., and assessing insect screening of Convolvulus equitans.
- Requested materials belonged to 149 genera and 386 species and subspecies.

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):

Highlights of submitted report:

- Alaska had 25 accepted orders, 154 order items of which 99 were filled on 10 addresses.
- Many apple accessions being evaluated for adaptation and survival in this harsh Northern latitude environment.

Arizona state report (Dave Stout):

Highlights of submitted report:

- Arizona had 75 accepted orders, 1,748 order items of which 1,665 were filled on 38 addresses.
- Asclepius sp. were used in an experiment testing restoration design and response from the pollinator community.

Hawaii state report (Dave Stout):

Highlights of submitted report:

- Hawaii had 33 accepted orders, 303 order items of which 233 were filled on 26 addresses.
- Chickpea accessions are being evaluated for their adaptation in the state. This is part of an effort to evaluate chickpea crop suitability to different growth conditions in Hawaii as part of the crop diversity and self-sufficiency movement in the state.

Wyoming state report (Dave Stout):

Highlights of submitted report:

- Wyoming had 18 accepted orders, 636 order items of which 571 were filled on 7 addresses.
- Pepper accessions being evaluated in a dry, high desert location. The goal is to increase the diversity of pepper genotypes available to local growers.

Open discussion:

The W6 TAC has discussed the role of TAC members over the years. The individual TAC members contribute in at least two important ways. First, to facilitate the flow of money to germplasm facilities. This is done through review and recommendation of budget. Second, communicate with germplasm users and stakeholders in individual states. The importance of stakeholders was emphasized.

There is increasing emphasis on impact. The group discussed ways of tracing and documenting impact. One suggestion was for each TAC member to forward a 1 or 2 bullet point statement documenting the impact of plant germplasm in their state. One problem with our current system of reporting is that it does not do a good job of tracking long term impact. That issue was discussed.

The issue of vacancies among the state TAC representatives was mentioned. Representatives from CA, CO, and MT will leave the committee due to retirement this year. At WPRIS all federal scientists except the new forage curator are eligible for retirement.

Election of Officers:

The slate of officers includes Carol Miles to move to Chair, Ian Ray as Vice-chair, and Joe Kuhl as secretary for 2018. The slate of officers was approved by acclamation.

Meeting site for 2018:

Corvallis, OR was selected as the meeting site for the 2018 TAC meeting.

Shawn Mehlenbacher moved and Dan Parfitt seconded the motion that the 2018 TAC meeting be held at Corvallis, OR in the 3rd or 4th week of June. Motion passed.

Resolutions:

Be it resolved that the W6 TAC committee thanks Jinguo Hu and his staff at WPRIS for organizing and hosting the 2017 teleconference meeting originating from Pullman, WA.

Be it resolved that the W6 TAC committee thanks Dan Parfitt, Jack Martin, and Mark Brick for their many years of service on the W6 TAC committee.

The resolutions were approved by an email vote of state representatives.

Meeting was adjourned at approximately 4:30pm Pacific Coast Time.

Jack Martin

W6 TAC Secretary