NRSP-6 and Regional Plant Introduction Stations Update

Melanie Harrison

National Plant Germplasm Coordinating Committee

Annual Meeting – June 2, 2021

Southern Regional S-009 Project

Plant Genetic Resources Conservation Unit

Griffin, GA

Southern Regional (S-009)

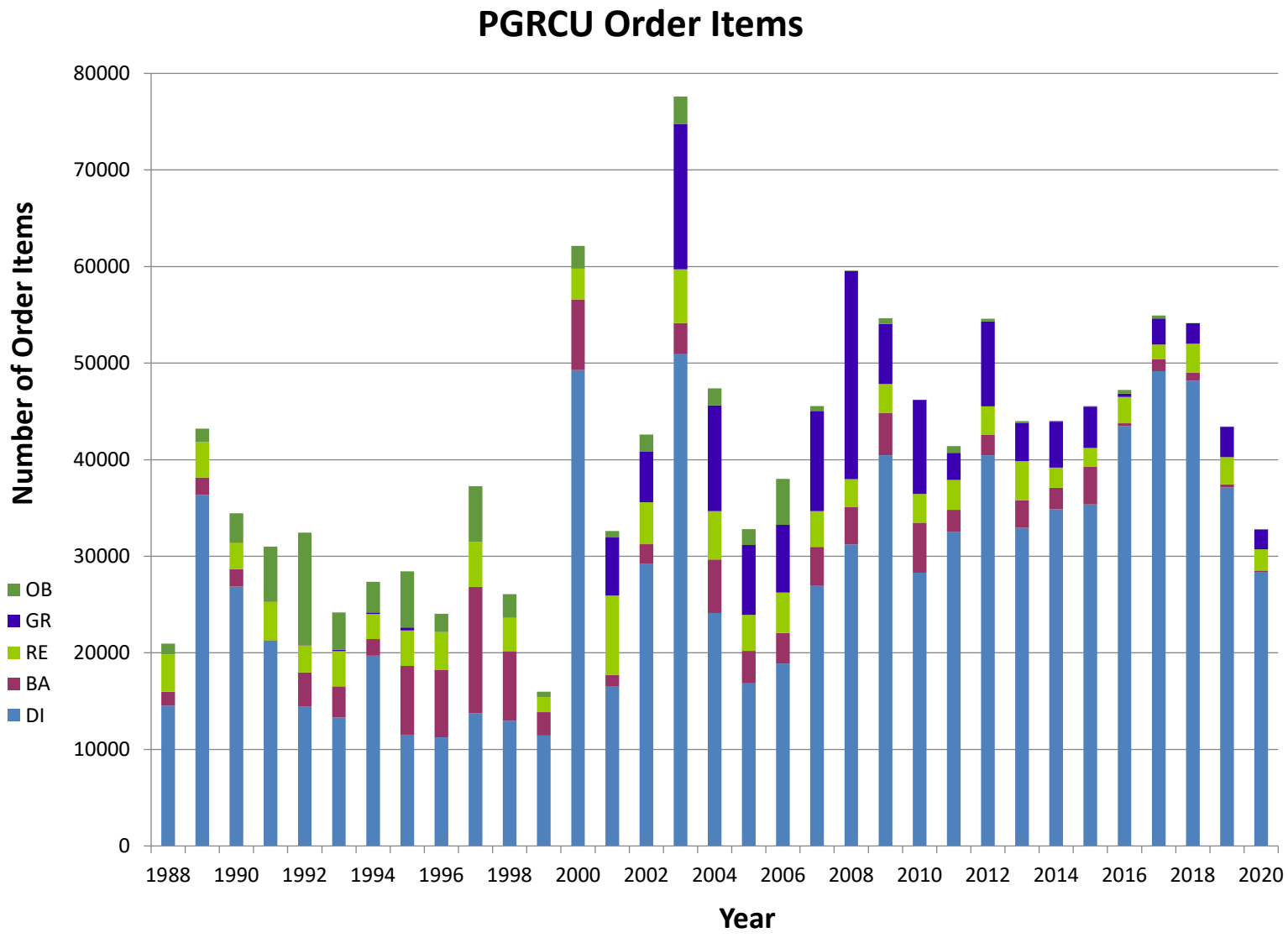
- Sorghum & S-009 Millets (Melanie Harrison)
- Peanut & Vigna (Shyam Tallury)
- Pepper, Melons, Vegetables (Bob Jarret)
- Legumes, Warm-season Grasses, Clover (Brad Morris)
- Sweet Potatoes (Ming Li Wang)

Southern Regional (S-009) Stats

- The PGRCU collection totals 102,210 accessions of 1603 species and 285 genera with 87% available for distribution and 95% backed up at Ft. Collins, CO. Additions to the collection include the Sorghum NAM population donated by Ramasamy Perumal (Kansas State University)

- A total of 28,384 accessions were distributed in worldwide in 2020. For comparison, 5-year average = 41,265 and 10-year average = 38,251.

- Currently, 88,119 accessions or 87% of the seeded accessions in the collection are stored at -18°C. Seed longevity is improved by storage in -18°C rather than 4°C.



OB = Observation; GR = Germination; RE = Regeneration; BA = Back Up; DI = Distribution

S-009 Activities

- Regenerations and characterization of germplasm was greatly reduced in 2020 due to the pandemic. Regenerations were planted this spring.
- In 2020, a total of 221 images and 3,687 observations were uploaded to GRIN-Global; 1,835 viability tests were conducted; and 1,723 inventories were processed into the collection.
- Characterization included protein/flavonoid measurements on leaves of Corchorus accessions and oil/protein/fatty acid measurements in peanut.
- The S-009 Regional Technical Advisory Committee met virtually on August 26, 2020 hosted by Rick Boyles, 2020 S-009 Chair and Representative from South Carolina. The next meeting is scheduled August 10, 2021 and hosted by Virginia Sykes, 2021 S-009 Chair and Representative from Tennessee.

Capsicum Collection

- Portions of the *Capsicum* collection have been screened for the presence of Tobamoviruses (ToBRFV).
- Seed samples of >3000 genebank accessions of *Capsicum* (pepper) were screened for pospiviroids.
- Collaborative studies continue in an effort to develop and apply advances in NGS to determine/define genetic relatedness among and within *Capsicum* spp. and to examine gene/genome evolution in CWR via examination of genome structure (in collaboration with Baylor College of Medicine).
- Collaborative efforts to identify and characterize novel uses of capsinoids are on-going.






16 USDA, ARS Employees
8 University of Georgia (S-009) Employees

















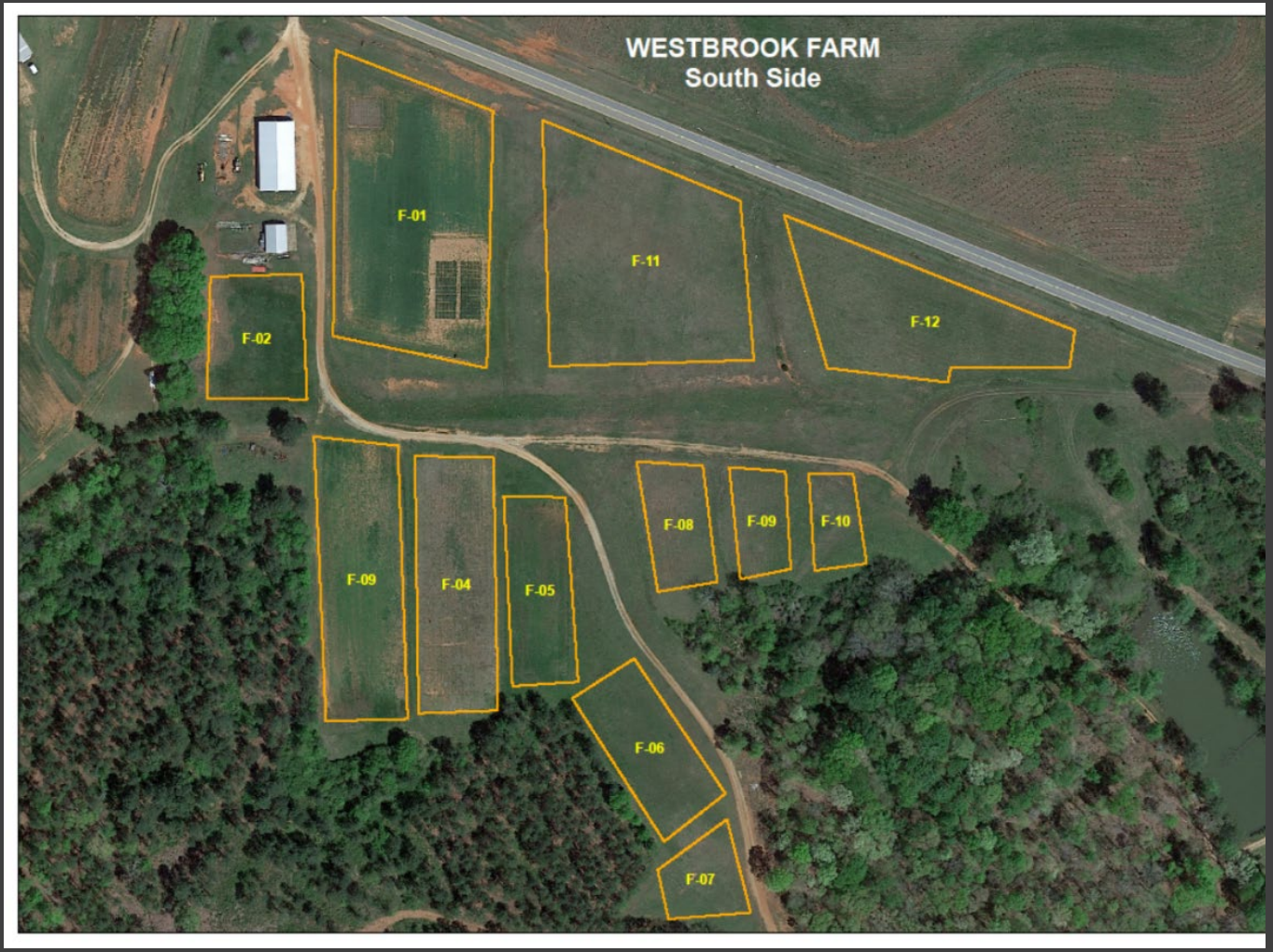
- **Mylee Mobley** was hired in 2020 as a federal Biological Science Technician. Her role is to assist in the curation of peanut and vigna.
- **Chris Boyle** was hired in 2020 as a federal Maintenance Mechanic. His role is to repair and maintain facilities and equipment including the greenhouses and coldrooms.
- **Cassa Munroe** was hired in 2019 as a federal Biological Science Technician. Her role is to handle germplasm requests and ship germplasm.

- **Luke Doss** was hired in 2020 as an S-009 Agricultural Science Technician. His role is to provide field support services for all crops
- **Katie Mullinex** was hired in 2020 as an S-009 Biological Science Technician. Her role is to assist in the curation of peanut and vigna.
- **Peggy Tubertini-Morgan** (Program Support Assistant) transferred to a new agency after 26 years of service with ARS.

Southern Regional (S-009) Facilities & Equipment

- Custom built small plot peanut combine and solvent extractor for the biochemical lab.
- Roof repair to metal storage building and seed storage building
- Renovation of field shop including replacement of exterior.
- Renovation of HVAC and greenhouse heating system in main greenhouse complex
- Reglazing and asbestos abatement in two greenhouses.
- Design for addition to include new coldroom and freezer.
- New pumphouse for existing irrigation system
- Proposed new land lease

Proposed Site of Addition for New Coldroom and Freezer



New Land Lease Proposal

Potato Genebank (NRSP-6)

-- Service basics--

Preservation, evaluation and distribution of ~5,000 botanical seed accessions of about 100 species and ~1,000 cultivated *in vitro* clones.

Collected 2 new rare populations from Southeast Colorado despite pandemic.

Increased 155 accessions as botanical seed populations and did 18,352 *in vitro* clonal stocks transfers.

Performed over 1,200 virus and germ tests.

Filled all germplasm requests… 3,183 accessions in USA and 813 abroad.

Potato Genebank (NRSP-6)

-- Research and Development --

Thousands of field plots, and screenhouse and greenhouse plantings supported cooperative research with a broad array of state, federal, industry and foreign collaborators on a full spectrum of topics.

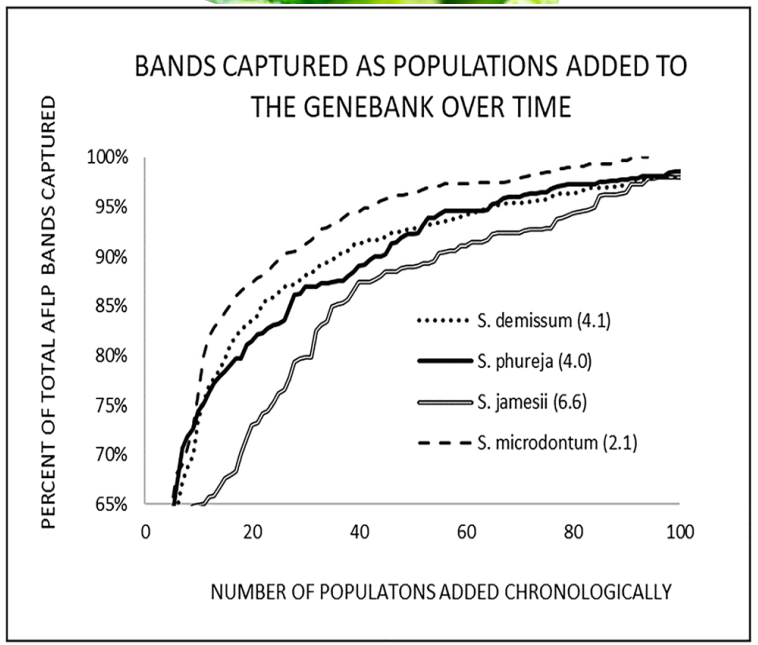
Potato Genebank (NRSP-6)

-- Impact highlights--

Continued collaborative research and breeding in Peru.

Continued drought, heat, cold, *Dickeya*, Zebra Chip, CPB and other screening and produced novel custom interspecific hybrids for cooperators.

Created a metric for sufficiency of population coverage of species.



<u>All</u> cultivar and breeding stocks published in 2020 had NRSP6 species in their pedigrees.

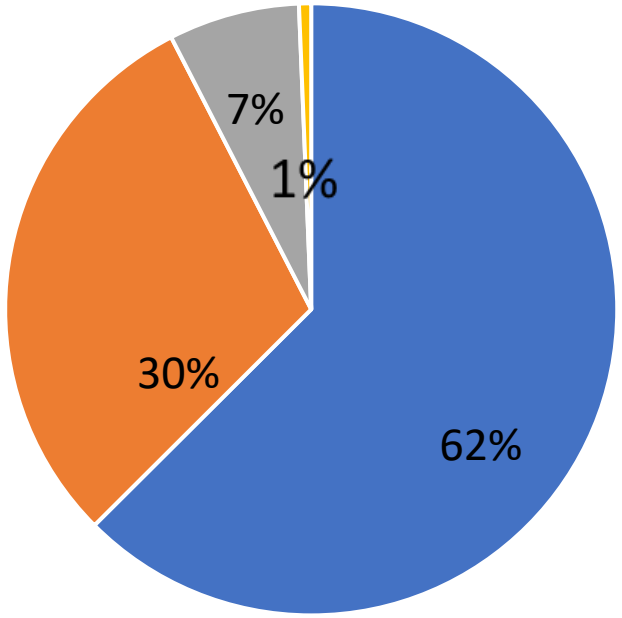
Potato Genebank (NRSP-6)

-- Administration--

The NRSP Review Committee recommended, and the Directors voted to reject our FY21-25 renewal proposal, so the NRSP6 part of USPG has been defunct for most of FY21.

Northeast Regional PI Station (NE9)

Crops conserved



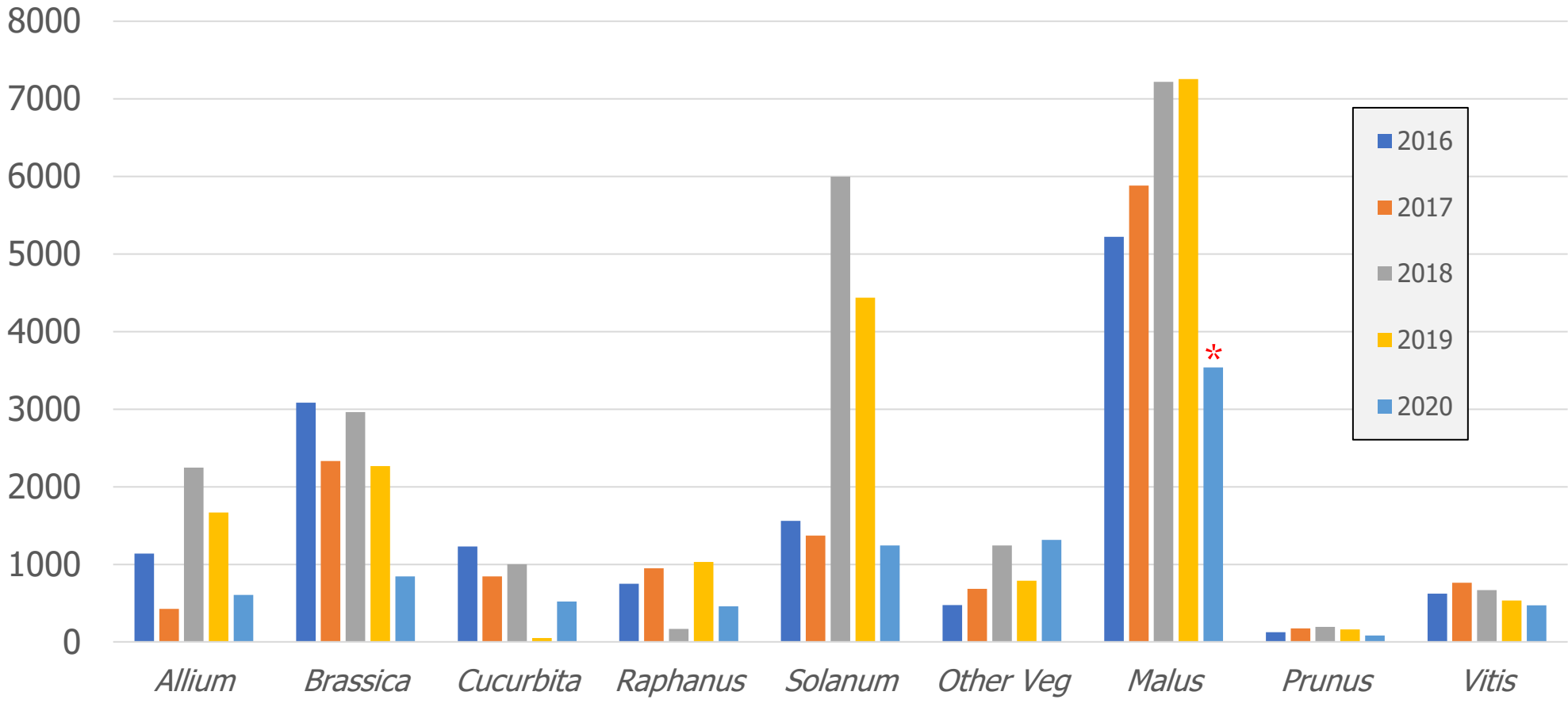
Vegetables	12716 accessions
Apples	6073 accessions
Grapes	1421 accessions
Tart cherries	149 accessions

Three curatorial programs:

- Industrial Hemp (Zachary Stansell & one vacancy)
- Vegetable Crops (tomato, onion, radish, winter squash, cabbage, cauliflower, cole crops, celery, tomatillo, asparagus, buckwheat and other vegetables) (Joanne Labate) The major crops managed by this project represent approximately 40% of the combined dollar value of fresh and processing vegetables in the US.
- Clonal Crops (Ben Gutierrez & one vacancy) apples, grapes and tart cherries
- Apples, grapes, and tart cherries are among the most valuable fruit crops worldwide, with US production valued at
  - $ 6.3 billion for grapes
  - $ 3.5 billion for apples
  - $ 89.4 million for tart cherry

Distribution of NE9 Geneva Germplasm

9,080 vegetable and clonal germplasm samples in 2020 and 76,611 samples from 2016 – 2020



* Reduction due to fire blight

Northeast Regional PI Station (NE9)

Germplasm regeneration, collection, and outreach highlights:

- Successful regeneration of 745 accessions from 2016 – 2020 (average 149 seed lots produced/yr), 217 regenerations planned in 2021 for seed production of vegetable germplasm to distribute and replenish stocks.

- PGRU continues to support organic farming by providing germplasm and demonstrations for small-scale seed production as part of the Northern Organic Vegetable Improvement Collaborative (NOVIC3).

Korean pig celery

seed-saving outreach NOVICIII

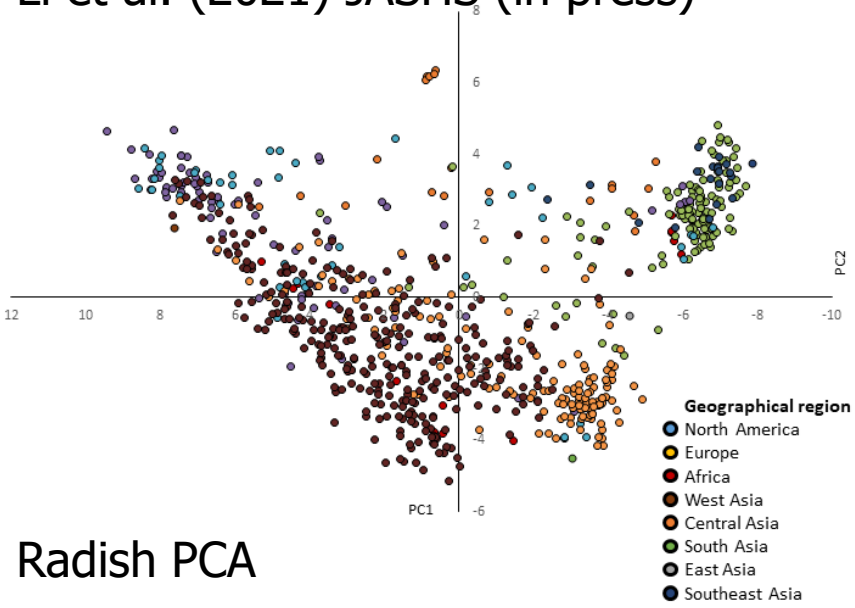
Northeast Regional PI Station (NE9)

Germplasm research highlights:

- Principal Components of 760 radish plants based on DNA sequences revealed an East to West genetic pattern across the globe. Labate, J.A., and J. Arro (2021) Genet. Resour. Crop Evol. (in press)

- Wild tomato *Solanum pennellii* was evaluated for resistance to all three races of the Fusarium wilt pathogen. Several new, independent sources of disease resistance genes were discovered among the 42 screened accessions.

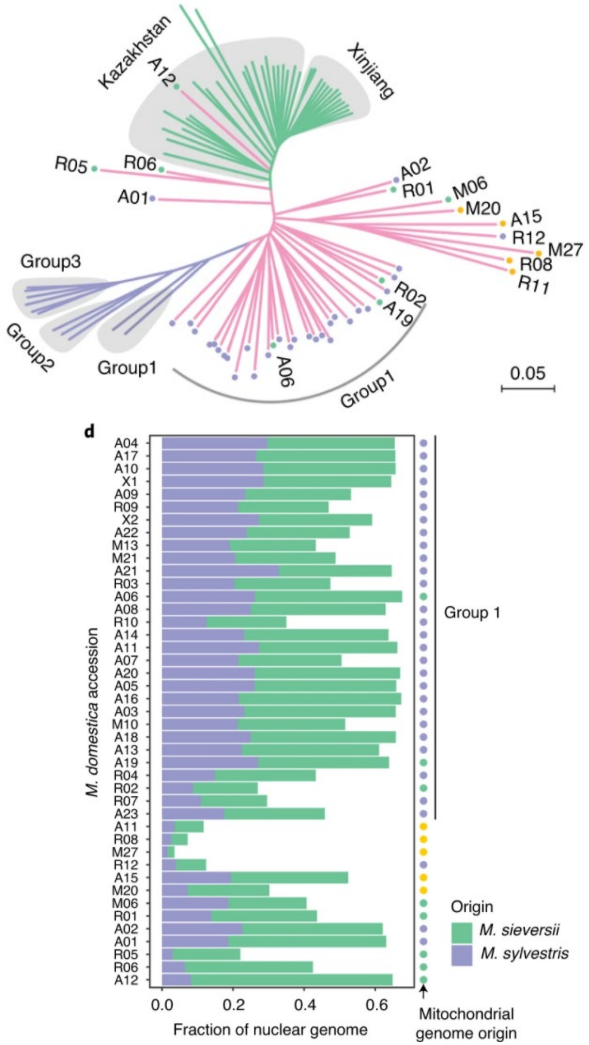
  Li et al. (2021) JASHS (in press)



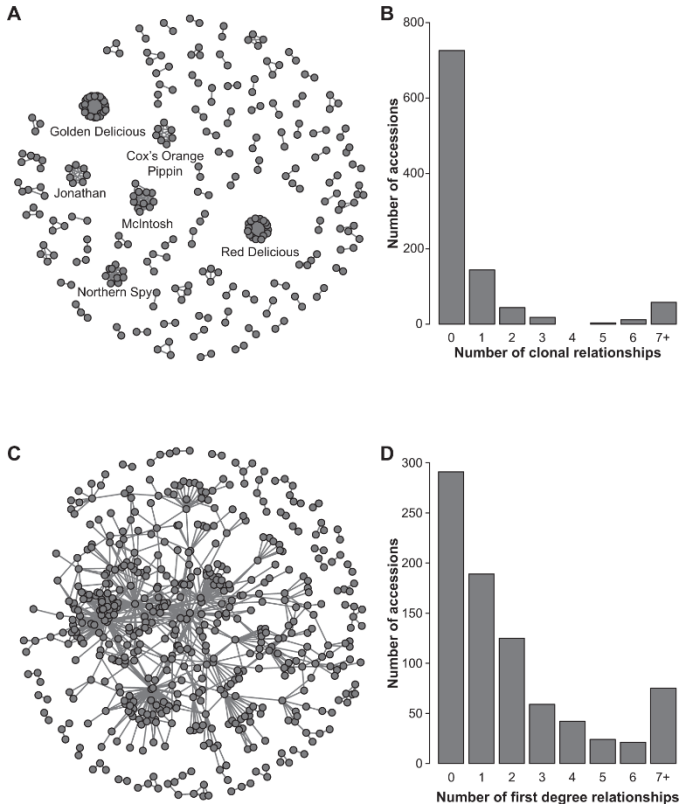
Radish PCA

Fusarium wilt of tomato

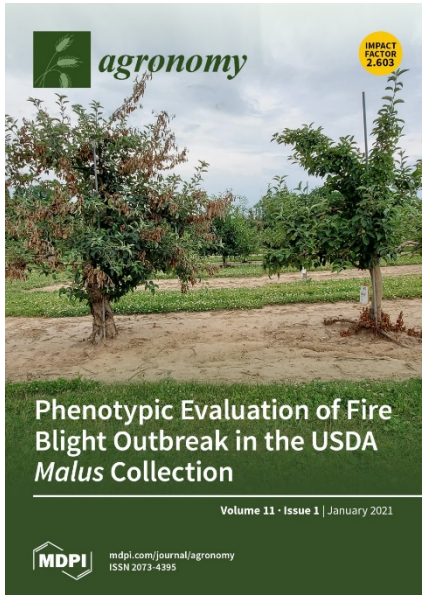
Apple Preservation and Genomics



Sun et al. Nature Genetics (2020) 52:12



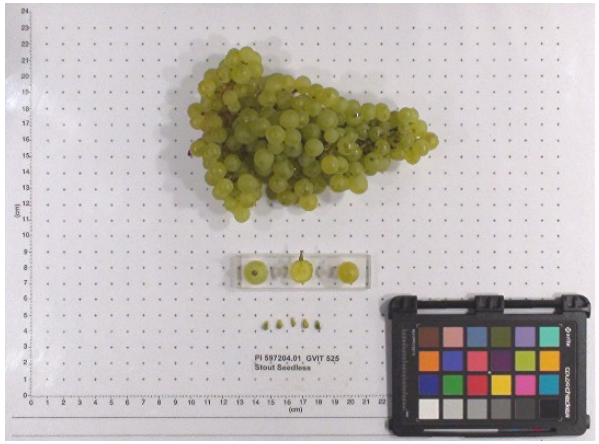
Migicovsky et al. Horticulture Research (2021) 8:9



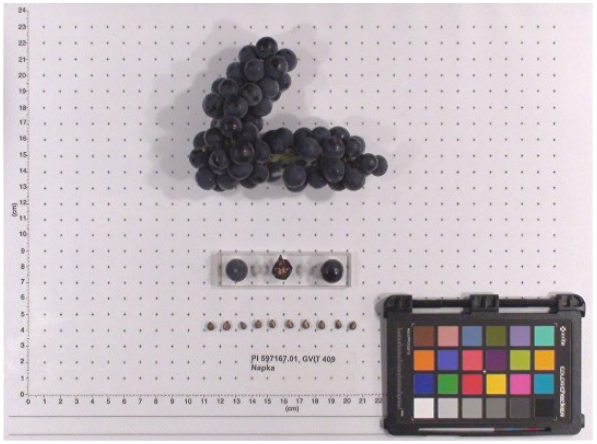
Dougherty et al. Agronomy (2021) 11:1 144

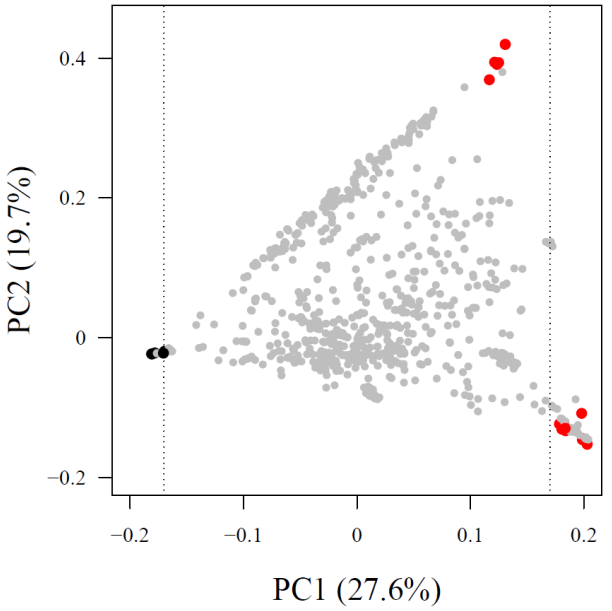
Genomic Ancestry Estimation in Hybrid Grapes

'Stout Seedless'
90% *V. vinifera*



'Napka'
10% *V. vinifera*

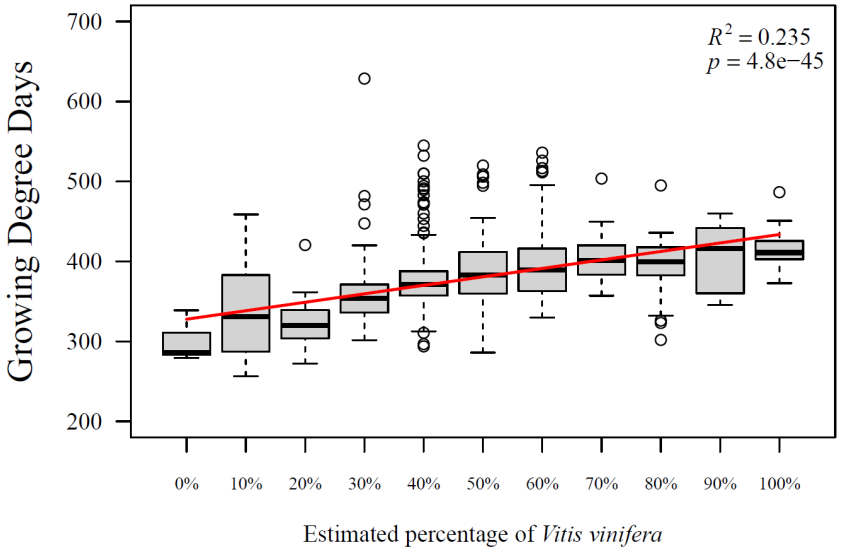




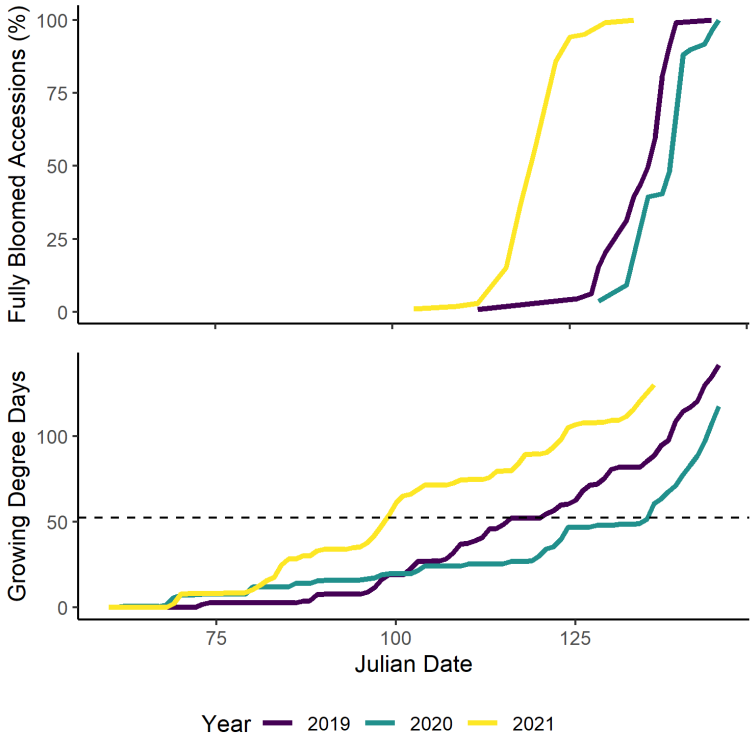
Nearly half of the collection are *Vitis* hybrids, a generic term to describe progeny from any interspecific cross

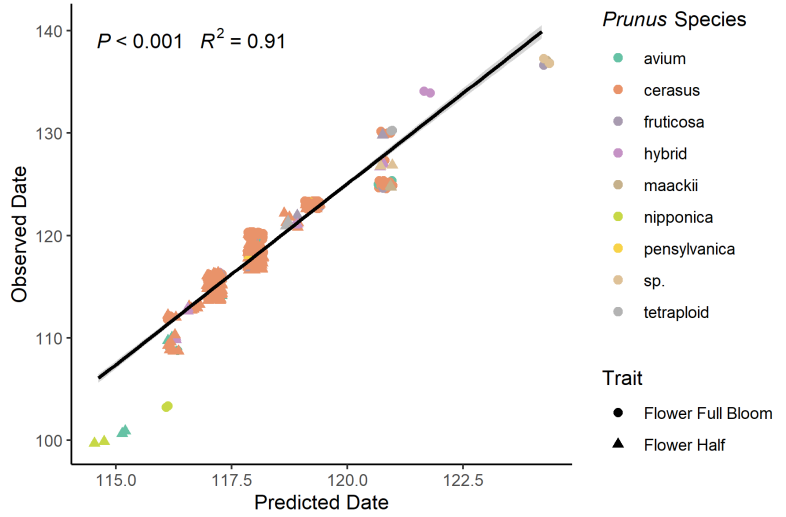
PCA based ancestry estimate of *Vitis* hybrids (grey), using *Vitis vinifera* (black) and wild *Vitis* (red) were used to determine % of *Vitis vinifera* ancestry

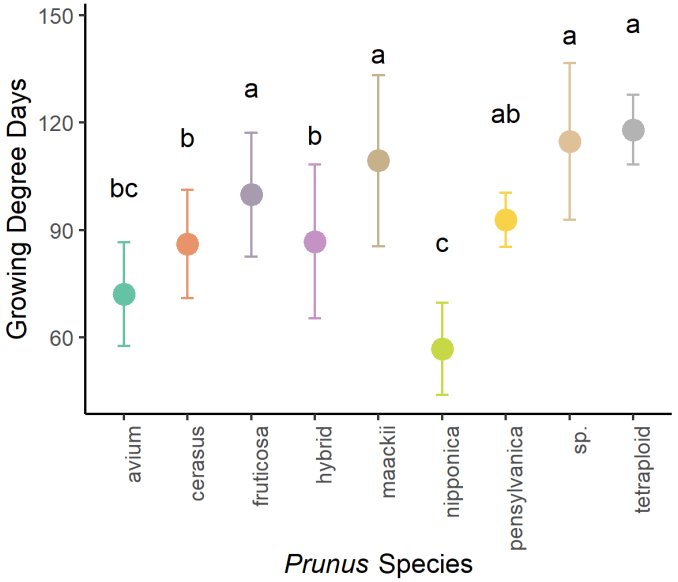
Increased growing degree days for bloom associated with increasing % of *V. vinifera* in hybrid grapes



Bloom Phenology in Tart Cherry and Wild Relatives







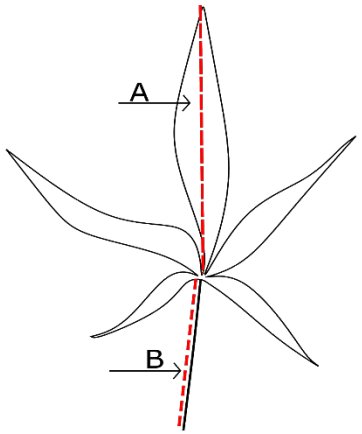
Spring frost is one of the critical environmental factors that impacts yield in cherries. We've recorded bloom date in the Tart Cherry Collection for three seasons. Data will be used to validate UAV captured images.

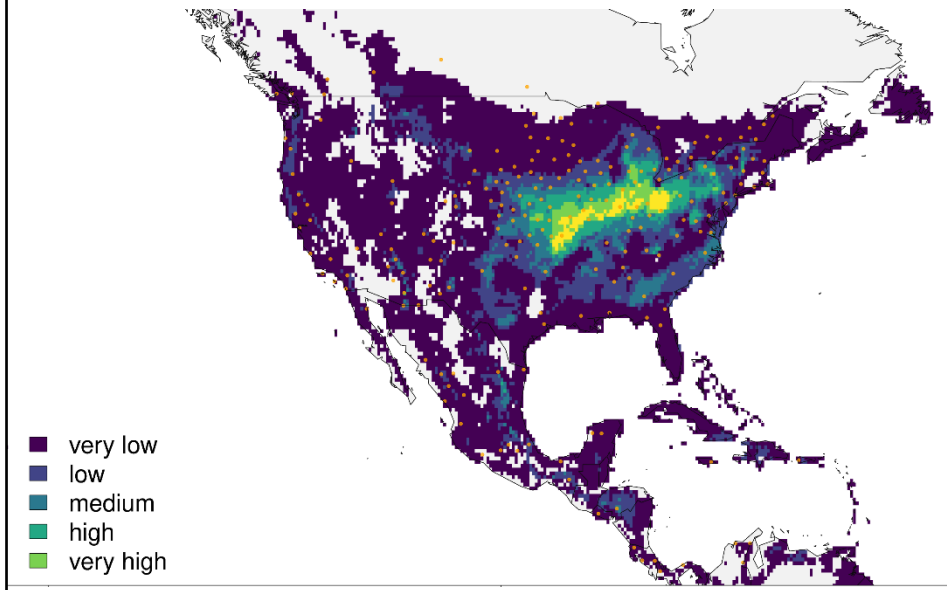
Hemp germplasm repository:

Resolving urgent production bottlenecks and safeguarding critical germplasm resources

Germplasm status review (completed) → **Established BMPs & Protocols** (completed) → **Hired Hemp Curator** (completed) → **Established Collaborator Network** (complete) → **Infrastructure Upgrades** (Complete) → **DEA Permit Approval** (May 2021) → **Germplasm acquisition, increase, distribution** (Summer 2021)

USDA Hemp Germplasm Characterization and Descriptor Handbook





Bioclimatic modeling of collected and feral hemp germplasm

New infrastructure, data, and vital partnerships:

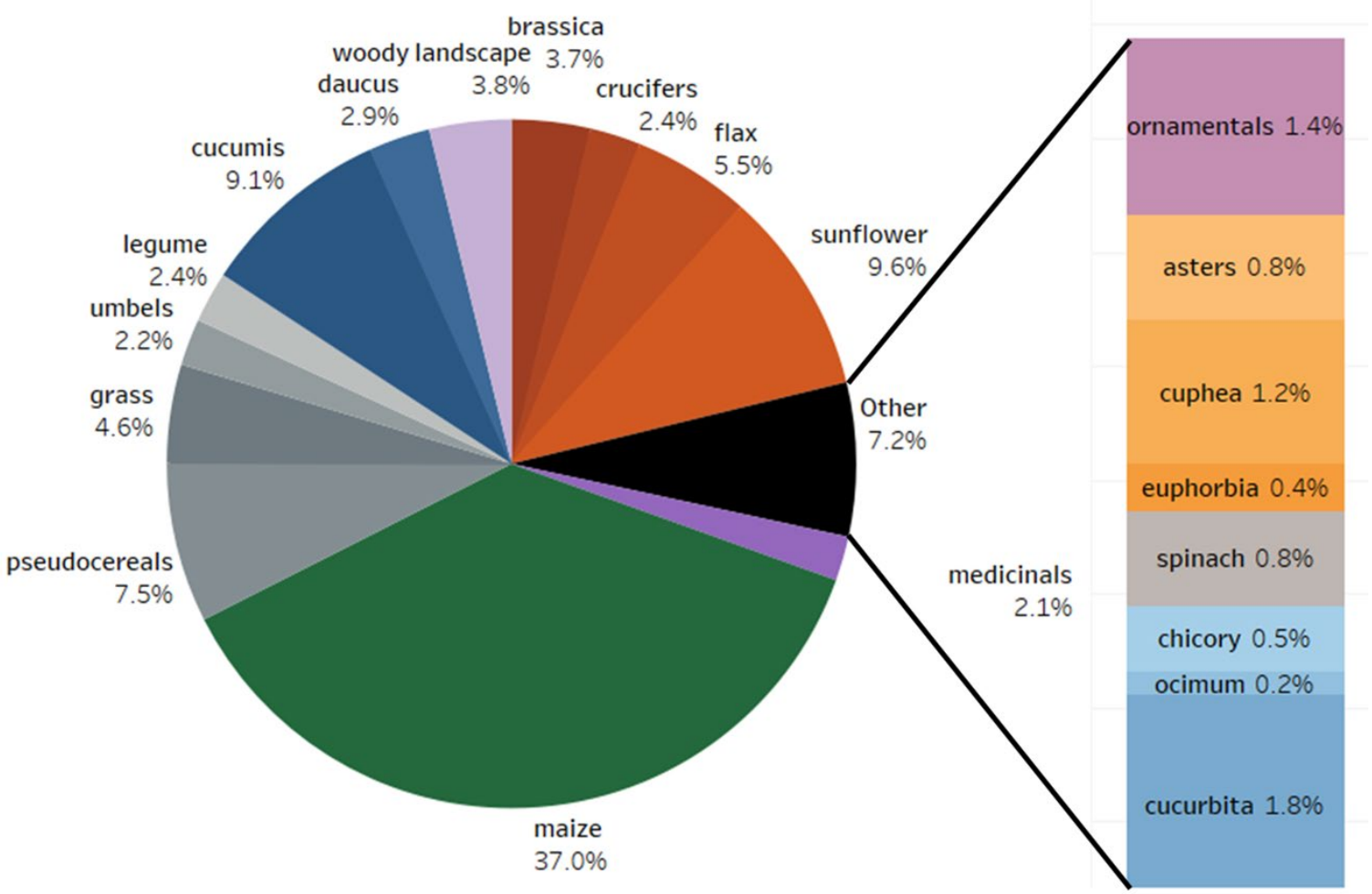
- Security infrastructure completed.
- New infrastructure and partnerships will enable high-throughput screening of hemp collection for priority agronomic, oil, fiber, and secondary metabolites (cannabinoids, terpenes, phenolics, etc.).
- Publication of *Hemp Germplasm Descriptors Handbook.*
- Identified 17 germplasm sources and >1K unique genotypes.
- Funding allocated to scale seed production infrastructure 8-fold.

Ongoing Challenges:

- Waiting for DEA approval to begin handling germplasm
- Rapidly scaling seed increase and production to meet high demands.

North Central Regional PI Station (NC-007)

Curation of more than 55,000 Accessions



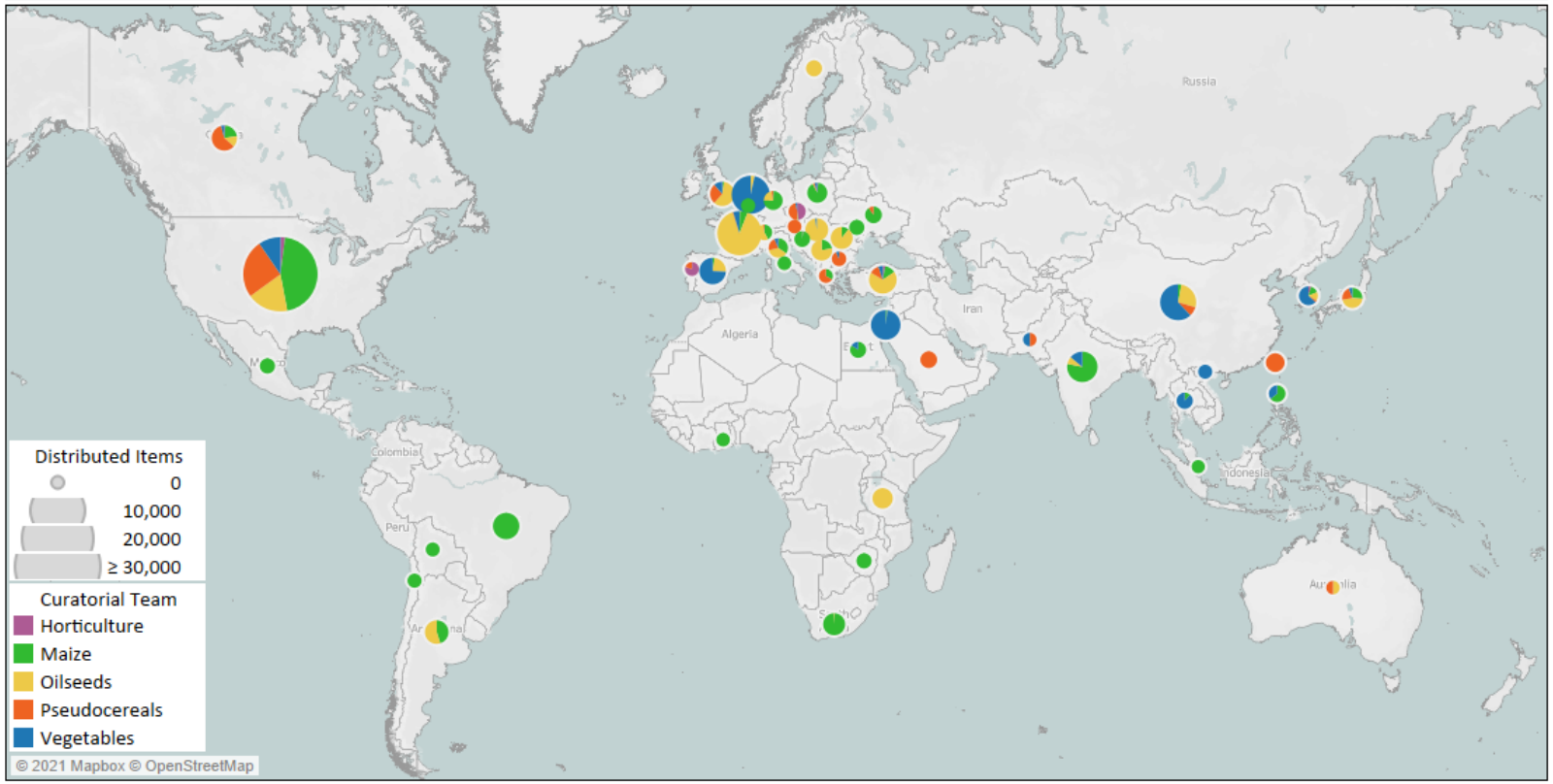
2020 NCRPIS Germplasm Distribution

- Germplasm requests were reduced by the pandemic impact
- Distributed more than 45,500 packets in 20; ~45% in U.S., 55% to internationals
- Shipment to many international locations was more difficult in 2020

2020 - NCRPIS External Germplasm Distribution Summary by Curatorial Group

Curatorial Team	Orders		Order Items		Avg. Items per Order	
	United States	International	United States	International	United States	International
Horticulture	98	13	428	143	4	11
Maize	449	115	9,396	4,926	21	43
Oilseeds	165	66	3,760	9,668	23	146
Pseudocereals	133	47	5,313	1,567	40	33
Vegetables	102	57	2,001	8,407	20	147
Grand Total	**854**	**270**	**20,898**	**24,711**	**24**	**92**

2020 - Worldwide NCRPIS Germplasm Distributions

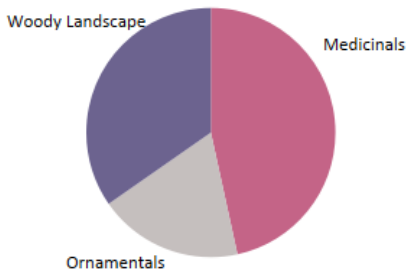


2020 - NCRPIS External Germplasm Distribution Summary

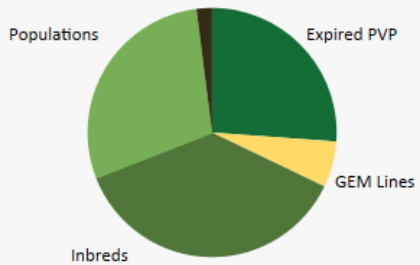
Curatorial Team	Orders		Order Items		Avg. Items per Order	
	U.S.A.	Int'l	U.S.A.	Int'l	U.S.A.	Int'l
Horticulture	98	13	428	143	4	11
Maize	449	115	9,396	4,926	21	43
Oilseeds	165	66	3,760	9,668	23	146
Pseudocereals	133	47	5,313	1,567	40	33
Vegetables	102	57	2,001	8,407	20	147
NCRPIS Distributions	**854**	**270**	**20,898**	**24,711**	**24**	**92**

2020 - Crop Distributed Order Items by NCRPIS Curatorial Group

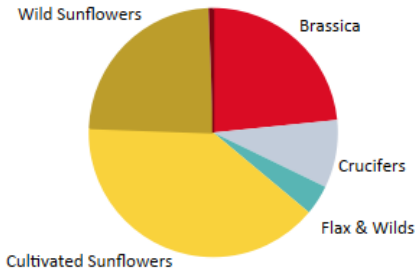
Horticulture



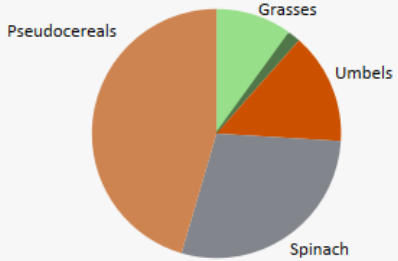
Maize



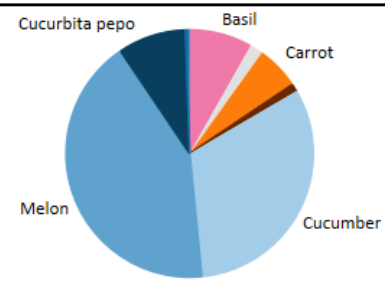
Oilseeds



Pseudocereals



Vegetables



2020 NCRPIS Curation

- **Amaranth Curation Collection Characterization**
  - Deciduous seed coat in Chenopodium
    - White seeded historically documented grain accession from Himalayan mountains. White seeds result of vestigial black seed coats exposing the white perisperm
  - Cytoplasmic male sterile accession (PI 686465) & restorer system characterized

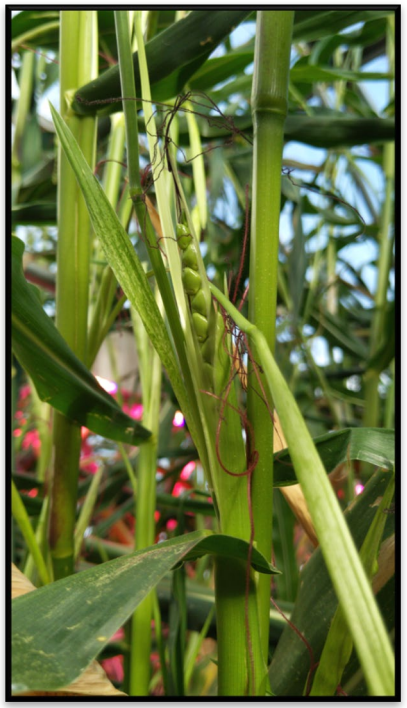
Deciduous seed coat in Chenopodium

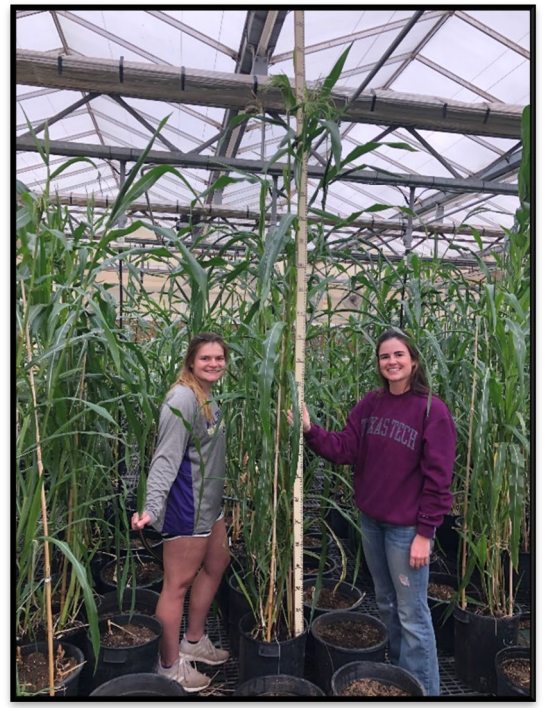
- **Vegetable Curation**
  - Using collapsible wire crates for harvest, transport, and storage of pumpkins and squash
  - Increased harvest efficiency
  - Reduced pre-processing storage space

Harvested squash in collapsible wire crate

2020 NCRPIS Curation

- **Maize Curation**
  - Developed Protocol to Increase Teosinte Accessions
  - Established Highland (2600m) Regeneration with CIMMYT to grow Accessions from the Andes





Greenhouse production of Teosinte

CIMMYT staff planting 2020 nursery

Information Technology 2020

- Development of inter-operability between GRINGlobal and other key information providers' portals, examples including MaizeGDB, Gramene, LIS (Legume Information System), or GOBii.
- Pete Cyr is investigating the use of BrAPi tools, which use a RESTFUL webservice interface, to achieve these
- In FY2020 Mr. Cyr developed 8 new versions of the Curator Tool Software Suite for testing and distribution. The 8 upgrades include 47 enhancements and 14 bug fixes in various components like the Order Wizard, Cooperator Wizard, Viability Wizard, Curator Tool and the Search Tool.
- As of December 2020, the NCRPIS had 50 desktop and 40 laptop/tablet workstations installed for use by permanent staff members and part-time temporary student help. All station computers are equipped with solid state drives, have at least eight gigabytes of memory, and quad core processors. The centralized functions required by the station were supported by 11 physical servers and around 20 active virtual servers including those used for file storage, intranet, backups, and access security systems and monitoring.
- A firewall was maintained in order to provide enhanced security as well as increased network performance in line with the 10-gigabit server network infrastructure.

NCRPIS Personnel Changes:

Federal:

New Hire:

- Dr. David Peters started in December 2020 as Research Leader with the retirement of Dr. Gardner
- Dr. Colleen Warfield started in April 2021 as germplasm collection Plant Pathologist
- Andrew Sherwood started in June of 2020 as Agricultural Research Technician for Horticulture Curation

Retired:

- Dr. Candice Gardner, Research Leader, retired in December 2020 after 21 years at NCRPIS

State:

Retired:

- Cindy Clark, Agricultural Specialist, retired in December 2020 after 21 years at NCRPIS

PGITRU (WRPIS)

- Pullman/Prosser, WA
- USDA & WSU partnership

- Established 1947 (1905)
- Curators and Research Scientists supporting PGR activities
- Conserve and encourage priority PGR use

Late 2019 PGITRU Unit retirement activity (Pre-Pandemic)

Curatorial & Research Programs

- Genetic resource management
  - Agronomy – grasses and safflower (vice-Bradley/Coyne)
    - Seeds of Success (BLM/ARS interagency project) - Irish
  - Bean – *Phaseoulous* spp. (vice-Kisha/Hellier)
  - Cool season food legumes – peas, chickpea, lentils, … (C. Coyne)
  - Horticultural crops – lettuce, sugar beets, ornamentals, … (B. Hellier)
  - Temperate forage legumes – alfalfa, clover, trefoil, … (B. Irish)
- Mission related RGR research/support
  - TBD – (vice-Hu/Research Leader)
  - Alfalfa genetics NP 2015– (Long-xi Yu)

CRIS projects:

- 2090 21000 032 00 D
- 2090 21000 026 00 D
- 2090 21000 036 00 D

Funding:

- $3,257,476 – Federal Appropriated
- $456,625 (2020) – W6 'in-kind' support
- Extramural funding/in-kind – for RESEARCH

Personnel Changes

- Res. Leader – Jinguo Hu (retired)
  - Interviews being conducted
  - New RL onboard ~late summer
- Agronomy Curator (Vice-Bradley)
  - Tentative offer & negotiating
- *Phaseolus* Curator (Vice-Kisha)
  - Certificates in-hand, interviews soon
- Postdoc. Associate – Lyle Wallace
  - *Phaseolus* research
  - Salary offset by Vice-Kisha
- Res. Plant Pathologist (Vice-Dugan)
  - Positions abolished (cost savings)
- IT specialist – Bo Gao (resigned)
  - Likely a CEC hire, not in Unit
- BST – Melissa Scholten (hired)
  - Seed germinations
- BST – William Luna (resigned)
  - Greenhouse maintenance
  - Interviews being conducted
- BST – Alfalfa genetics
  - Positions abolished (cost savings)

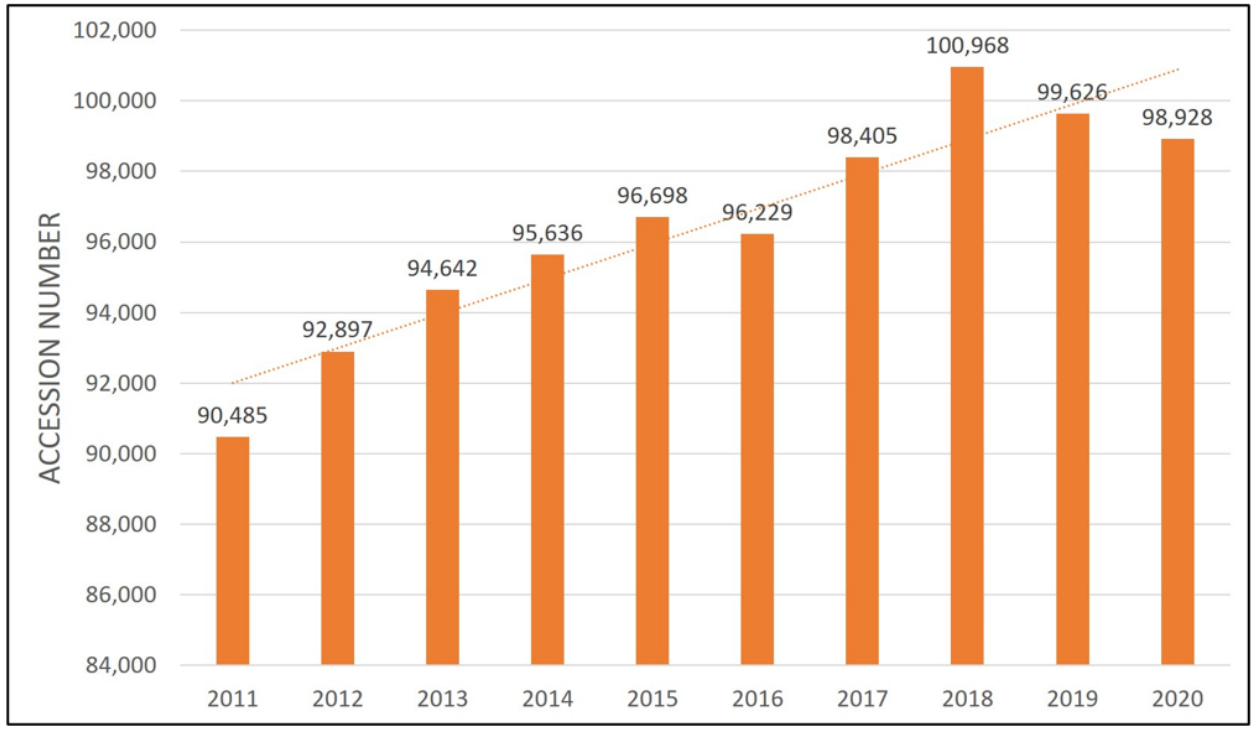
W6-supported personnel

- Fully staffed (6 members)
- Tech. – Jaqueline Cruver (retired)
  - David Van Klaveren (hired)

WASHINGTON STATE UNIVERSITY

PGR Holdings

- Total number of accessions over the past 10 years
- Numbers oscillate close to 100,000 accessions
- Affected by incoming and outgoing Seeds of Success accessions



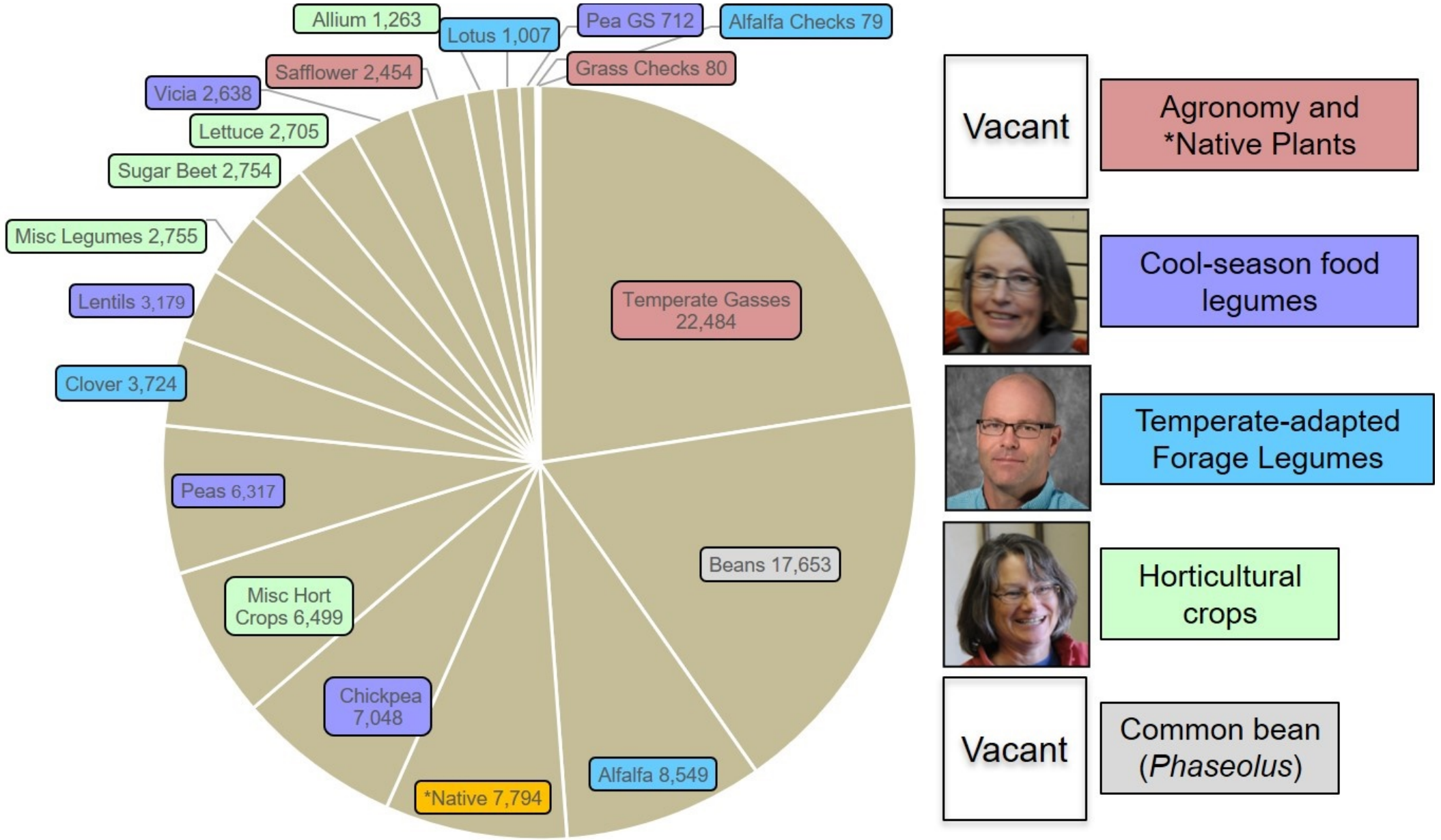
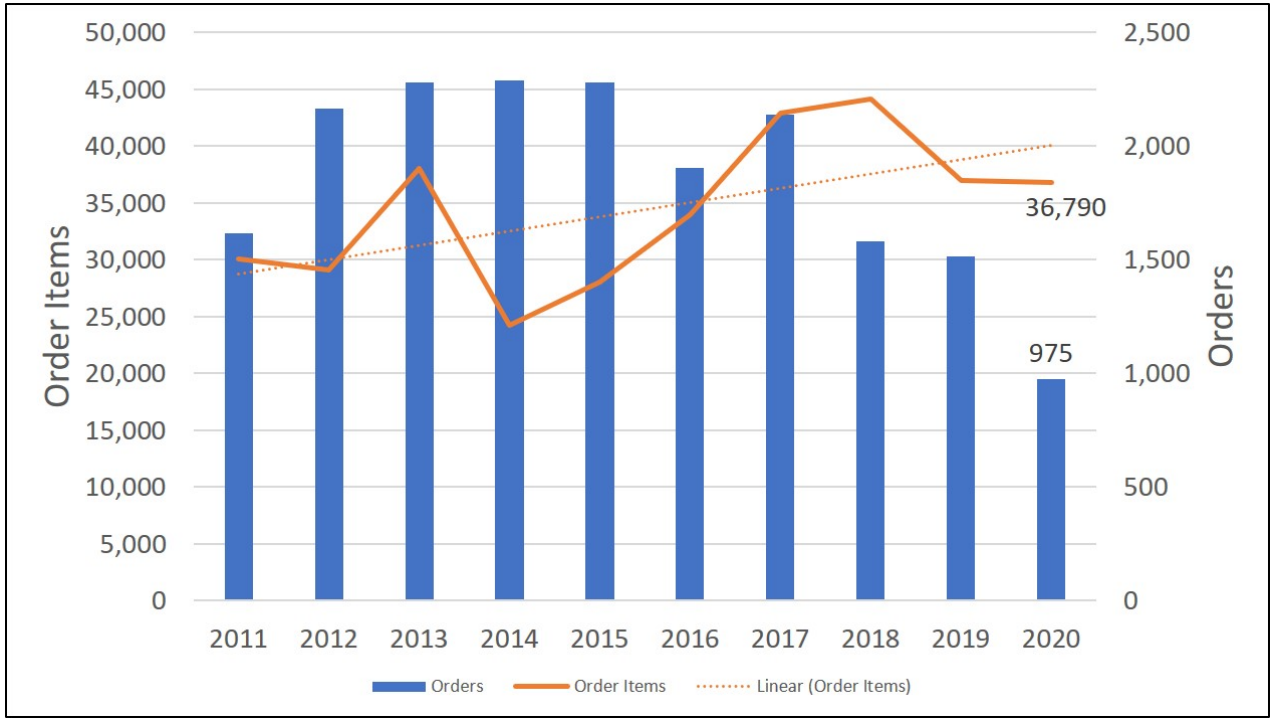


Figure 3. The five Curators, curatorial programs and assigned major crop groups at WRPIS.

Distributions

- Number of orders/order items distributed (10 years)
- Orders declining, but order items steady/increasing
- Curators not filling NRR and genotyping more popular



New Plant Biosciences building

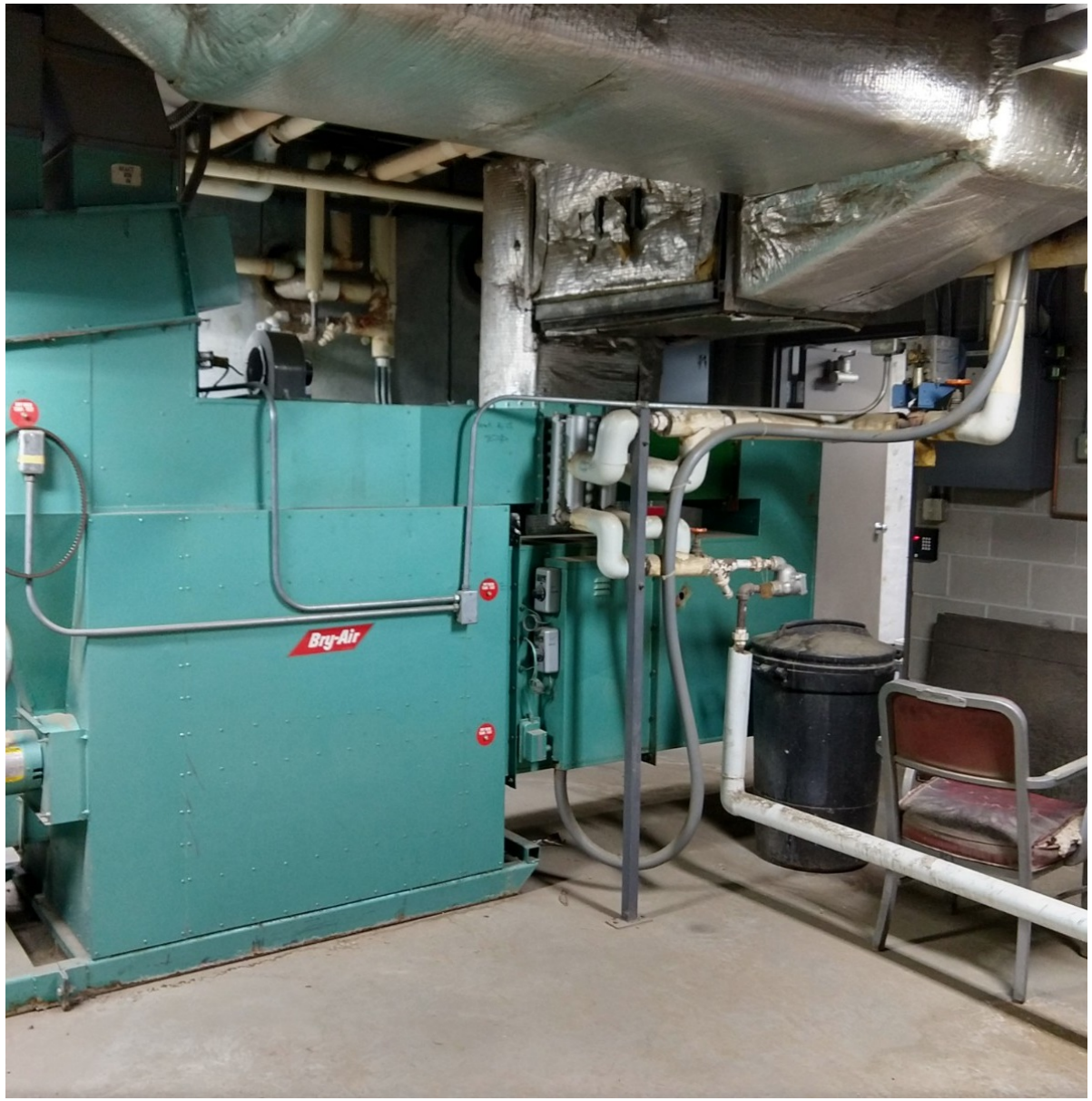
- $104.9 M 105,000 ft^2
- Using Johnson Hall footprint
- Unit's offices and labs temporarily reassigned to other campus locations
- Expected completion 2025/2026
- State of the art offices, laboratories and for working seed collections

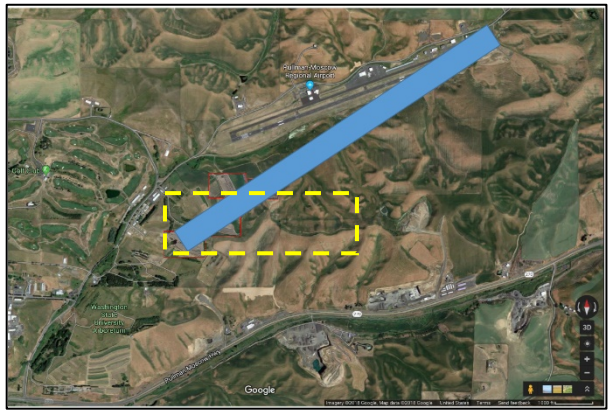
USDA ARS plans new building on WSU campus

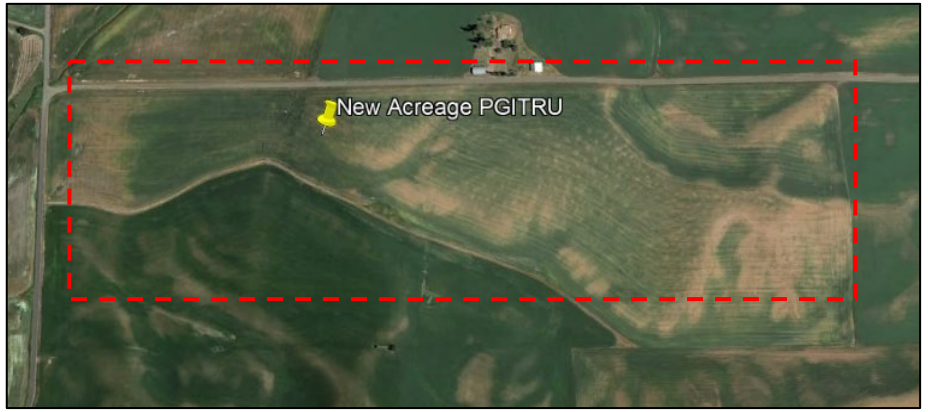
By MATTHEW WEAVER Capital Press Jul 19, 2019

The Washington State University campus in Pullman.

https://www.capitalpress.com/ag_sectors/research/usda-ars-plans-new-building-on-wsu-campus/article_04064a04-a80a-11e9-9d37-87ea3f808294.html


Bry-Air



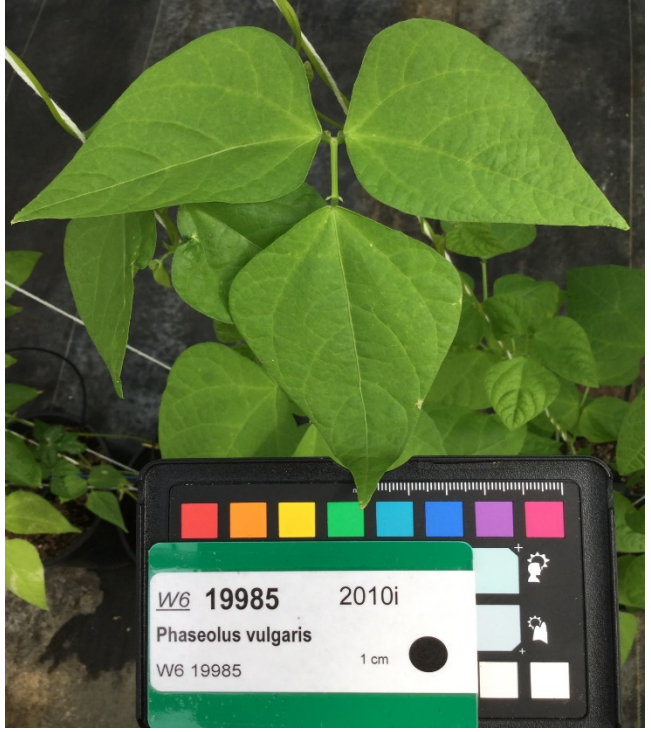


New land lease (Idaho)

- 12 acres @ $100/acre/year
- Dry land (no irrigation)
- ~20 miles and 30-minute drive

Land is to replace property lost on Pullman farm to airport expansion allowing for longer crop rotations and increased isolations distances required for regenerations

Central Ferry - 1) New Winandy GH with 1st bean crop; 2) Demolition of ‘old’ GH; and 3) Electrical installed refrigerated container.

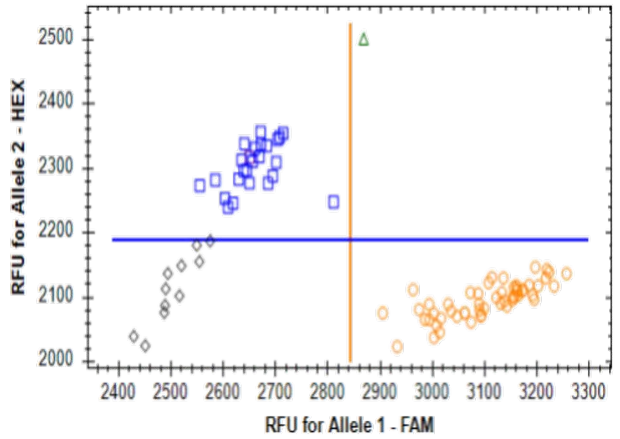


Horticultural Crops and Phaseolus

- Focusing on regeneration activities
  - *Allium*, *Phaseolus*, and *Lactuca*
- Characterization of 30 sugarbeet accession to 6 plant pests/diseases
- Crop Vulnerability Statements
  - *Phaseolus* (major updates)
  - Herb. Ornamental (initial full report)
  - Leafy Vegetable (minor updates)
  - New Crops (initial full report)

CSFL Research

- Aphanomyces root rot (ARR) is a devastating diseases in lentil
- USDA Lentil Core Collection screened in greenhouse/field root
- QTL identified and breeder-friendly KASP markers developed



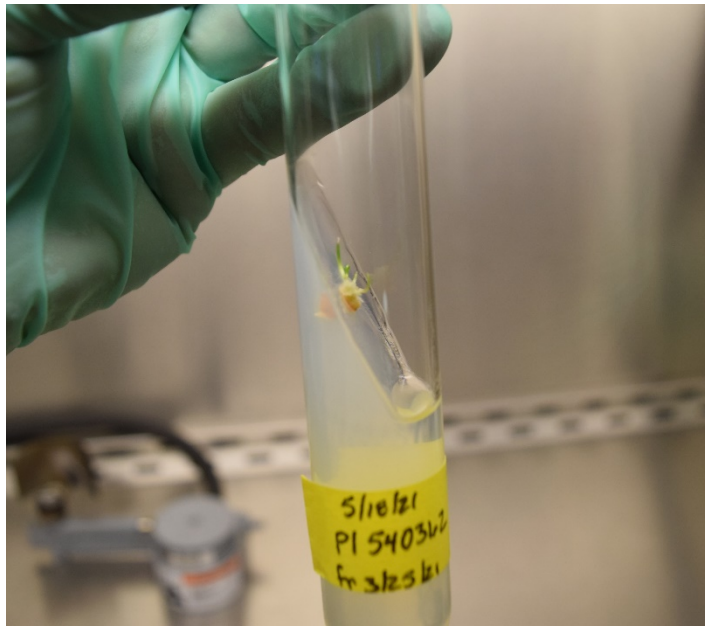
Alfalfa

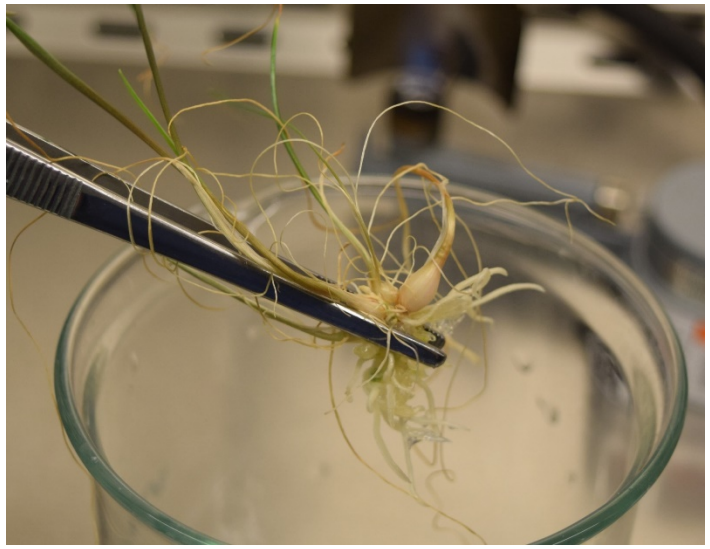
NAFA

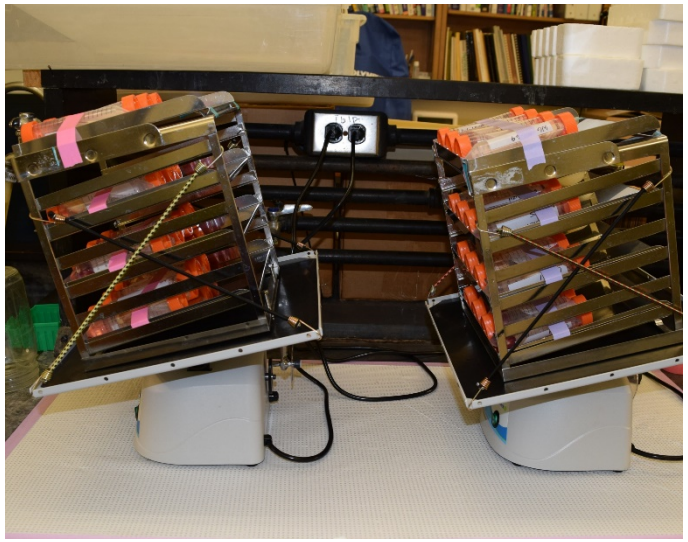
U.S. Alfalfa Farmer Research Initiative

Plant Pathology Research (*Allium*)

- Optimizing tissue culture
  - Increase propagation
  - Fungal/viral removal
- *Fusarium proliferatum*
  - Storage pathogen
  - Screening germplasm for presence and reaction to pathogen







Alfalfa Genetics (NP 215)

- Evaluate alfalfa PGR
  - Verticillium wilt
  - Drought, heat and salt stress
  - Forage quality
- Develop techniques and marker trait associations
- Improved alfalfa germplasm
- Teams - USDA, academia, industry
- Industry using markers/germplasm