

Strengthening the NPGS & Its Pullman-Based Genebank Plant Genetic Resources

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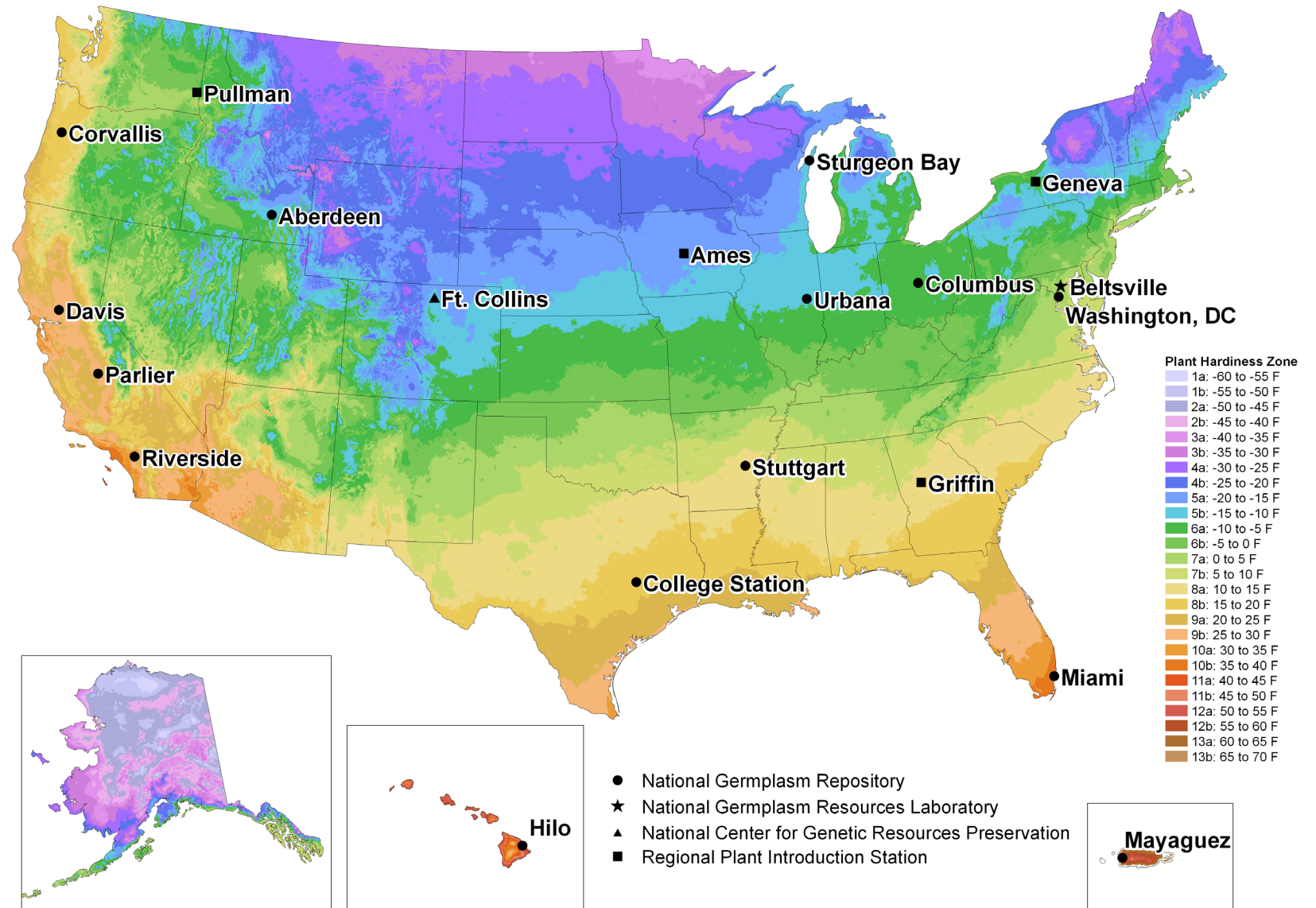
Plant Germplasm Introduction and Testing Research Unit (WRPIS)
Pullman, WA





National Plant Germplasm System

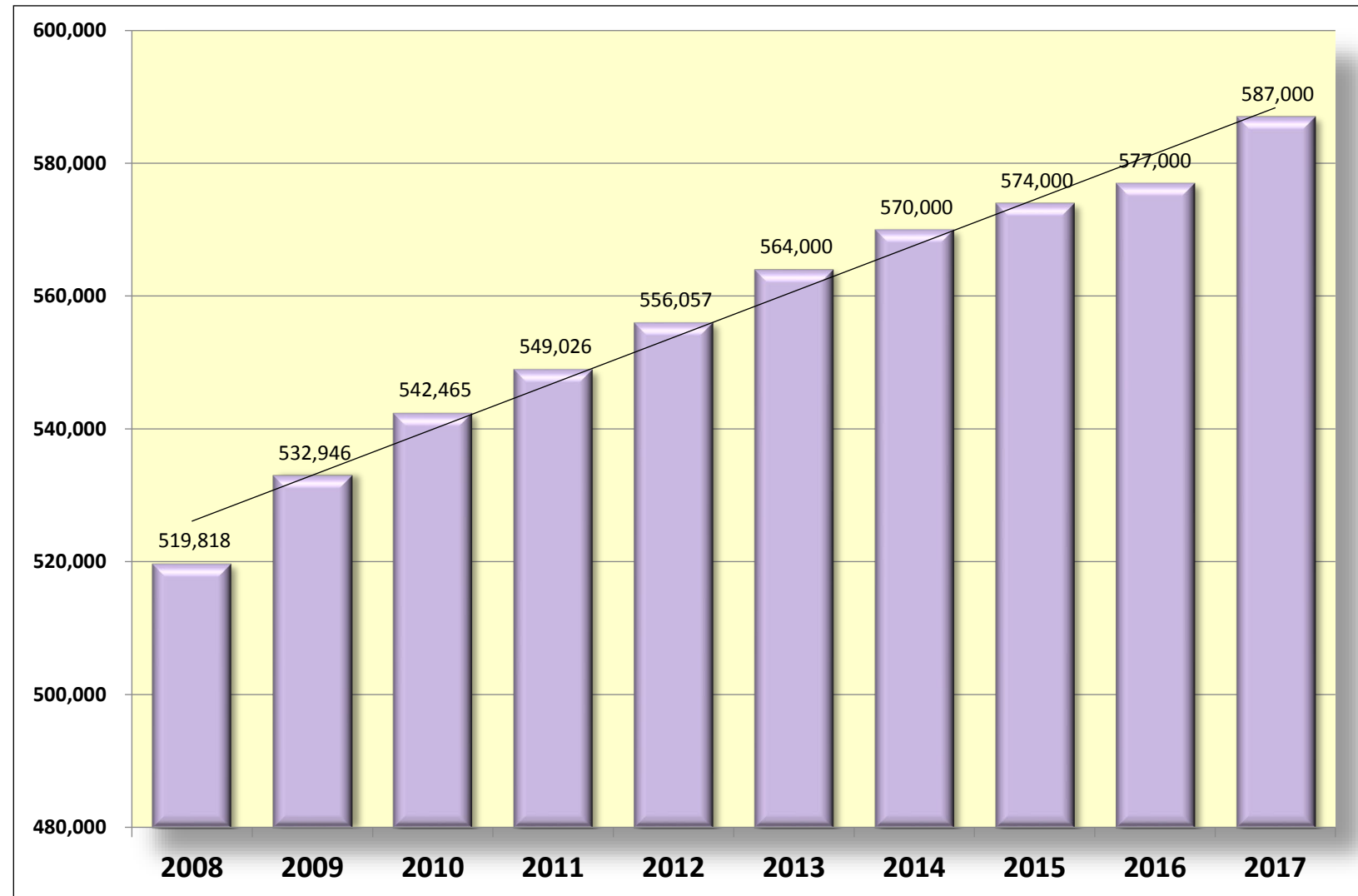
- 17 active sites
- 4 PI Stations
 - Pullman, Griffin, Ames, Geneva
- NLGRP – Fort Collins, CO
- NGRL – Beltsville, MD
- Clonal repositories
- Examples: Small grains, Potatoes, Corn, Citrus, Apples, Avocado, ...



NPGS accessions numbers

- NPGS has a long history of acquiring accession
- 2018 – **596,191**
- Continues to expand, but needs to do so very strategically from this point forward
- Sources: exchanges, plant explorations, donations

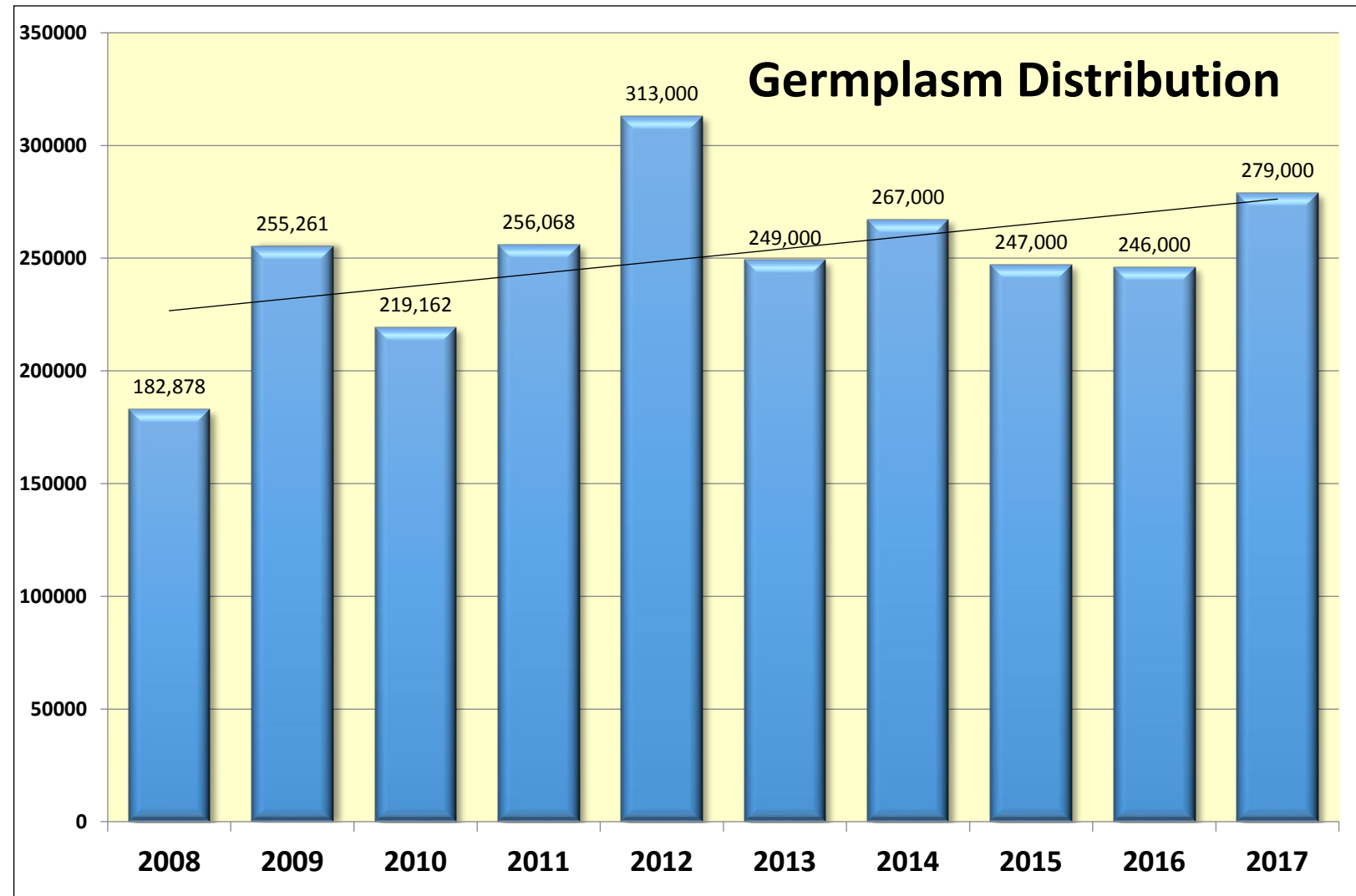
*Adapted from NPL – Dr. P. Bretting



NPGS germplasm demand

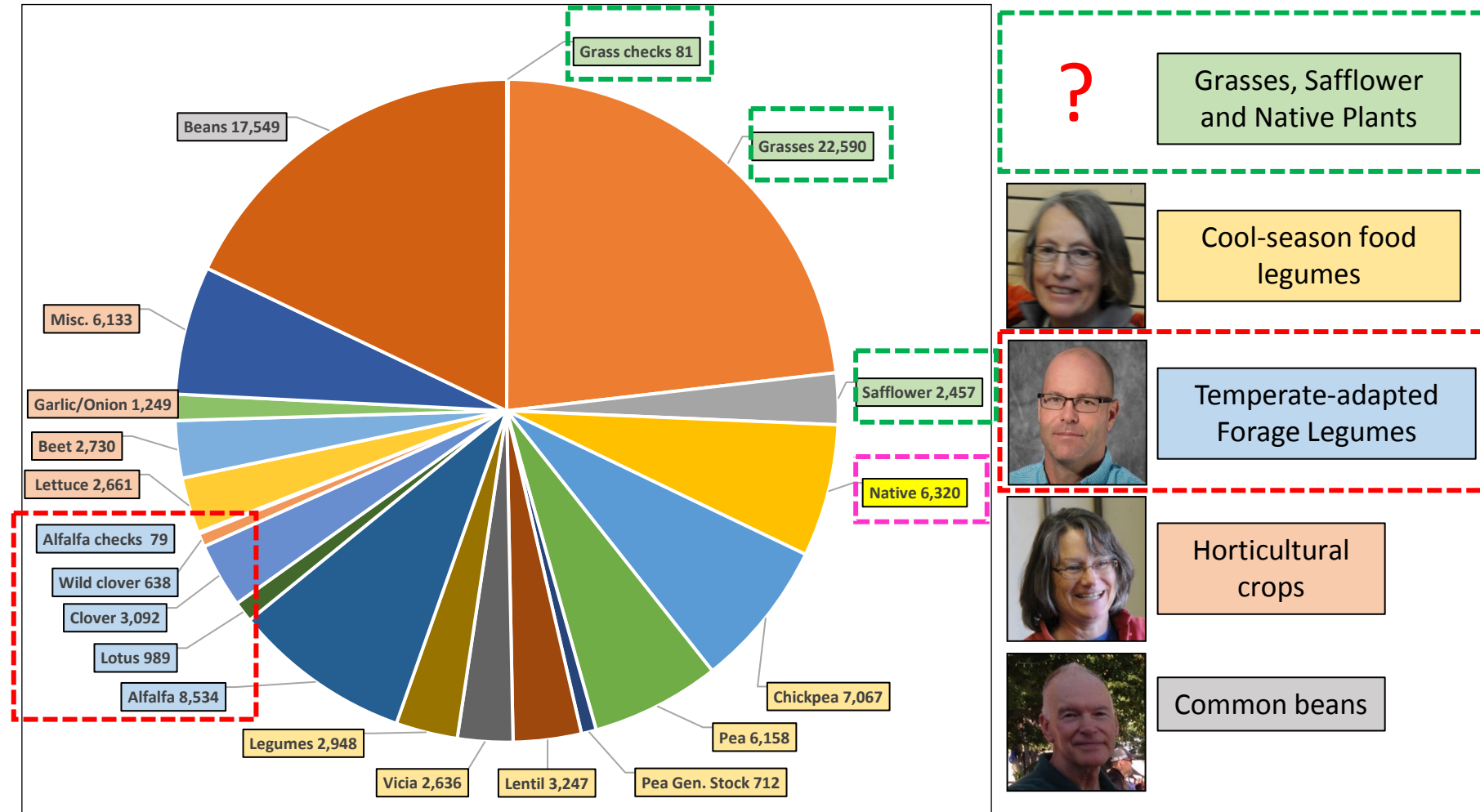
- 2018 – 7,538 (278,863)
- On average distribute close to 250,000 accessions/year
- Demand continues to increase (nominally) in spite of efforts to be more selective
- Seeds, scionwood, cuttings, rhizomes, bulbs, leaves, pollen, DNA, ...

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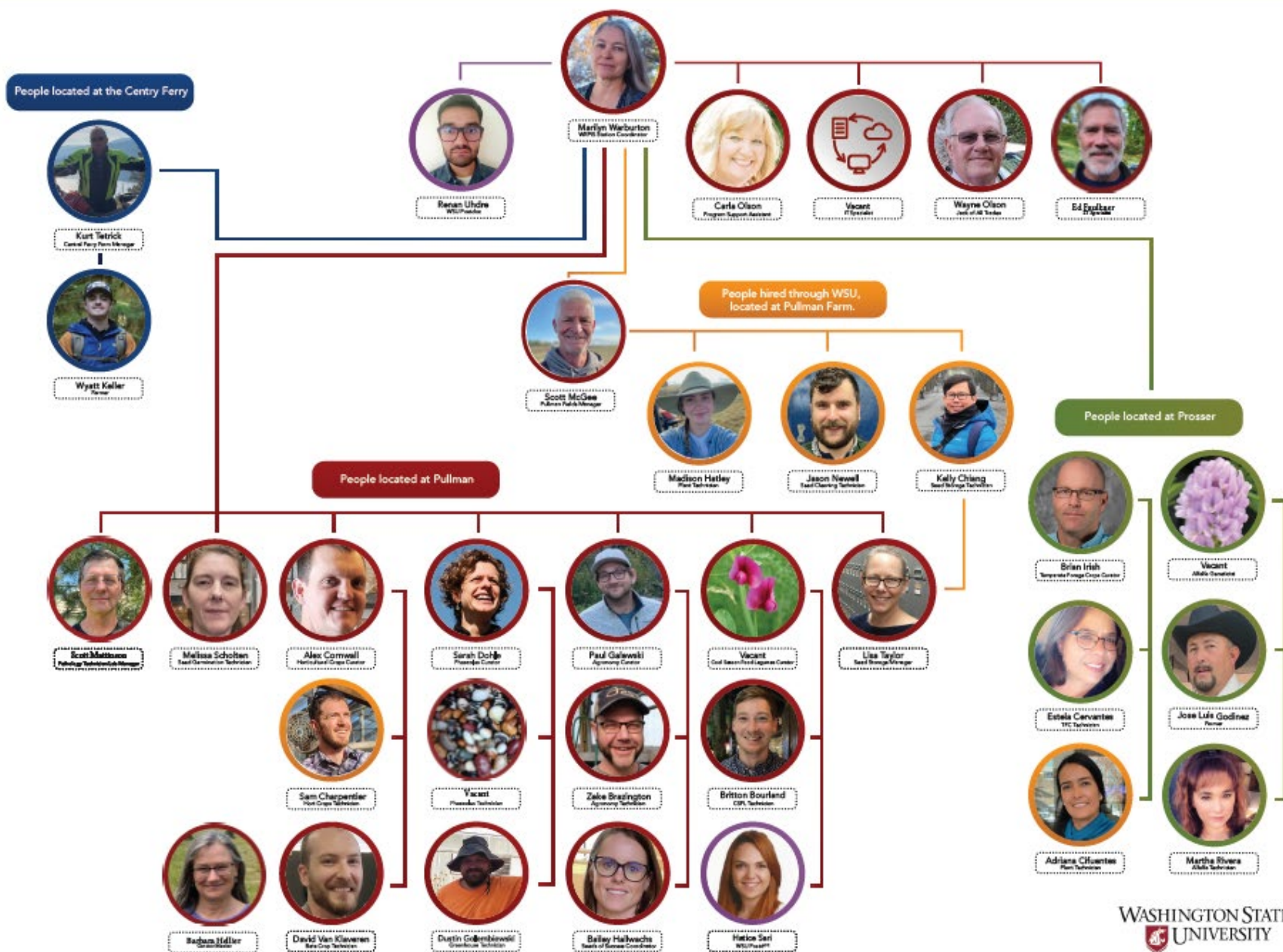
WRPIS/PGITRU - Curatorial Programs

- 2nd Largest active collection within NPGS – 102,628
- Five curatorial programs
 - Grasses...
 - Food legumes
 - Temperate forages...
 - Horticultural crops...
 - Common beans...
- SOS - Native plant collections (forages)





Plant Germplasm Introduction and Testing Research Unit (Western Regional Plant Introduction Station)



NATIONAL PLANT GERMPLASM SYSTEM'S COOL-SEASON GRASS AND TEMPERATE-ADAPTED LEGUME FORAGE GENETIC RESOURCES

Paul Galewski – Grass, Safflower, and Native Curator
Brian Irish - Temperate-adapted Forage Legume Curator
Marilyn Warburton - Research Leader

Plant Germplasm Introduction and Testing Research Unit





Conserve, preserve, and maintain plant genetic resources for species of agronomic/economic importance to the United States.

Understand diversity with collection (Functional and Genetic)

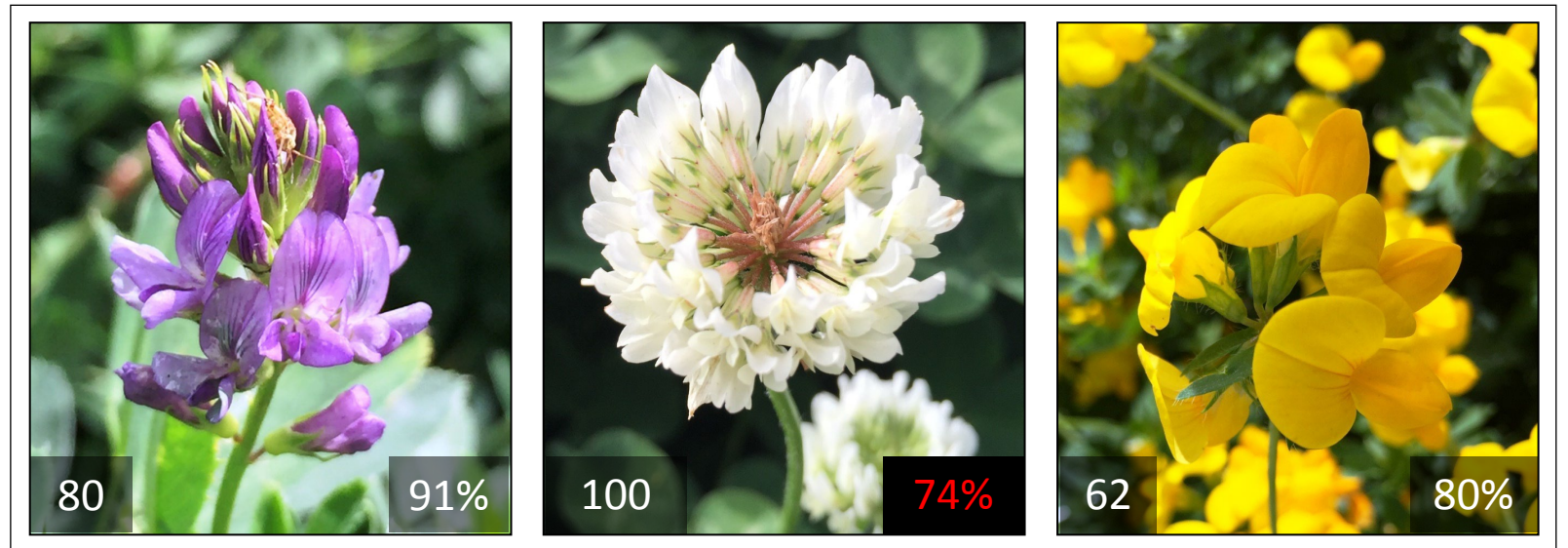
Understand the distribution of plant genetic resources for species

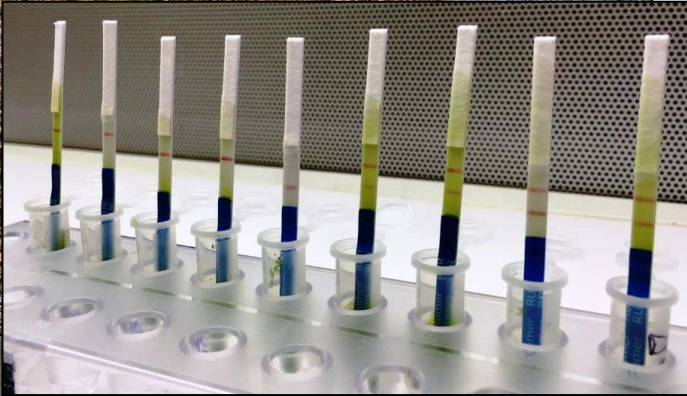
Implement/Develop tools for PGR conservation, preservation, and management

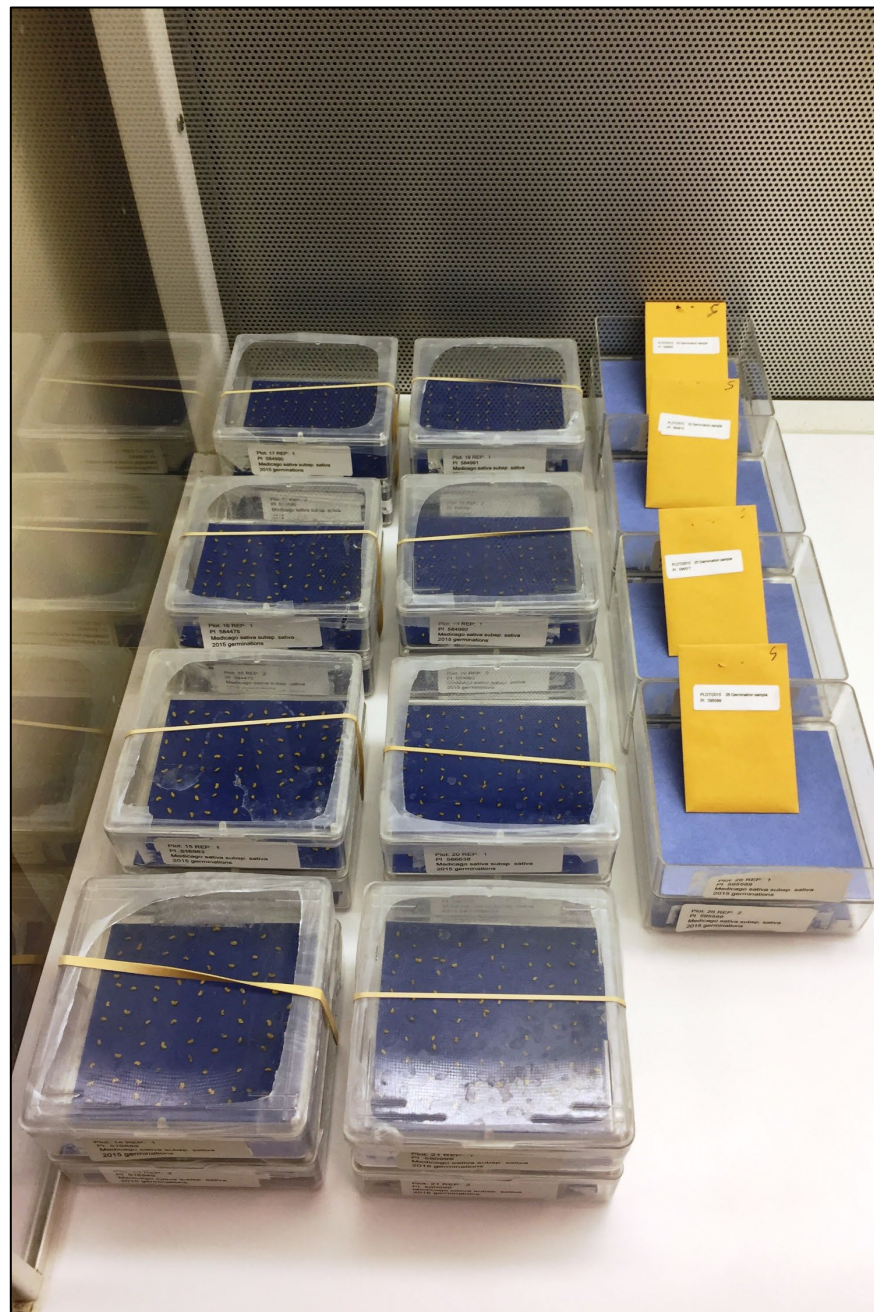
- Accessions – 13,000
- Taxa – 236
 - **FIVE genera!**
- Availability
 - Not all available*
- Backed up
 - **Clover 74%**
- Increase – 200-300
- Distribute – 4,000
- Acquisitions – fewer and fewer
- GRIN-Global data incorporated

Table 1. Summary statistics for the Temperate-adapted Forage Legumes collections conserved by the Western Regional Plant Introduction Station (WRPIS) of the NPGS.

Crop	Acc. ^a	Spe. ^a	Ava. ^a	Bac. ^a	Inc. ^b	Dis. ^b	Acq. ^b	Rec. ^b
<i>Medicago</i>	8,612	80	7,739	7,773	429	16,457	390	1,315
<i>Trifolium</i>	3,733	98	2,730	2,778	179	2,315	99	0
<i>Lotus</i>	920	40	772	736	168	674	26	14
<i>Acmispon</i>	60	18	51	52	5	18	18	13
Total	13,325	236	11,292	11,299	759	<u>19,462</u>	533	1,342







Some key challenges for the NPGS

- Managing and expanding the NPGS operational capacity and infrastructure to meet the increased demand for germplasm and associated information
- Recent and upcoming NPGS personnel retirements
- Developing and applying cryopreservation and/or in vitro conservation methods for clonal germplasm
- BMPs and procedures for managing accessions (and breeding stocks) with GE traits and the occurrence of adventitious presence (AP)
- Acquiring and conserving additional germplasm, especially of crop wild relatives

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Major Phases –PGR Management

Higher precedence

- Acquisition
- Maintenance
- Regeneration
- Documentation/Data Management
- Distribution

Lower precedence

- Characterization
- Evaluation
- Enhancement
- Research in support of the preceding priorities

Strengthening the USDA/ARS National Plant Germplasm System to Conserve and Deliver Crop Germplasm That Sustains Us

The U. S. National Plant Germplasm System (NPGS) is Crucial to Global Food Security

NPGS safeguards and delivers plant germplasm for food, fiber, animal feed, industrial, medicinal and ornamental crops. Plant breeders use that plant germplasm to develop new crop varieties with higher yields, resilience to extreme weather, and resistance to virulent diseases and pests.



22 NPGS genebanks...

manage	maintain	distribute
200 + crops	600,000 + unique kinds of plant germplasm	200,000 + research samples each year

The NPGS Faces Daunting Challenges

- 1 NPGS collections have critical backlogs in:
 - filling collection gaps
 - securing plant germplasm in long-term storage
 - testing plant quality and health
 - regenerating plant germplasm
 - characterization, trait evaluations and genetic enhancement
- 2 Lack of technical knowledge for conserving some plant germplasm, particularly wild species, limits the scope of germplasm the NPGS can effectively safeguard.
- 3 Inadequate NPGS genebank operational capacity results in losses and deteriorating germplasm quality.



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NPGS Plan to Meet the Challenges

Directed by the 2018 Farm Bill, the NPGS developed a 10-year plan for expanding leading-edge research and germplasm management capacity to reduce critical backlogs in safeguarding and making available NPGS germplasm, thereby delivering:



New plant germplasm with valuable traits acquired & conserved



Knowledge of the intrinsic genetic variation & high value traits in plant germplasm



More plant germplasm maintained disease-free, securely backed-up, & available for research & breeding

Budget Increases Starting in Years 1-5

Increased recurrent annual base funding:

- \$17.45 million for germplasm maintenance
- \$25 million for trait evaluations
- \$1.8 million to manage genetic characterization data
- \$50-150 million for genetic enhancement

Non-recurrent funding increase:

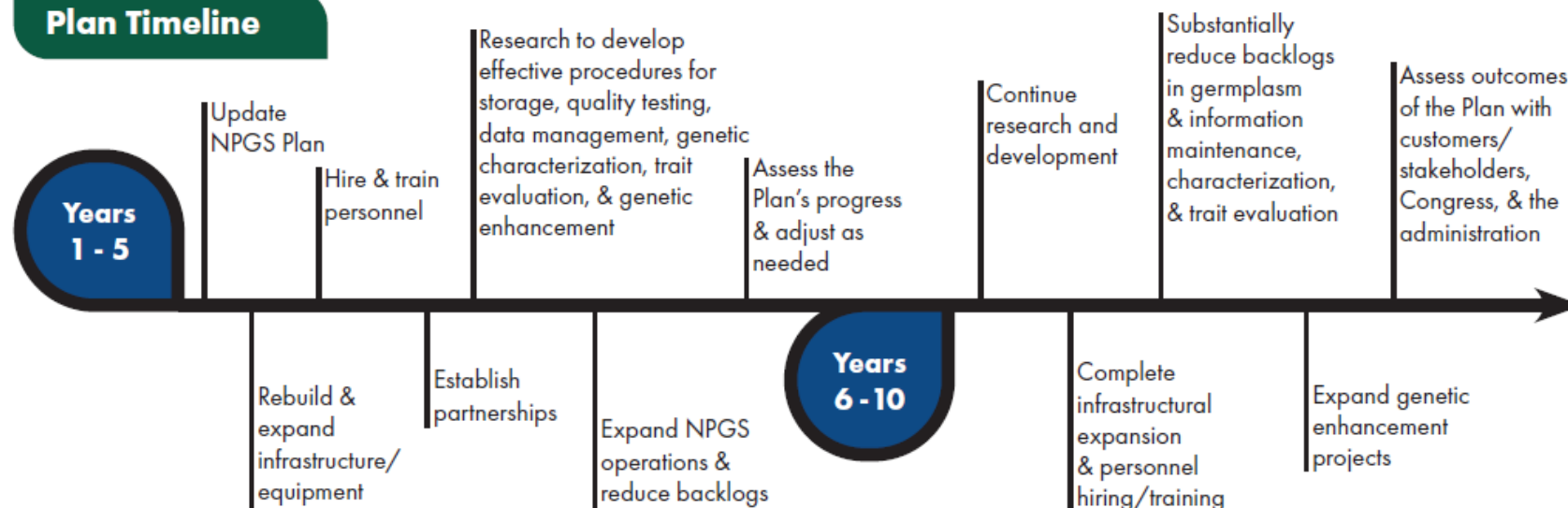
- \$57.7 million for genetic characterization

Budget Increases Starting in Years 6-10

Increased recurrent annual base funding:

- An additional \$12.25 million for germplasm maintenance (for a total increase of \$29.7 million)

Plan Timeline



NATIONAL STRATEGIC GERMPLASM AND CULTIVAR COLLECTION ASSESSMENT AND UTILIZATION **PLAN**



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Plan Directed by 2018 Farm Bill

- **SEC. 7205. NATIONAL STRATEGIC GERMPLASM AND CULTIVAR COLLECTION ASSESSMENT AND UTILIZATION **PLAN**.**
- (a) **IN GENERAL.**—Section 1632(d) of the Food, Agriculture, Conservation, and Trade Act of 1990 (7 U.S.C. 6 5841(d)) is amended—...
- (3) by inserting after paragraph (5) the following:
- “(6) develop and implement a national strategic germplasm and cultivar collection assessment and utilization **plan** that takes into consideration the resources and research necessary to **address the significant backlog of characterization and maintenance of existing accessions considered to be critical to preserve the viability of, and public access to, germplasm and cultivars; and**”.
- ‘(f) **PLAN PUBLICATION.**—On completion of the development of the **plan** described in section 1632(d)(6), the Secretary shall make the plan available to the public.”



NPGS Plan to Reduce Backlogs and Strengthen PGR Maintenance Capacities

- **Primary causes for NPGS backlogs:**



- Inadequate operational resources and PGR management capacities.
- Knowledge gaps and lack of efficient and effective PGR management methods, especially for crop wild relatives (CWR).

- **Increased resources needed** to reduce backlogs over +10 years:

Annual Recurrent (Base)
Funding

Personnel



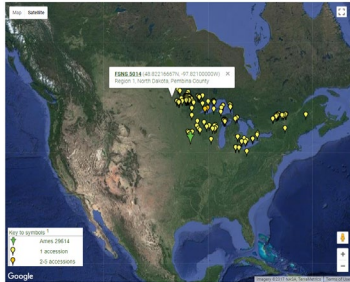
Greenhouse,
Screenhouse, and
Field Space

Cold Storage Space
(0°F, -18°C)

Goal: Expand NPGS PGR Maintenance Capacities

NPGS Plan: Built on a Strong Foundation

Despite knowledge gaps, and suboptimal resources and PGR management capacities, the NPGS has accomplished much.

National Plant Germplasm System					
GRIN-Global <ul style="list-style-type: none"> Superior information management system 	NPGS identified priorities for conserving crop wild relatives (CWR)  <p>Coffee CWR</p>	Safeguarding PGR at the NLGRP, Ft. Collins <ul style="list-style-type: none"> New cryo-preservation methods for safeguarding clonally-propagated crops 80% of seed-propagated accessions duplicated 	Significant Demand for NPGS PGR <ul style="list-style-type: none"> 87% of NPGS accessions available for distribution Large volumes of NPGS PGR (avg. 200,000 samples/yr.) distributed annually 	Origin or Provenance well-documented for 90%+ of NPGS accessions 	Skilled and Experienced Staff <ul style="list-style-type: none"> Undergoing substantial transitions with retirements PGR management training program is underway

This foundation is crucial for implementing the NPGS Plan

USDA/ARS National Plant Germplasm System (NPGS): Intended Focus of Plan

Scope and Approach:

- Summarize current NPGS status, plant genetic resource (PGR) management capacities, operations, and support available to meet demands for PGR and associated information.
- Focus on **current** “backlogs” for maintenance, characterization, and other PGR management operations; formulate strategies to reduce or eliminate backlogs during the next +5 and +10 years, taking into account the forecast slow growth (12%) of collections.
- PGR maintenance and characterization emphasized; other PGR management operations (e.g., evaluation, genetic enhancement) also covered.

NPGS Plan: Scope and Approach

- Measured current status of NPGS PGR collections with **75+ metrics** for PGR management, genebank operations and capacities.
- 22 NPGS genebank units generated **75,000+ datapoints** in 2019-2020 to describe the current status and determine PGR management goals (+5 and +10 years) for the NPGS.

Example of PGR management metrics for ca. 200 NPGS crops

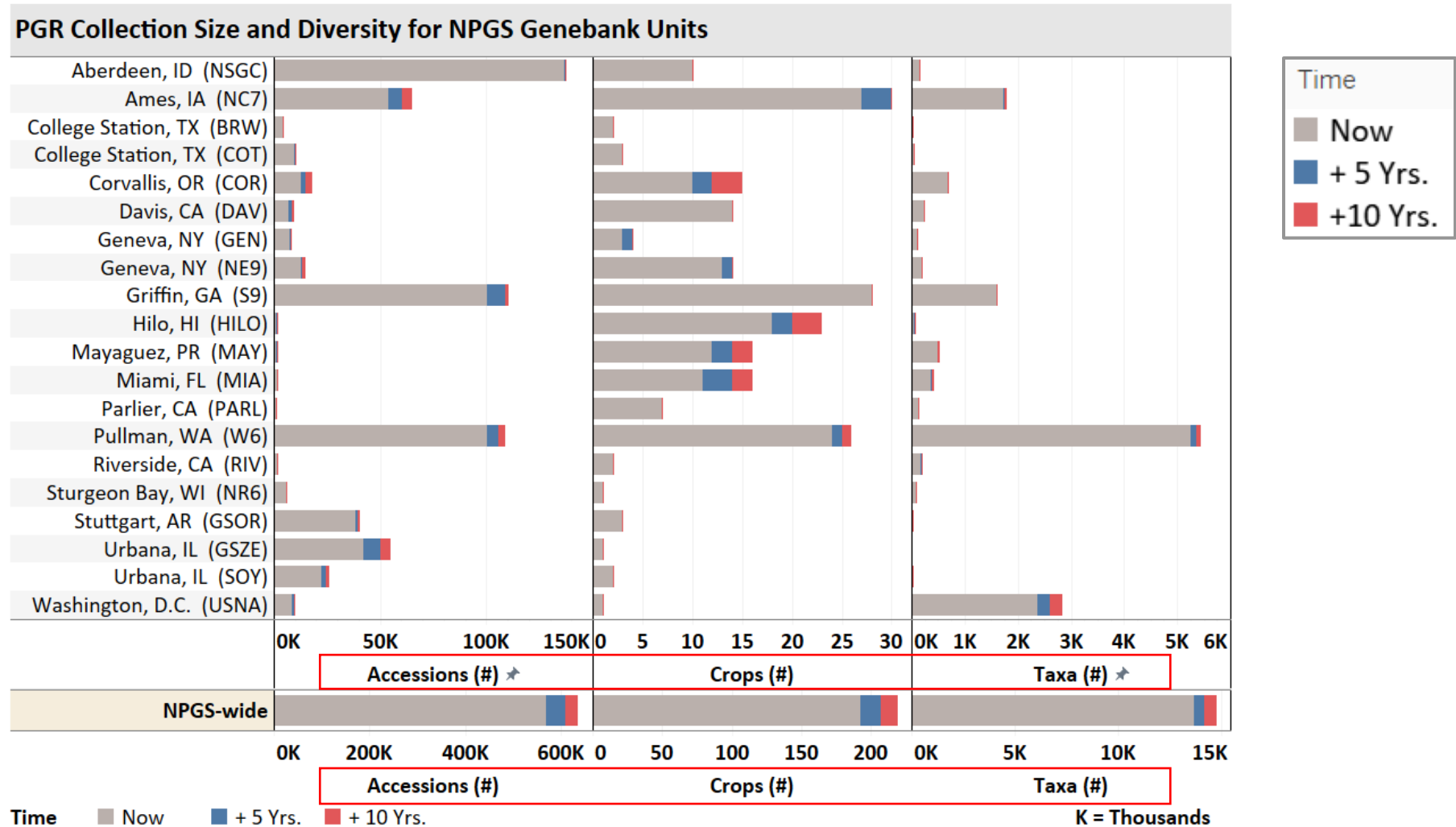
ARS Crop Genebank Site >	Ames, IA	Ames, IA	Ames, IA
Genebank code >	NC7	NC7	NC7
Crop >	MAIZE	MAIZE	MAIZE
	Now	+ 5 Yrs.	+ 10 Yrs.
<u># of accessions requiring controlled hand pollination</u>	7945	5983	1395
<u>% of accessions requiring controlled hand pollination</u>	41	24	5
# of accessions requiring controlled hand pollination regenerated annually	363	1361	1856
% of accessions requiring controlled hand pollination regenerated annually	5	23	33

Example of PGR management metrics for 22 NPGS genebank units

ARS Crop Genebank Site	Griffin, GA	Griffin, GA	Griffin, GA
Genebank code	S9	S9	S9
<u>1 Infrastructure, capacity and support for NPGS PGR and information management</u>	<u>Now</u>	<u>+ 5 Yrs.</u>	<u>+ 10 Yrs.</u>
<u>A) Overall genebank collection size and diversity</u>			
# of genebank taxa	1602	1602	1602
# of genebank accessions	100,181	108,726	110,435
# of different crops	28 Maintenance Groups	28	28
<u>B) Financial support</u>			
Annual operational budget (\$; ARS and off-the-top)	2,911,541	4,050,115	4,299,024
<u>C) Staffing</u>			
# FTEs permanent	24	31	31
# FTEs temporary	1.5	3.5	3.5
<u>D) Physical resources</u>			
Cold storage space (ft3); +41F; 0F; cryo conditions	33,600	85,000	85,000

Data analyzed and presented by infographics.

Example: NPGS PGR collection size and diversity



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22 NPGS genebanks...



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