agInnovation Business Meeting Agenda V8
10:30 AM-12:30 PM, 1:45-2:45 PM, September 26, 2023
DeVos Place, Ballroom D. Grand Rapids, MI

10:30 am	Gathering of attendees/Call to order – Matt Wilson, agInnovation chair
10:35 am – 10:45 am	*Meeting administration* – Matt Wilson • Introductions • Announcements • Consent Agenda Approval • Agenda Modification (Additions/Deletions) and Approval • Approval of agInnovation Executive Committee (ESCOP) Minutes (July 19, 2023)
10:45 am – 11:15 am	*Reflections:* ESS/ESCOP/agInnovation: A year in retrospect – Matt Wilson, agInnovation chair
11:15 am – 11:45 am	*Reporting that requires agInnovation decisions*: National Research Support Project Review Committee – Mark McGuire, NRSP RC chair • NRSP1 Budget Modification • NRSP8: Building Applied Genomic Capacity for Animal Industries • NRSP 11 Building Collaborative Research Networks to Advance the Science of Soil Fertility: Fertilizer Recommendation Support Tool (FRST) • Revisions to NRSP Guidelines
11:45 am – 12:15 pm	*Work session:* AG-NGINE Update – Elaine Turner, Dean College of Agriculture, University of Florida
12:15 pm – 12:30 pm	*Work session:* agInnovation rebranding effort-rollout – Matt Wilson, agInnovation chair
12:30 pm – 1:45 pm	**agInnovation Awards Luncheon**
1:45 pm – 2:30 pm	*Work session:* agInnovation Finance Committee – Chris Pritsos, Finance Committee chair; Matt Wilson, agInnovation chair; and George Smith, agInnovation incoming chair • Finance Committee report (Chris Pritsos)

	• agInnovation 501(c)3 update (Chris Pritsos) • agInnovation priorities and chair's initiatives (George Smith) • agInnovation budget presentation (Matt Wilson and George Smith)
2:30 pm – 2:35 pm	*Work session:* Nomination and election of agInnovation chair elect – Matt Wilson
2:35 pm – 2:45 pm	*Work session:* Passing of the gavel – Matt Wilson and George Smith
	Supporting Materials • NRSP Review Committee (p. 3-4) • 2023-2024 agInnovation Priorities/Chair's Initiatives (p. 5) • Proposed agInnovation Budget (p. 6)
	Consent Agenda, Agenda Briefs • Budget and Legislative Committee (p. 7-11) • Diversity Catalyst Committee (p. 12-14) • National Plant Germplasm Coordinating Committee (NPGCC) (p. 15-39) • NRSP-1 Management Committee (p. 40-42) • Policy Board of Directors (p. 43-44) • Science and Technology Committee (p. 45) • Communications and Marketing Committee (p. 46-49) • Resolutions and Personnel Changes (p. 50-55)

Agenda Brief: National Research Support Project (NRSP) Review Committee (RC)
(http://escop.info/committee/nrsp-rc/)
Date: September 26, 2023
Presenter: Mark McGuire
Action Requested: Vote by 1862 SAES Directors

Committee Members:

Chair: Mark McGuire (WAAESD)
Executive Vice Chair: Bret Hess (WAAESD ED)
Members:
Steve Lommel (SAAESD, incoming chair)
Gary Thompson (SAAESD ED, incoming executive vice chair)
Blair Siegfried as proxy for Matt Wilson (NERA)
Carolyn Lawrence-Dill (NCRA)
Erdogan Memili (ARD)
Robert Mattive (CARET)
Tom Bewick (NIFA)
Mike Schmitt (ECOP)
Ex-officio:
Jennifer Tippetts (WAAESD Administrative Management, Recording Secretary)

Meeting: An in-person business meeting was held at the Grand Sierra Resort in Reno, NV on June 1.

Meeting Attendance: Committee members- Steve Lommel, Mark McGuire, Bret Hess, Blair Siegfried (proxy for Matt Wilson), Bob Mattive, Tom Bewick, Mike Schmitt, Carolyn Lawrence-Dill, Gary Thompson, and Jennifer Tippetts (recording secretary). Virtual guests- Noelle Cockett presented on NRSP8, Deanna Osmond presented on NRSP_TEMP_11, and Brad Gaolach presented an intent to submit a proposal to establish an NRSP on a National Urban Research and Extension Center.

NRSP RC Accomplishments/Upcoming Plans

- Funding commitments from 2021 through 2027 would suggest that there is room to fund the existing NRSPs and consider new proposals.

- The NRSP RC voted to accept the NRSP1 request to change the budget for the remainder of the project's life. The requested change is to increase the impact statement coordinator's salary to a level that is commensurate with the quality of work being produced (for example, visit https://www.mrfimpacts.org/). The NRSP1 AAs are also concerned about retaining the impact statement coordinator if she does not receive an increase in compensation greater than the 3% annual COLA that 1862 SAES directors approved when the project was initiated. NRSP1 requested to increase the impact statement coordinator's salary 15% in FY24, 11% in FY25, and 3% in FY26 and FY27.

- Recommend approving the proposal to renew NRSP8 (NRSP_TEMP_8: National Animal Genome Research Program) with the title changed to Genomic Capacity: *Building applied genomic capacity for animal industries* along with accepting the proposed budget. The project AAs have been notified that an evaluation or impact analysis will be expected at midterm review.

- The proposal and associated budget to establish a new Emerging Innovation NRSP (NRSP_TEMP_11: Building Collaborative Research Networks to Advance the Science of Soil Fertility: Fertilizer Recommendation Support Tool (FRST)) is recommended for acceptance following satisfactory responses to the concerns about managing expectations with the proposed tool and answering questions about the budget. NERA will need to appoint a representative to serve as AA.

- An NRSP proposal to create a National Urban Research and Extension Center should be delivered with more of a data-driven perspective. NRSP RC encourages drafting a proposal that involves more research and includes how Extension can be leveraged to support research activities. The 2025 submission deadline was recommended to allow sufficient time to prepare a proposal that has a better chance of being accepted by NRSP RC and the Section.

- The midterm evaluation of NRSP4 was very positive. Unfortunately, NRSP RC requested a plan for transitioning off OTT rather than a description of the great work performed by NRSP4. NRSP RC requested that the proposal to renew NRSP4 include a budget that shows a reduction in reliance in OTT from NRSP, especially since IR4 received an additional $4 million from NIFA and fewer fields are expected to be enrolled in the program due to regulatory pressures. NRSP RC recommended starting with a 15% reduction in OTT in the business plan that will be submitted with the proposal to renew.

- In addition to evaluating NRSP9's progress, the midterm review included consideration of the NRSP RC request to conduct an evaluation of NRSP9 and to demonstrate progress on development of an alternative business model that would lead to less reliance on OTT funding. The independent evaluation of the project's accomplishments was very thorough. The creation of a 501(c)3 non-profit was a tremendous step toward demonstrating NRSP9's commitment to developing an alternative business model and decreasing future reliance on OTT. Therefore, NRSP RC had no reservation with recommending continuation of NRSP9 through the current five-year cycle.

- Revisions to NRSP guidelines under consideration largely reflect NRSP RC expectations since creating two tracks. For example, contracts for services should be re-evaluated at each renewal and an impact analysis is required as part of the midterm review. agInnovation was included where appropriate throughout the document. Lastly, the reimbursement policy was updated to reflect that agInnovation will cover expenses while attending the in-person meeting.

2023-2024 agInnovation/ESCOP Priorities

I. Support increased appropriations for USDA-NIFA to enhance capacity and competitive funding for research.
II. Identify opportunities and develop short- and long-term funding strategies to address critical infrastructure needs at colleges of agriculture at Land-grant universities.
III. Fully integrate diversity, equity, and inclusion as an essential component of all agInnovation activities and programs.
IV. Continued emphasis and activities supporting agInnovation's leading role in addressing climate change challenges as they impact agriculture and natural resources.
V. Strengthen partnership and engagement efforts with USDA, including the OCS, NIFA, ARS, and NRCS.
VI. Engage agInnovation directors through effective and regular communication.

2023-2024 Chair's Initiatives, *working with and through ESCOP and other APLU committees, where appropriate.*

I. Develop and implement an agInnovation "Research Funding Framework" and Implementation Plan that includes well-articulated goals, data driven and other effective advocacy strategies, and clear 1-, 5-, and 10-year science deliverables and funding benchmarks for achieving identified goals.

Strategy Examples:

- Convene a planning team to identify goals, strategies, deliverables, and benchmarks. This may include seeking the advice of an external consultant on effective advocacy strategies, to facilitate an agInnovation blueprint discussion, provide guidance, and share fresh and effective approaches to the planning team.
- Develop and implement data-driven and other advocacy strategies that effectively demonstrate the need and value of capacity and other research funding to different audiences (within and outside agriculture), including current and new (see priority II) stakeholders and partners.
- In a proactive and timely manner, engage with and arm APLU and Lewis Burke and Associates with the qualitative and quantitative data, stories, and other information important in research funding advocacy. This includes collecting and analyzing data critical to other advocacy partners beyond APLU/LBA, i.e., NGOs, industry, professional organizations, and others.

II. **Strengthen current and build new strategic partnerships with traditional and nontraditional entities to 1) broaden network to industry, NGOs, other federal agencies, professional organizations, and others; 2) build and strengthen awareness of our LGU system's research capabilities and coordination; 3) generate and reinforce appreciation of our national and global impact on lives and livelihoods, and 4) catalyze advocacy for federal and other funding to support agInnovation's food security, environmental stewardship, nutrition and health, agricultural systems, energy, bioproducts, and community health and resilience priorities.**

Strategy Examples:

- *Using a town hall or similar approach, engage leaders within professional societies to inform and gain input on our funding lines, needs, and national and global impacts to catalyze strong support for research funding.*
- *Engage in complimentary advocacy efforts—e.g., NCFAR, SOAR, and others.*
- *Identify new stakeholders and actively build relationships with industry, NGOs, non-ag organizations, professional organizations, and others.*

For more information, visit ESCOP or agInnovation, or contact:
George Smith (agInnovation/ESCOP Chair; smithge@msu.edu);
Jeanette Thurston (agInnovation/ESCOP Executive Vice Chair; jthurston@ksu.edu)

Proposed CY24 agInnovation Annual Budget	CY24 Proposed	CY23 Approved	CY23 Actuals/Encum
INCOME			
Previous CY Carryover (estimate)	$109,402	$143,717	$133,425
ESS Assessment	$100,000	$100,000	$100,000
Other	$0	$0	$0
TOTAL INCOME	$209,402	$243,717	$233,425
EXPENSES			
National Impact Database (TAMU hosted)	$0	$12,500	$0
National Impact Database Writing (travel)	$0	$5,000	$0
Printing (APLU, other)	$0	$4,000	$0
Training	$15,000	$15,000	$15,000
Website	$1,000	$1,000	$0
NCFAR Membership	$1,000	$1,000	$1,000
NRSP Stakeholder (travel)	$1,500	$1,500	$761
ESS Committee Meetings	$5,000	$5,000	$2,220
AG-NGINE *[New in CY23]*	$50,000	$50,000	$50,000
Communications and Advocacy	$10,000	$15,000	$22,150
Meeting Support (agInnovation Annual Meeting)	$15,000	$10,000	$10,000
Promotion (meeting travel, printing, etc.)	$20,000	$10,000	$9,998
Diversity Catalyst and Leadership Awards (new for 2024, approved for addition to the CY2023 budget)	$12,000	$6,000	$10,329
Strategic Advocacy--Facilitator *(NEW in CY24)*	$15,000	$0	$0
Planning Team in-person Meetings *(NEW in CY24)*	$35,000	$0	$0
agInnovation 501(c)3 *(NEW in CY24)*	$2,500	$0	$2,565
Other			
TOTAL EXPENSES	$183,000	$136,000	$124,023
PROJECTED BALANCE AT END OF CY	$26,402	$107,717	$109,402

Agenda Brief: ESCOP Budget and Legislative Committee (BLC)
September 26, 2023
BLC Chair: Anton Bekkerman
Action: For Information

Budget and Legislative Committee (BLC, http://escop.info/committee/blc/)

Anton Bekkerman (NERA, University of New Hampshire) assumed the duties of the BLC chair for a two-year term replacing Glenda Humiston at the 2022 ESS Annual Meeting in Baltimore. The BLC chair is a multifaceted leadership position given the multiple committee assignments (BAA-BAC voting member, BAA-CLP voting member, ECOP BLC liaison). Lewis-Burke Associates (LBA) has regularly participated in our meetings with Dr. Elizabeth Stulberg being designated as the point person to the ESCOP BLC from LBA. Monthly meetings occur on the fourth Tuesday of every month from 4:00-5:00 ET. In January 2023, Gary Thompson replaced Jeff Jacobsen as Executive Vice-Chair after Jeff Jacobsen retired from his role as the NCRA executive director.

The predominant focus of the ESCOP BLC is to create, adapt, monitor, and change agInnovation's input into the BAC, CLP, and infrastructure budget and legislative activities. Modification to existing processes, advancing new deadlines, and creation of new steps and requests make this an iterative process. The BAA Unified FY 2024 Appropriations Request was approved by the BAC and the BAA Policy Board of Directors and is summarized here (FY24 approps). The CLP finalized the BAA Farm Bill Request, which is summarized here (BAA Farm Bill).

The BLC is working to assess what changes to its operations structure may be needed to better represent and serve the needs of the section. The BLC Rules of Operation were formally adopted at our March meeting (BLC Operations). The committee also began alternating its meetings: one month the meeting is for voting members only to foster open discussion, and the alternating month includes the more traditional discussion and liaison report structure. One of the outcomes of this revised structure is more time for in-depth discussions by the voting members that is valuable in reflecting on broader questions that the BLC needs to address, while still receiving timely input from the liaisons. Additionally, due to the BLC chair's involvement in many other parts of the BAA where liaisons provide updates, the chair can bring back information to the BLC in a timely manner even with liaisons joining the BLC meetings less frequently.

The BLC Finance subcommittee was formally dissolved on March 8, 2023, and its activities incorporated into the newly formed ESCOP Finance Committee, which was approved by the membership as an ESCOP standing committee.

The APLU BAA Budget and Advocacy Committee (BAC) is in the process of developing an "advocacy framework" for FY2025 appropriations earlier in the annual advocacy cycle. Each section was asked to outline the description, justification, and initial budget request for relevant NIFA lines. The BLC presented the following information for Hatch, AFRI, and RFA at the Joint COPs agInnovation and BAC meetings, respectively.

Defining the State Agricultural Experiment Station

What is an Agricultural Experiment Station?

AESs are research institutes that steward public federal and state investments toward scientifically proven and trusted solutions for ensuring food security and access, economic and environmental sustainability, and continual innovations in the agri-food sector.

Why do Agricultural Experiment Stations exist?

AESs push the frontiers of innovation and knowledge development to help U.S. food systems be more resilient, secure, forward-looking, and accessible by every community—ensuring economic strength for food producers and economic stability for consumers.

Where are Agricultural Experiment Stations located?
By being in every state and territory and leveraging the highly connected network of Land-grant universities, the nation-wide AES research system is the primary and largest contributor to advancing food, economic and environmental resiliency within every U.S. community while also elevating U.S. leadership in global agriculture.

How are Agricultural Experiment Stations funded?
Agricultural Experiment Stations receive capacity funding through federal and state appropriations. Capacity funding is leveraged with support from granting agencies, foundations, commodity groups, and private industry.

Who do Agricultural Experiment Stations represent?
AESs are comprised of university faculty, staff, graduate students, and affiliated scientists who partner and collaborate with agricultural producers, agri-food sector, and consumers—all of whom are the beneficiaries of the scientific knowledge and innovations.

Our Purpose – to promote and elevate agricultural research that improves lives and makes the world more food secure.

Our Vision – enhanced human and world well-being through agricultural innovation.

Our Values – collaborative, solution-oriented, impactful, global, innovative, science-based.

Map of AES locations: https://webdoc.agsci.colostate.edu/aes/wcrc/US_Map/

Hatch Act (includes Hatch Multistate)
Program description:

- Federal (USDA-NIFA) funding through Hatch and Hatch multistate grants provides long-term sustainable support for scientists to undertake critical research on national, regional, and local challenges to agricultural systems.
- Over 140 years of strategic federal investment funding to conduct bold, long-term, location-specific research at State Agricultural Experiment Stations in the 50 States, D.C., and Insular Areas in agricultural, food, forestry, natural, and human resources research.
- Science experts at AESs address issues of national importance with research addressing local problems. These experts respond to critical issues that affect their state's production, profitability, invasive plant/animal species, biosecurity, land and water use, climate resilience, economic analysis, and farm safety.
- "Knowledge capital arising from public (research) spending spurs innovation that promotes productivity and enhances the global competitiveness of US agriculture."

Facts and figures:

- AESs are the lynchpin in the National Public Agricultural Research System.
  - "The federal government funds about two-thirds of public agricultural research in the United States, with State governments and non-government sources funding the rest."
  - "Land-grant universities and other non-federal institutions perform about 70% of US public agricultural research. USDA agencies perform the remainder."
  - USDA agencies (ARS, ERS, and NASS) form strong partnerships with AESs, often co-locating on LGU campuses.

- “Long-term, multifaceted benefits from public spending on agricultural R&D (research) will benefit the agri-food sector, the economy in general, and the environment.”

- “US public investment in agri-food research and development has lost considerable ground over the past two decades, exacerbating the shrinking US share of global agri-food R&D spending to such an extent that America now lags well behind China.”
  - “US public agricultural R&D expenditures, when adjusted for the rising cost of conducting research, have declined by about one-third since peaking in 2002.”
  - Inflation adjusted decreased funding has led to -21% of scientist FTEs, -20% research projects, -32% of annual hours of research (12.37 million) since 2004.

Impacts and aspirations (developed for the OGA process – issues of national importance):
We’ve identified five key topics around which we can build a central impact communication strategy. For each, we will summarize a national-level impact summary and provide examples of impacts from each of the four ESS regions. Sources from which impacts will be drawn are below:
Five topics of focus for ESS:

- Food security is national security
  - https://www.mrfimpacts.org/impact-statements/categories/food-security
  - https://landgrantimpacts.org/food-security/
- Climate resilience
  - https://www.mrfimpacts.org/impact-statements/categories/climate-change
  - https://landgrantimpacts.org/environmental-stewardship/
- Advanced technology agriculture
  - https://www.mrfimpacts.org/impact-statements/categories/automation
- Food systems’ effects on nutrition and health
  - https://www.mrfimpacts.org/impact-statements/categories/human-health-nutrition
  - https://landgrantimpacts.org/nutrition-health/
- Global innovation leader
  - https://www.mrfimpacts.org/impact-statements/categories/biofuels
  - https://landgrantimpacts.org/agricultural-systems/

Funding goal: **Request $300 million for the Hatch Act in FY 2025**

- Annual growth of 14% is needed to keep pace with international competitors that are investing at an aggressive rate. Annual growth of 7% (FY25: 5% inflation rate plus 2%) is the minimum essential to keep our activities on a constant trajectory and to avoid putting public and food security in danger.

AFRI

Program description:

- The nation’s premier competitive grants program in agricultural, food and natural resource sciences, supporting pioneering research in federally identified priorities for practical innovations that improve rural economies, increase food production and security, stimulate the bioeconomy, mitigate the impacts of climate variability, address water availability issues, ensure food safety, enhance human nutrition, and train the next generation of agricultural scientists and professionals. Much of AFRI’s successes is built on the back of long-term research carried out via capacity programs.

Facts and figures:

- The success rate for AFRI applications in FY 2020, calculated in terms of number of proposals funded (excluding conferences, supplements, continuing increments of the same grant, and

NIFA Fellowships) divided by the number of proposals submitted for review, was 24%, up from the reported success rate in 2019 of 16%.

- However, since AFRI's authorization in the 2008 Farm Bill, the program has not received more than approximately 60 percent of its authorized level of $700 million.
- In FY 2019, over 2,000 competitive funding applications, totaling over $1.5 billion, were submitted, but congress only provided $415 million to AFRI that year, leaving many promising proposals unfunded.
- In 2022, NIFA invested $73.5 million of AFRI appropriations for development and adoption of climate-smart agricultural and forestry practices, including launch of a new program to respond rapidly to extreme weather events that impact agriculture. (USDA FY24 Budget)
- The FY24 AFRI budget proposal includes $94 million for innovations in development and application of clean energy technologies for food and agricultural systems and $45 million for climate science and monitoring greenhouse gas emissions from agriculture.
- The FY24 Budget invests $240 million in supporting new supply chains and markets that uplift small and mid-sized farmers through programs such as the Local Agriculture Market Program, Dairy Business Innovation, Farmers Market and Local Food Production, and Transportation and Market Development, through Agriculture and Food Research Initiative (AFRI) grants and other programs. (USDA FY24 Budget)

Impacts (developed for the OGA process):

- https://www.nifa.usda.gov/national-institute-food-agriculture-annual-report/impacts
- https://www.nifa.usda.gov/national-institute-food-agriculture-annual-report/agriculture-food-research-initiative-afri
- Food and Agricultural Science Enhancement (FASE) grants, which constituted 20 percent of AFRI awards in 2019, provide support for pre- and postdoctoral fellowships, and new investigators from a diverse array of institutions.
- Agriculture Workforce Development: AFRI supported 5,026 undergraduate/graduate/post-doctoral students in 2022 and has targeted 5,659 in 2023 and 5,951 in 2024.

Funding goal: **Request $500 million for AFRI in FY 2025**

- We recommend reframing the ask in terms of a timeline to get to the $700m authorized in the 2018 Farm Bill. For example, if we continue increasing AFRI at its historically typical level of $10m/year, it will take about 25 years to get to full authorized funding. If we increased AFRI by 3% each year, it would take about 15 years; 5%, 9 years; 9%, 5 years; 15%, 3 years.
- We recommend using a 5-year goal of 9% to align with the length of a Farm Bill.

Research Facilities Act (RFA)

Program description:

- Statute supports NIFA capacity eligible institutions as contenders for the Research Facilities Act competitive grants program to assist in the construction, alteration, acquisition, modernization, renovation, or remodeling of agricultural research facilities at colleges of agriculture.

Facts and figures (Gordian report):

- Today, agricultural researchers at U.S. colleges of agriculture are conducting 21st century research in mid-20th century facilities.
- A 2021 report found that 70 percent of the facilities at agricultural colleges and universities are beyond their useful life, with an estimate of deferred maintenance of $11.5 billion and a replacement value of $38.1 billion.

Impacts (developed for the OGA process):

- Modernizing research, Extension, and education facilities would advance cutting-edge research and applied science innovations critical for 21st century R&D goals at public colleges of agriculture, veterinarian, forestry, and natural resources across the country.
- Investment in the RFA will also help further attract and retain top-level talent into the U.S. agri-science sector and raise the return on other federal public agricultural research and Extension investments.
- We suggest that USDA outline a framework for the disbursement of funds for the Research Facilities Act Program, as it will be a vital tool to ensure all colleges of agriculture can:
    - recruit top talent,
    - develop a diverse workforce nation-wide,
    - continue to develop transformative agricultural innovation that will benefit all farmers and ranchers, and
    - keep pace with international competitors.

Funding goal: **Request $500 million for the Research Facilities Act in FY 2025**

Historical Funding (in thousands)				
Account	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
Hatch Act	$195,812	$207,106	$215,000	$236,334
AFRI	$190,883	$201,504	$262,482	$264,470
	FY 2012	**FY 2013**	**FY 2014**	**FY 2015**
Hatch Act	$236,334	$218,577	$243,701	$243,701
AFRI	$264,470	$275,569	$316,409	$325,000
	FY 2016	**FY 2017**	**FY 2018**	**FY 2019**
Hatch Act	$243,701	$243,701	$243,701	$259,000
AFRI	$350,000	$375,000	$400,000	$415,000
	FY 2020	**FY 2021**	**FY 2022**	**FY 2023**
Hatch Act	$259,000	$259,000	$260,000	$265,000
AFRI	$425,000	$435,000	$445,000	$455,000

Agenda Brief: ag Innovation Diversity Catalyst Committee (DCC)
Date: September 26, 2023
Chair: Brian Raison (Ohio State)

1.) **Committee Membership** (as of September 26, 2023): see ESCOP Diversity Catalyst Committee (DCC) webpage – http://escop.info/committee/dcc/

2.) **Meetings** (since July 2023): The DCC held the following meetings via Zoom. Minutes/notes from those meetings are available on the DCC's page on the ESCOP website (see Past Events).
   - August 24, 2023.
   - Upcoming Meetings
     - September 28, 2023
     - October 26, 2023

3.) **Accomplishments / Upcoming Plans**:
   - The Diversity Catalyst Committee submitted an agenda brief for the Joint COPS Meeting in Kansas City, MO on July 19, 2023. The brief covered the period from March 2023 through July 2023 and is posted as part of the agInnovation Executive Committee Agenda and Supporting Materials (July 19, 2023). See page 26 for the brief.
   - The Diversity Catalyst Committee received a robust set of nominations for the individual and group National agInnovation Diversity, Equity, and Inclusion awards. The DCC selected Dr. Jacquelyn Mosley (University of Arkansas) as the individual award winner and the Cloquet Forestry Center (University of Minnesota) as the group winner. Dr. Mosley and Mr. Kyle Gill (representing the Cloquet Forestry Center) will be recognized at the awards luncheon held during the agInnovation meeting in Grand Rapids.
   - Incoming agInnovation chair George Smith solicited the DCC's input and advice on the Section's priority to "Fully integrate diversity, equity and inclusion as a central component of all agInnovation activities and programs." The DCC discussed the solicitation and DCC chair Brian Raison responded to Dr. Smith on August 29, a response on which all DCC members were copied. A copy of the letter is included as an attached file to this brief.

4.) **Action Requested:** For information only.

5.) **<u>Attachments:</u>**

- Letter from the chair of the Diversity Catalyst Committee in response to a solicitation for advice by agInnovation Chair George Smith.

August 29, 2023

Dr. George Smith
Director of AgBioResearch, Senior Associate Dean for Research
Michigan State University
East Lansing, MI 48824

Dear George,

Thank you very much for seeking input from the Diversity Catalyst Committee (DCC) on the priorities of agInnovation. We appreciate that that one of the priorities of agInnovation states "Fully integrate diversity, equity, and inclusion as an essential component of all agInnovation activities and programs." And to that end, we share the following reflections.

Despite the fact that we are experiencing the promulgation of state-based, anti-DEI legislation, the DCC supports the priority as stated. While there is no precise definition of DEI, the DCC notes that DEI represents a philosophy in which organizations commit themselves to increasing representation of those with identities that have been previously marginalized. We do not believe that this commitment should change. The DCC applauds the work of the current director of Cooperative Extension at MSU, Dr. Quentin Tyler, who recently led a session at the APLU's New Administrators Orientation titled "Creative and Innovative DEI in an Anti-DEI Climate". While individual state stations may be mandated to not use the term "DEI", all Americans are protected by foundational Federal anti-discrimination laws.

To assist you in integrating DEI as an essential component of all agInnovation activities and programs, the Diversity Catalyst Committee has developed a Plan of Work that includes a broad swath of opportunities for ongoing professional development of the agInnovation directors. We plan and host webinars (e.g., we will be offering learning opportunity in the fall on "Tribal Relations and Equity"), share best practices based on the work of our DEI Award winners, gather DEI practices currently in use by agInnovation directors through responses to the DCC's Call to Action, and offer DEI related training (e.g., the Intercultural Development Inventory). We are also identifying metrics for assessing how we're doing. Are we making progress? We think so!

The Diversity Catalyst Committee supports the initiatives and priorities of the Section and is poised to assist you. We want to help you make a difference.

Sincerely,

Brian Raison
Chair, agInnovation Diversity Catalyst Committee

Agenda Brief: National Plant Germplasm Coordinating Committee (NPGCC)
(http://escop.info/committee/national-plat-germplasm-coordinating-committee-npgcc/)
Date: September 26, 2023
Presenter: Bob Stougaard
Action Requested: For Information

Committee Members:

Chair: Bob Stougaard (SAAESD) **Executive Vice Chair:** Bret Hess (WAAESD ED) **Members:** Carolyn Lawrence-Dill (NCRA) Scot Hulbert (WAAESD) Olga Padilla-Zakour (NERA) Melanie Harrison (USDA ARS) Peter Bretting (USDA ARS) Larry Chandler (USDA ARS) Ann Stapleton (NIFA) **Liaisons:** David Baltensperger (NAPB) Sarah Wilbanks (AOSCA) Ksenija Gasic (PBCC) Tim Cupka (ASTA) **Ex-officio:** Jennifer Tippetts (WAAESD Administrative Management, Recording Secretary)

Meetings: A virtual meeting was held via Zoom on May 30, 2023. Plans are to host a hybrid meeting in Ames, IA next year, likely in June.

Meeting Attendance: Bob Stougaard, Bret Hess, Carolyn Lawrence-Dill, Melanie Harrison, Peter Bretting, Larry Chandler, Ann Stapleton, David Baltensperger, Sarah Wilbanks, Ksenija Gasic, Tim Cupka, Jennifer Tippetts (recording secretary). Guest: Clarice Coyne.

NPGCC Reports: Peter Bretting presented on the USDA ARS National Plant Germplasm System's (NPGS) status, prospects, and challenges. Total numbers of accessions and distributions are up in 2022 reaching 605,700 and 233,500, respectively. Although the total dollar amount in the NPGS budget is up through 2018, the buying power has dropped to approximately mid-1990s levels. Challenges include: 1) expanding the NPGS operational capacity and infrastructure to reduce PGR management backlogs and meet increased demand for PGR and associated information; 2) increased operational costs (labor, inputs, overall inflation). See https://www.ers.usda.gov/amber-waves/2022/june/investment-in-u-s-public-agricultural-research-and-development-has-fallen-by-a-third-over-past-two-decades-lags-major-trade-competitors/?cpid=email#; 3) NPGS personnel transitions—hiring, training, etc.; 4) developing and applying cryopreservation and/or in vitro conservation methods for clonal and some seed PGR; 5) BMPs and procedures for managing accessions (and breeding stocks) with an increasing diversity of GE traits in more crops, the occurrence of adventitious presence (AP), and the products of gene editing; 6) acquiring and conserving additional PGR, especially of crop wild relatives. To address some of these challenges, G. Volk (ARS-Ft. Collins) and P. Byrne (CSU-Ft. C.) lead a project, supported by ARS and a NIFA grant, to design and develop a training program for PGR management to be delivered primarily through distance-learning. The

PGR Management Training is a three module, 3 credit hour Colorado State online course Plant Genetic Resources: Genomes, Genebanks, and Growers was taught for the first time in Aug.-Sept. 2022 (http://pgrcourse.colostate.edu/). Numerous PGR training/educational materials are also freely accessible from GRIN-University at https://grin-u.org/. Infographic posters for PGR, genebanks and conservation, and PGR and food security in 6 languages (download at http://genebanktraining.colostate.edu/trainingmaterials.html). Lastly, the internal USDA review and clearance process for the Congressionally-directed NPGS Plan is estimated to be 85% complete. A recently published article by NPGS staff on "Safeguarding plant genetic resources in the United States during global climate change" includes case studies, software for estimating future conditions, identification of potential adaptive strategies and actions. (The article is also attached to this brief.)

Melanie Harrison provided an update on behalf of the Regional Plant Introduction Stations. The update included staffing, accessions, and distributions by each of the stations.

Ann Stapleton discussed NIFA's new and current funding opportunities, the agency's priorities, how the agency is addressing the needs of partners, and that the agency is beginning to realize its potential.

Liaison representatives provided brief reports. Concern was expressed about very valuable germplasm potentially being ignored and/or eliminated from breeding programs if selections of germplasm for further breeding were based solely on genetic markers.

August 9 update-

The NPGCC reported to the agInnovation Executive Committee in July, and the agenda brief is available on the ESCOP website (p 29).

In light of the committee's discussions, committee members were encouraged to join a workshop entitled "Nuts & Bolts of U.S. Regulatory Dossiers for GE Products" to learn from US regulatory agency officials about the specifics of putting together actual dossiers for regulatory review – based on real case studies.

Received: 22 January 2023 | Accepted: 15 April 2023

DOI: 10.1002/csc2.21003

Crop Science

ORIGINAL ARTICLE

Plant Genetic Resources

Safeguarding plant genetic resources in the United States during global climate change

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Assigned to Associate Editor Irwin L. Goldman.

Abstract

Plant genetic resources (PGR) underpin the security of global agriculture. Rapid global climate change presents formidable challenges for ex situ and in situ PGR management programs that operate over extended timeframes. The U.S. Department of Agriculture National Plant Germplasm System (NPGS) maintains more than 605,000 PGR accessions representing over 16,300 plant species in 20 genebank locations. These PGR are maintained in cold storage as seeds and vegetative tissues that must be periodically regenerated; or as actively growing plants in fields, greenhouses, screenhouses, and in vitro; or in some cases within in situ reserves. The complicated relationships between crops and their growth environments present unique challenges regarding PGR maintenance under a changing climate. Here we present potential effects of climate change on ex situ PGR maintenance and reproductive success, pollinators and beneficial insects, pathogens and pests, infrastructure considerations, and wild populations within NPGS in situ reserves. We provide a novel tool that summarizes past US temperature and precipitation data alongside future climate projections to guide ongoing planning for the effects of climate change for NPGS genebanks throughout the United States. A series of case studies exemplify instances where climate change has already impacted NPGS PGR management. Ongoing improvements to NPGS PGR management in response to climate change require continued observations of the current effects, careful and innovative planning, and creative approaches to ensure that PGR are successfully conserved for future generations.

Abbreviations: CWR, crop wild relatives; NLGRP, National Laboratory for Genetic Resources Preservation; NPGS, National Plant Germplasm System; PGR, plant genetic resources; SOS, Seeds of Success; USFS, U.S. Forest Service; USPG, U.S. Potato Genebank; WCBA, Wild Chile Botanical Area.

1 | INTRODUCTION

Plant genetic resources (PGR; synonymous with plant germplasm) comprise the organs and tissues (seeds, fruits, cuttings, pollen, tissue cultures, etc.) by which plants can be propagated. PGR provide the raw genetic materials instrumental for continued genetic gain through crop breeding that is crucial to food security. PGR underpin "the green line that stands between humanity and calamity" (Bretting, 2018). Without ready access to PGR, progress in crop research and breeding can be severely hampered. Furthermore, if PGR that constitute critical components of traditional cultures and agricultural economies were lost, the survival of key elements of traditional and indigenous cultures and knowledge might be threatened (Nabhan, 1989).

Climate change, the commonly used term for rapid global warming, threatens the persistence of crop agriculture (Pörtner et al., 2022). The consequences of climate change include rising temperatures, severe wildfires, increasingly damaging storms, flooding, drought, sea level rise, and threats to biodiversity (Pörtner et al., 2022). Climate change endangers the survival of plant communities (Thuiller et al., 2005) that include crop wild relatives (CWR; Dempewolf et al., 2014), PGR that are vital to the survival of some elements of traditional cultures, and that contain genes and traits valuable for crop production and protection (Castañeda-Alvarez et al., 2016; Dempewolf et al., 2017; Jarvis et al., 2008). Ex situ conservation in genebanks currently constitutes the most widely adopted strategy for safeguarding CWR and PGR from threats such as loss of natural and agricultural habitats, cultural and societal changes, and other factors (Byrne et al., 2018). Nevertheless, ex situ conservation is not fail proof: Fu (2017) and Khoury et al. (2021) comprehensively cataloged the factors, including climate change, contributing to the vulnerability of PGR protected ex situ in genebanks. Those factors can cause not only complete loss of PGR, but also genetic drift, genetic erosion, and overall reduction of diversity.

This essay describes some of the dangers from climate change faced by PGR protected in the United States. It focuses particularly on the actual or potential effects of climate change on PGR management in the U.S. National Plant Germplasm System (NPGS; Byrne et al., 2018) and covers the complementary approaches of in situ, dynamic PGR conservation and ex situ, static PGR conservation (Bretting & Duvick, 1997). This essay examines specific case studies from the NPGS's ex situ PGR management programs. The experiences and results from several in situ conservation projects, conducted by the NPGS in partnership with land management agencies, are also recounted. Methods to prepare the NPGS genebanks for climate change are provided, including a novel software application for rapidly delivering temperature and precipitation forecasts and climatic trends for NPGS genebank locations. Finally, the insights gained from this review are summarized as a means for identifying priorities for subsequent analyses and research, and future prospects are assessed for successfully safeguarding PGR from the effects of climate change.

Core Ideas

- Plant genetic resources (PGR) are crucial for continued crop improvement that underpins global food security.
- Climate change can threaten PGR safeguarded by the USDA-ARS National Plant Germplasm System (NPGS).
- Approaches developed by the NPGS to adapt its PGR management operations to climate change are reviewed.
- The new NPGS Climate Futures Application delivers key estimates for future climatic conditions at NPGS locations.
- The NPGS's PGR management operations can adjust to climate change using current experience and those estimates.

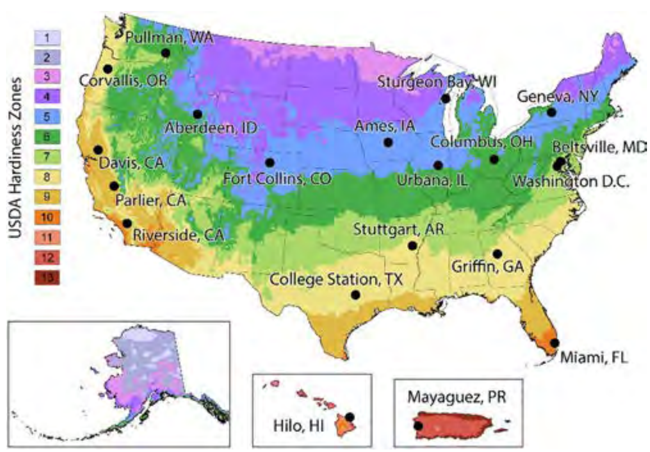

FIGURE 1 The 20 locations for National Plant Germplasm System genebanks (indicated by black dots) projected on the 2012 USDA Plant Hardiness Zone Map. Collectively, these genebanks are located in most of the different growing areas for US crops.

2 | PGR MANAGEMENT IN THE NPGS

The U.S. NPGS comprises genebank and support units at 20 geographical locations (Figure 1). Each NPGS genebank unit is operated by the USDA-Agricultural Research Service (ARS), often in partnership with land-grant universities. At this writing, the NPGS manages PGR ex situ in the form of 605,000+ accessions (plant samples) of 16,300+

species (USDA-ARS GRIN-Global, 2022a). These accessions encompass highly bred contemporary cultivars; traditional and heirloom cultivars developed historically and even prehistorically; genetic stocks that serve as research tools; wild species for ecological land restoration and research; and CWR for major and specialty crops. The NPGS acquires, maintains, characterizes, evaluates, documents, and distributes those PGR and associated information. The NPGS also conducts applied research to devise more efficient and effective management procedures for PGR and to add value to accessions through characterization and evaluation. In some cases, NPGS scientists work to improve PGR via genetic enhancement (Byrne et al., 2018).

PGR can contain novel alleles and allelic combinations that control plant responses to pests and pathogens, daylength, and extreme temperature and moisture levels (Byrne, 2023; Cortés & López-Hernández, 2021). In particular, CWR can encompass allelic diversity that was not captured or maintained during the domestication bottleneck, and thus could be valuable sources of new traits for crop improvement. Assessments of the status of CWR both in situ and ex situ will guide future acquisition and preservation efforts on a national and global scale (Castañeda-Álvarez et al., 2016; Dempewolf et al., 2014; Eastwood et al., 2022; Khoury, Carver, Greene et al., 2013, 2020; Ramirez-Villegas et al., 2022; Vincent et al., 2019).

By virtue of its mandate, the NPGS has emphasized PGR management ex situ, rather than in situ through protected land reserves. The USDA-ARS is not a land management agency but partners with other agencies and institutions (USFS & USDA-ARS, 2014) that manage lands where several in situ conservation projects for the PGR of US CWR are located, such as for chile peppers (Khoury, Carver, Barchenger et al., 2020) and cranberries (Khoury, Greene et al., 2020). Linking in situ and ex situ conservation in a complementary (or integrated) approach can efficiently increase the overall amount of genetic diversity conserved. In situ conservation preserves the intraspecific diversity in the entire plant population rather than just a sample of the population held in ex situ collections (USFS & USDA-ARS, 2014). As such, the NPGS's participation in such in situ conservation projects will likely expand in the future and efforts to do so are described in this review.

2.1 | Ex situ PGR management

Diverse PGR collections in NPGS genebanks are maintained as seeds in storage or as actively growing plants. Plant collections maintained ex situ have the advantage of being readily available for evaluation and distribution. Seed collections are often maintained in refrigerated (+4°C) or freezer (−18°C) conditions at low relative humidity levels that have been optimized for long-term storage (FAO, 2014). Seed lots are replenished through grow-outs (regenerations) when their quantities decline due to insufficient inventory or low viability. Most seed regeneration activities take place in the field, which expose the PGR to prevailing climatic conditions. Drought can affect plant establishment and growth throughout the season, as can other extreme weather. Many factors determine successful seed production including temperature and humidity effects on flower and seed development, pollen viability, and pollinator activity. Increasing night temperatures are also a serious confounding factor for seed production and overall yield (Desai et al., 2021; Hatfield & Pruger, 2015; Sadok & Jagadish, 2020), in part because plants cannot recover from high daytime temperatures affecting the circadian clock, pollen viability, and many other physiological and biochemical processes. Field regenerations also involve exposure to pests and pathogens, whose presence is often determined by specific weather conditions and changing climatic factors (Taylor et al., 2014).

Successful regeneration involves surmounting many challenges even in the absence of climate change. Diverse accessions of a crop likely cannot all be regenerated successfully under similar environmental conditions. For example, wild sunflower (*Helianthus* L.) species from southern latitudes do not flower if they are grown in the Northern United States. These accessions are regenerated by the NPGS at Parlier, CA where the Central Valley provides a long and dry growing season for successful seed production. In some climate change scenarios, wild species might have a greater resilience and capacity to adapt to climate change. In contrast, domesticated cultivars might have narrower parameters (i.e., temperature, moisture) for phenological processes such as flowering. In addition, accessions of inbred or introgressed cultivars can yield poorly due to reduced fertility resulting from the breeding process. To mitigate the effects of climate change on the sometimes inherently poor yielding PGR, increased irrigation applications or protective infrastructure can be necessary.

Many fruit, nut, and some vegetable PGR are maintained as plants in the field, greenhouse, screenhouse, or as in vitro cultures because seeds do not represent the desired genotype; the plants do not produce seeds; the regeneration cycle is long; or because seed storage methods have not yet been established (Panis et al., 2020; Volk & Walters, 2003). These plants require pruning, pest and disease control, irrigation, and field maintenance throughout the year (Postman et al., 2006). They also undergo weather-dependent physiological processes that include winter dormancy, spring bud break, flowering, pollination, and fruit set. In addition, they are susceptible to natural disasters (e.g., fires, hurricanes, and windstorms) that might damage protective structures or the plants themselves. Field, greenhouse, and screenhouse plants must be repropagated when plants reach the end of their life cycles or when they are lost due to abiotic or biotic (pests and pathogens) stresses. Maintaining PGR in vitro is labor intensive, and their survival depends on skilled staff who perform routine transfers to fresh medium. They are also susceptible to growth room arthropod infestations (e.g., spider mites [*Tetranychus urticae* Donnadieu, 1875] and thrips [*Thrips physapus* Linnaeus, 1758]), endophytic contamination, a loss in culture vigor, and potentially by somaclonal variation (Panis et al., 2020). Plants actively growing in vitro must be repropagated frequently, and those in cold storage will not survive beyond a year or two without repropagation.

The anticipated impact of climate change on PGR maintenance and regeneration makes safety duplication of PGR collections even more urgent. Secure storage at two separate geographic locations can guard against loss if PGR in the field are damaged by extreme weather and natural disasters exacerbated by climate change. Genebank best practices (FAO, 2014) recommend a long-term off-site secure back-up for PGR.

The National Laboratory for Genetic Resource Preservation (NLGRP) in Fort Collins, CO was built and is managed to withstand catastrophes and to serve as the NPGS long-term PGR back-up facility by providing −18˚C and liquid nitrogen PGR storage capacities. Depending on the type of PGR, plant materials can be backed-up at the NLGRP as seeds, embryos, dormant buds, shoot tips, pollen, or other plant propagule types. Approximately 82% of the NPGS seed accessions are currently stored at the NLGRP, where orthodox seeds, typified by those of many temperate annual crops, are secured according to standard methods (FAO, 2014; Pathirana & Carimi, 2022). Orthodox seeds can be dried and stored at cold temperatures without decreasing seed viability; however, seeds with recalcitrant or intermediate storage characteristics, including those of many tropical, perennial, or large-seeded species, might need to be cryopreserved as seeds or embryos. Crops that are clonally propagated can be backed-up by duplicate plantings, in vitro or as cryopreserved shoot tips or dormant buds. Cryopreservation is costly, but not as costly as maintaining duplicate collections of field-grown plants in different geographic locations, especially as climate change contributes to unpredictable field conditions (Dulloo et al., 2009; Keller et al., 2013). Cryopreservation is also not as costly in the long term as is in vitro storage, with its requirements for ongoing subculturing and whole plant regeneration. Cryopreservation will become increasingly important for backing up clonally propagated species and those with recalcitrant and intermediate seed because it avoids the risks associated with maintaining PGR in field cultivation.

2.2 | In situ reserves for PGR

The conservation of PGR in situ ensures that dynamic evolutionary forces can continue to influence plant adaptation and survival (Bretting & Duvick, 1997; Riordan & Nabhan, 2019). When land is designated as an in situ conservation area, the associated ecosystem is also conserved, ensuring that plant populations survive and coevolve with native ecosystems. Wild plant species occurring naturally in ecological communities throughout the world include CWR—the progenitors of domesticated crop varieties and species with close genetic relationships to crops—and wild plants used directly by people (Greene et al., 2018). More than 600 plant species native to the United States are CWR of 37 different crops (Warschefsky & Rieseberg, 2021) and have tremendous potential to contribute to the productivity, sustainability, and quality of agronomic and horticultural crops. Documenting and protecting CWR have advanced significantly in recent years (Castañeda-Álvarez et al., 2016). In the United States, many of these advances have been led by the NPGS (Greene et al., 2018; Greene, Williams et al., 2019; Khoury, Carver, Greene et al., 2020). Nonetheless, more than half of the CWR native to the United States are still insufficiently protected either in situ or ex situ (Khoury, Carver, Greene et al., 2020, Khoury, Greene, 2020). In view of their importance, additional in situ reserves will be considered in the future whenever inter-agency cooperation enables their establishment.

Many native CWR can be conserved in situ in the United States on lands managed by federal or state agencies that likely already confer some protection to wild plant populations (Williams & Greene, 2018). The NPGS developed a process to select in situ conservation sites for CWR and a policy to guide the establishment of agreements between the NPGS and landholding agencies for in situ conservation (Pavek et al., 2003; USFS & USDA-ARS, 2014; Williams & Greene, 2018). In particular, the NPGS and the U.S. Forest Service (USFS) developed a Joint Strategic Framework on the Conservation and Use of Native CWR in the United States (USFS & USDA-ARS, 2014). This framework outlines two approaches to establishing In Situ Genetic Resource Reserves (IGRRs) for complementary in situ and ex situ conservation. The crop-specific approach establishes IGRRs for populations of CWR for specific crops based on several factors, including the population size, genetic profile, sustainability, and ease of access for monitoring and collecting samples for ex situ conservation. The protected area approach focuses on land encompassing multiple important taxa of CWR for several crops. Criteria for designating these protected areas as IGRRs include the number and significance of CWR present and some of the same factors included in the crop-specific approach.

In the United States, two sites have been officially designated to protect CWR in situ: the Cranberry Glades Botanical Area in the Monongahela National Forest in West Virginia, and the Wild Chile Botanical Area (WCBA) in the Coronado National Forest. Originally designated to conserve the wild chile, or chiltepin (*Capsicum annuum* var. *glabriusculum* (Dunal) Heiser & Pickersgill), the WCBA provides habitat for many other CWR, serving as an example of both the crop-specific approach and the protected area approach (Khoury et al., 2020; Riordan & Nabhan, 2019). In addition to conserving the wild chile, the NPGS has selected in situ conservation sites for three of the most imperiled wild grape species (*Vitis* L. spp., Pavek et al., 2003). The crop-specific approach was also applied to select in situ reserves for a pilot project focused on two wild cranberry species (Rodriguez-Bonilla et al., 2020). The NPGS continues to collaborate with the USFS and other landowners to officially designate as IGRRs the selected in situ conservation sites for wild grapes and cranberries.

3 | ESTIMATING CLIMATE CHANGE EFFECTS AT NPGS GENEBANK SITES

PGR management will be affected by climate change in many ways. Warmer temperatures, altered precipitation patterns, and more frequent extreme weather will have an impact on PGR maintenance, including plant physiology and reproductive processes, as well as biotic interactions. Estimating quantitatively the scale of climate change effects at NPGS sites informs preparations for safeguarding NPGS PGR.

The atmospheric concentration of CO_2 has increased from 280 ppm at the start of the Industrial Age, to 420 ppm now (NOAA, 2022). Increased atmospheric CO_2 affects many climatic components, but one of the strongest effects is higher atmospheric temperatures (annually and seasonally), with more days of extreme temperatures, particularly in temperate locations. The current pattern of warmer night temperatures and fewer days of extreme cold is predicted to continue into the future (Dox et al., 2020). Future temperature and precipitation levels have been predicted based on regional models (Vano et al., 2015). The site specificity of these models makes it difficult to formulate generalized approaches, although it can assist with planning at specific locations.

Future precipitation levels are difficult to predict and cannot be forecast reliably across a geographic area as large as the United States (Vano et al., 2015). Some locations will experience more frequent heavy precipitation events and flooding. Others will have reduced precipitation and drier soils, with increased vulnerabilities to wildfire. Lower snowpack and shorter winters will reduce the availability of water for agriculture. Higher sea levels could result in saltwater contamination of irrigation water sources and flooded agricultural fields, resulting in salt deposition (Gibson et al., 2021). Although models can help to predict future climate conditions, the decreased accuracy of predictions over longer timeframes represent a major challenge, particularly for precipitation (Vano et al., 2015).

Optimal PGR management practices are determined by the nature of the crop and the environmental conditions at the genebank. Planning ex situ and in situ PGR management in the United States to account for the changing climate requires integrating information from numerous sources such as the Intergovernmental Panel on Climate Change (IPCC, 2022), USDA Climate Hubs (2022), the USDA Forest Service (2022), and others. The NPGS needs climatic predictions specific to each NPGS site to prepare for climate change. Consequently, an application titled "NPGS Climate Futures," has been developed and made publicly available at https://geocentroid.shinyapps.io/npgsclimatefutures

The NPGS Climate Futures Application provides visual displays and downloadable datasets for climate predictions for 31 ex situ and 6 in situ locations associated with the NPGS. Data for the climate prediction are generated for four scenarios of shared socioeconomic pathways (SSP): Low greenhouse gas emissions (SSP1–2.6), intermediate greenhouse gas emissions (SSP2–4.5), high greenhouse gas emissions (SSP3–7.0), and very high greenhouse gas emissions (SSP5–8.5) (Pörtner et al., 2022). All climatic prediction data were generated from an ensemble model consisting of 10 individual climate models with the lowest average weighted normalized relative error for the continental United States (Ashfaq et al., 2022; Fick & Hijmans, 2017; Vano et al., 2015). Historic temperature and precipitation data were gathered from WorldClim, based on observed measurements available from 1970 to 2000 (see Supporting Information).

For NPGS locations, the application presents data for six temperature bioclimatic indicators: BIO5 (Average Maximum Temperature of Warmest Month), BIO6 (Average Minimum Temperature of Coldest Month), BIO8 (Mean Temperature of Wettest Quarter), BIO9 (Mean Temperature of Driest Quarter), BIO10 (Mean Temperature of Warmest Quarter), and BIO11 (Mean Temperature of Coldest Quarter); and six precipitation bioclimatic indicators: BIO13 (Precipitation of Wettest Month), BIO14 (Precipitation of Driest Month), BIO16 (Precipitation of Wettest Quarter), BIO17 (Precipitation of Driest Quarter), BIO18 (Precipitation of Warmest Quarter), and BIO19 (Precipitation of Coldest Quarter) (O'Donnell & Ignizio, 2012). In the examples provided in this essay, graphical visualizations of data are provided for historic data (1970–2000), as well as predicted data for the following timeframes: 2021–2040, 2041–2060, 2061–2080, and 2081–2100. Tabulated information for bioclimatic indicators and mean monthly maximum temperature, mean monthly minimum temperature, and total monthly precipitation data can be downloaded from the NPGS Climate Futures Application.

4 | PROJECTED IMPACTS OF CLIMATE CHANGE ON NPGS PGR MANAGEMENT

4.1 | Climate change effects on ex situ PGR management

The effects of climate change currently relevant to NPGS PGR management are projected to intensify in the future. Changes in temperature and precipitation can alter the growth and reproduction of plants, reduce the abundance of beneficial wildlife that act as pollinators and seed dispersers, and increase the threats from pests and pathogens. Ex situ PGR management entails assessing these effects and adapting to changing field conditions. Many challenges described below constitute more severe cases of current operational difficulties. Others will be new but can be foreseen and planned for; but some will be too complicated to predict or project and must be addressed as they occur. Regardless of the challenge, the effects of climate change on PGR must be minimized before genetic diversity is lost and NPGS infrastructure is damaged.

4.1.1 | Plant reproductive success

Plant growth and reproduction are affected by intricate interactions of CO_2 levels, temperature, and precipitation. Growth and reproduction requirements of some crops have been extensively studied, while others have not. Regardless, it is still unknown how each species will adapt to the changing conditions at each site where they are grown; however, analyzing existing data, we review scenarios of how the growth and reproduction of PGR will be affected.

The effect of increased CO_2 on plant growth has been extensively studied. Some crops such as wheat, rice, and soybeans yield more in response to increased CO_2 (up to a saturation point) but maize, sugar cane, sorghum, and millet are much less responsive (Ainsworth & Long, 2020; Cho, 2022; Hatfield et al., 2011). Nitrogen or phosphorus, and not carbon, are often the nutrients limiting biomass production (Du et al., 2020; Terrer et al., 2019); but, when nitrogen is well supplied by fertilizer, a positive growth effect can be observed from increased CO_2. Seed regeneration of PGR in the NPGS usually takes place under optimal nutrient conditions, so for some species, increases in seed yield can be expected in response to increased atmospheric CO_2 with climate change.

On the other hand, increasing temperatures caused by increased atmospheric CO_2 can offset any photosynthetic gain from increased CO_2 concentrations. Although optimal growth temperatures have not been determined for many plant species, increased temperature can impede growth and reproduction for many species studied to date (Moore et al., 2017). Exposure of plants to temperature extremes at the onset of reproduction decreases fruit and grain production (Hatfield & Pruegar, 2015; Lohani et al., 2021; Pravallika et al., 2020). An especially critical variable is maximum night temperature, which has been increasing faster than the daytime temperature maxima (Hatfield & Pruegar, 2015). Cooler nighttime temperatures enable plants to recover physiologically. High temperatures also can reduce pollen viability, especially for species with determinant flowering that coincides with hottest months of the year. High temperatures during embryo and seed development can result in embryo abortion or in low-quality seed. In addition to the direct effect of higher temperature on seed production, higher and fluctuating temperatures can cause erratic rainfall in areas that had been ideal for crop production in the past. Irregular amounts of moisture can affect the development of fruit and consequently seed, especially of tree fruits that mature over a long period. Some CWR species might be affected less by extremes in temperature and rainfall, especially those that can flower throughout the growing season and mature seeds during cooler periods.

For all these reasons, higher temperatures can reduce the amount and quality of viable seed produced by each PGR regeneration. To mitigate these effects, curators could plant regeneration plots earlier in the season. If these early plantings do not experience damaging late frosts, higher-quality seeds could mature before the hottest months of the year. But species with flowering times regulated by daylength might not be amenable to earlier planting. Multiple plantings and harvests could capture optimal seed maturation times under these more variable conditions, and larger plots with more plants might produce sufficient seeds.

4.1.2 | Pollinators and other beneficial insects

For regenerating PGR, naturally occurring and managed insect pollinators are often key to successful production of needed quantities and qualities of seed during regeneration activities. Climate change effects have been documented for plant phenology when synchrony of flowering and pollinator activity shift due to warming, with predicted trends leading to increased asynchrony (Freimuth et al., 2022). Populations of honeybee (*Apis mellifera* L.), the best-known and essential crop pollinator, have declined because of agricultural pesticides, increases in pathogens, and increasing temperatures (Zhao et al., 2021). Honeybees maintain hive humidity and temperature within critical limits for bee survival and brood rearing. Honeybee pollinator activity decreases at high temperatures because bees focus on collecting more water than nectar to help maintain hive temperatures and humidity

(Kunholz & Seeley, 1997; Oliver, 2022; Seeley, 2009, 2019). Extreme temperatures can even melt the wax in the hive.

Integrated pest management often incorporates predatory arthropods for managing insect pests. Supplies of predatory arthropods might be affected by adverse climatic conditions. Biological control of pests (e.g., aphids, scale, and mites) is often an important tool for managing PGR, as insecticide application does not promote insect pollinator populations. For example, cold-adapted ladybird species might decline or retreat to higher latitudes or altitudes under warming temperatures (Sloggett, 2021). Not all climate change effects are negative because some research shows that many insect pollinators and biological control agents are resilient to such changes (Sloggett, 2021). The effects of climate change on these pollinators and beneficial insects are not entirely understood, but should be considered in future plans for PGR management practices.

4.1.3 | Pathogens and pests

Complicated by climate change, disease management is an increasingly challenging goal for both crop production and PGR management. Plant pathogen survival, infection timing, and virulence are influenced by temperature, precipitation/moisture, and concentrations of atmospheric gasses. Velásquez et al. (2018) and Kybartaite et al. (2020) suggest that rising temperatures are a leading factor for higher incidence and severity of crop diseases. Unpredictable and changing precipitation patterns have increased in the United States and globally (Environmental Protection Agency, 2022). Increased atmospheric moisture often leads to increases in fungal and bacterial diseases that can be especially problematic for spring established, seed-propagated annuals or clonally propagated perennial PGR maintained in the field. Soil-borne diseases, especially root-rot complexes, can be particularly severe and easily disseminated during floods or prolonged waterlogging (Reeksting et al., 2014).

Like plant diseases, the survival of many plant pests are favored by warming trends, erratic precipitation, and increased levels of CO_2 brought on by climate change. The expanded local, regional, and global distribution of pests; earlier outbreaks due to overwinter survival and warmer springs; expanded multiplication rates and generation numbers; and the possibility of more frequent disease outbreaks vectored by insect pests are all predicted to complicate crop production and PGR management (Skendžić et al., 2021). Under scenarios of only moderate warming, earlier infestations coupled with migration and expanded distribution into higher latitudes has been forecast for several insect pest species (Porter et al., 1991; Zeng et al., 2020). Increasing temperatures can lead to larger insect pest populations. Consequently, plant pathogens vectored by insects and mites would also increase. Huanglongbing disease of citrus (Ajene et al., 2020) and zebra chip of potato (Zelinger et al., 2017) are both examples of psyllid-vectored bacterial diseases with expanded global ranges attributed to globalization, but also to larger insect pest populations favored by global warming trends. The same insects and mites that endanger agricultural production will impede PGR regeneration and maintenance in the field and greenhouses or screenhouses.

4.1.4 | Genebank infrastructure considerations

As mentioned earlier, increased temperatures in some cases could improve the success of PGR regenerations. Warmer (non-freezing) temperatures earlier or later in the season can extend plant growth, which could enhance seed production for some species that need longer growing seasons. Nonetheless, increased temperatures and extreme weather can also make field work more challenging for both personnel and plants. Higher summer temperatures can make greenhouses and screenhouses without cooling systems unusable for plant growth, necessitating costly infrastructural investment in cooling systems or new greenhouses. Decreased rainfall as part of changing weather patterns could necessitate expanding costly irrigation capacities (Rosa et al., 2020) which could be especially challenging at NPGS locations currently without that infrastructure. If higher summer temperatures limit plant growth in some areas beyond what new infrastructure can economically allay, regenerations and seed production for some PGR might need to be transferred to more favorable locations. If PGR management were moved to locations farther north, the shorter nights during the growing season might interfere with flowering; consequently, higher elevation sites at lower latitudes might serve as an alternative. As a more extreme resort, establishment and maintenance of PGR by in vitro cultures, much more expensive than growing plants in the field or greenhouse, might be warranted.

Extreme and erratic weather can impede field work. For example, if soil is too wet to cultivate in the spring, then plant establishment can be delayed, preventing seed maturity before the end of the growing season. Warmer early-spring weather could enable earlier planting dates. Although earlier planting can help plants escape injuriously high temperatures later in the summer, it could result in poor stand establishment because of cold soil temperatures in the spring. Extreme weather that occurs randomly across the growing season, such as hail, heavy rains and high winds, can destroy established plots so that regenerations must be repeated. In addition, cages and other field structures that enable pollination control for seed production (Figure 2) can be damaged or destroyed.

Clonally propagated PGR maintained in the field are particularly susceptible to the effects of climate change. Perennial

FIGURE 2 Insect-proof cages for seed regenerations of National Plant Germplasm System plant genetic resources. (a) Intact cages in Prosser, WA (photo credit B. Irish); (b) Cages with sunflower seed regenerations destroyed by a windstorm in Ames, IA (photo credit L. Marek).

plants might not experience the chilling hours required to break winter dormancy, thus impeding subsequent flowering and vegetative growth. Specialized growth chambers/rooms could be needed for vernalization to occur in controlled environments. Perennials that do experience the required winter dormancy could experience budbreak during early warm springs, and then be damaged by late spring frosts that kill flower buds and young fruit (Atkinson et al., 2013; Pagter & Arora, 2013). More frequent hurricanes in warmer southern NPGS locations might imperil subtropical and tropical clonal PGR. The expense and logistics of relocating established, large perennial PGR will be significant, but might need to be considered to avoid the loss of diversity in these PGR.

4.2 | Climate change effects on PGR management at in situ reserves

CWR and other PGR face the same threats in nature as other wild plant species, although the frequency of specific threats might differ for certain CWR (Frances et al., 2018). The survival of wild plant species can be reduced by several interacting threats, including many that occur in protected areas, such as invasive species, grazing, and energy development (Frances et al., 2018; Hernández-Yáñez et al., 2016). For example, a natural area with a high diversity of potato (*Solanum* L. spp.) CWR is now dominated by cheatgrass (*Bromus tectorum* L.), a non-native invasive grass found throughout much of the Western United States (J. Bamberg, personal communication, 2022). Cheatgrass not only competes with native species, but also increases the risk of severe wildfire with climate change through increased fuel loads. Highly diverse native populations of potato CWR are currently difficult to find due to fluctuating environmental conditions, and it is expected that potential in situ conservation sites will become harder to locate because of the effects of climate change (J. Bamberg, personal communication, 2023). Consequently, IGRRs must be managed to mitigate current and future threats.

Climate change introduces additional challenges to ensuring CWR persistence when selecting, designating, and managing IGRRs. Wild plants and their associated ecological communities are impacted by climate change much as are cultivated plants (Aguirre-Liguori et al., 2022; Cho, 2022; Hatfield & Pruger, 2015; Jarvis et al., 2008) including altered growth and reproduction, changes in pollinators and dispersers, and increased threats from pests and pathogens. Moreover, it can take years or even decades for ecosystems, habitats, and plant populations to recover (if possible) from the increased frequency of catastrophic wildfire, floods, and storms.

Changing climatic conditions interact with and intensify existing threats and plant populations will likely shift their geographic ranges in response. With changing environmental conditions, plant populations of interest should be monitored more frequently and intensively. Physical boundaries for designated IGRRs might need to be modified to encompass the shifting locations of plant populations. Creating, expanding, or relocating in situ reserves for PGR might be aided by other federal initiatives to safeguard biodiversity in the face of climate change. The "30 × 30" federal initiative (National Climate Task Force, 2021) aims to actively conserve 30% of US land and water by 2030. Incorporating the in situ conservation of CWR into this initiative and others (USDA, 2021; USDA Forest Service, 2022) could help safeguard the nation's PGR in situ.

5 | CASE STUDIES FOR THE EFFECTS OF CLIMATE CHANGE ON PGR MANAGEMENT AT NPGS LOCATIONS

5.1 | Cool-season legumes in Pullman and Central Ferry, Washington

At the end of June 2021, the US Pacific Northwest experienced a "heat dome" in which extremely high temperatures were recorded for 5 days (Cotlier et al., 2022; Emerton et al., 2022; USDA Climate Hubs, 2022). In Eastern Washington, where the NPGS genebank in Pullman manages cool-season pulse PGR, summer rainfall is negligible, and irrigation is usually unavailable for crop production. The heat dome caused record high temperatures as high as 46.3˚C during the day and 23.5˚C at night in Eastern Washington (Cotlier et al., 2022). This novel weather phenomenon occurred during peak flowering of pea (*Pisum* L.), lentil (*Lens* Mill.), wild and cultivated chickpea (*Cicer* L.), lupin (*Lupinus* L.), and faba bean (*Vicia faba* L.) (Figure 3a,b). Pollen quality and availability, flower abortion, and seed development were likely all impacted leading to drastically reduced yields for plantings both at Pullman and Central Ferry, WA (Gogoi et al., 2018; Jiang et al., 2019; Walters et al., 2022). Numerous regenerations and evaluations failed completely or failed to replace the number of seed sown, even with access to irrigation at the Central Ferry farm. The reduction in seed yield can be determined by comparing seed yields in 2021 to either 2020 or 2022, when temperatures were normal and within the optimal range for pulse crops (Gogoi et al., 2018). Yield reductions due to the heat in a replicated phenotypic characterization plot for lentils averaged 87% (121.9 g/plot in 2022 vs. 15.6 g/plot in 2021). Yield data were not available for other pulse species, but 100 seed weight, which is a yield component and important measure of seed quality, was reduced due to the heat by 54% in field-grown chickpeas (USDA-ARS GRIN-Global, 2022b).

In the future, expanding the capacity for irrigation is planned for the Pullman farm to reduce drought stresses. Nonetheless, because the main threat during the 2021 summer growing season was heat and not lack of water, irrigation might be of limited help in remedying the low seed set in the pulse PGR. Strategies to overcome high summer temperatures (Figure 3c) for cultivating pulses and cold tolerant grass species in the future might require fall planting and field overwintering; earlier spring sowing might be possible for non-cold tolerant species. This would enable these PGR to flower and set seed earlier before summer temperatures become prohibitively high. An additional, cooler field location might be needed for spring-planted regeneration of some PGR managed at the Pullman genebank.

5.2 | Maize (*Zea* L.) PGR in Ames, Iowa

The NPGS maize PGR collection maintained at Ames, IA contains 20,157 accessions. Maize is grown during the summer in rows in the field and hand pollinated from early July (occasionally late June) into September depending on when each accession flowers. Increasing temperature, a hallmark of climate change, has a clear, negative effect on pollination success in maize (Herrero & Johnson, 1980; Figure 4a). For the daily maximum temperature range of 23 to 31˚C, the median number of ears harvested per pollination exceeds 75%. In contrast, above 31˚C, the median number of ears harvested decreases sharply and by 38˚C, median success of the pollinations is only 12%. It is likely that any successful pollinations on these hottest days represent the earliest pollinations of the day, rather than heat resistant genotypes, but time of pollination is not generally recorded to confirm that. Maximum temperatures during the maize pollination season (summer quarter) are expected to increase in Ames during the coming decades (Figure 4b, maximum temperature for July). These increasing temperatures are expected to decrease the success of pollinations. By 2100, the worst-case scenario (emission SSP5–8.5 and predicted maximum temperature of 41˚C; Figure 4b), maize pollination during the current usual growing season would have limited success in Ames.

5.3 | *Prunus* L. PGR in Davis, California

The NPGS *Prunus* PGR collection is maintained in orchards at Davis, CA and Geneva, NY. The Davis orchards, including plum (*Prunus domestica* L. and others), sweet cherry (*Prunus avium* (L.) L.), peach (*Prunus persica* (L.) Batsch), apricot (*Prunus armeniaca* L.), and almond (*Prunus dulcis* (Mill.) D. A. Webb), have experienced warmer, shorter winters with cold periods interrupted by unseasonably warm temperatures (Figure 5). *Prunus* trees (depending on crop and cultivar) require between 200 and 1800 h below a threshold temperature of 7˚C before shoots will sprout in the spring (Baldocchi & Wong, 2008). Currently, some accessions in the NPGS sweet cherry collection are not achieving their full winter dormancy. The inadequate chilling hours can delay pollination and foliation, and reduce plant performance, fruit yield, and quality (C. DeBuse, personal communication, 2022; Pathak et al., 2018). In addition, plum are reacting with later leafing and flowering that extend over a longer period in the spring (C. DeBuse, personal communication, 2022). These trends are expected to continue with warmer winter temperatures predicted for the future (Figure 6a). Cryopreservation of dormant buds for the *Prunus* PGR in the Davis, CA location has been challenging, likely because the trees do not experience sufficient cold temperatures for winter dormancy required for

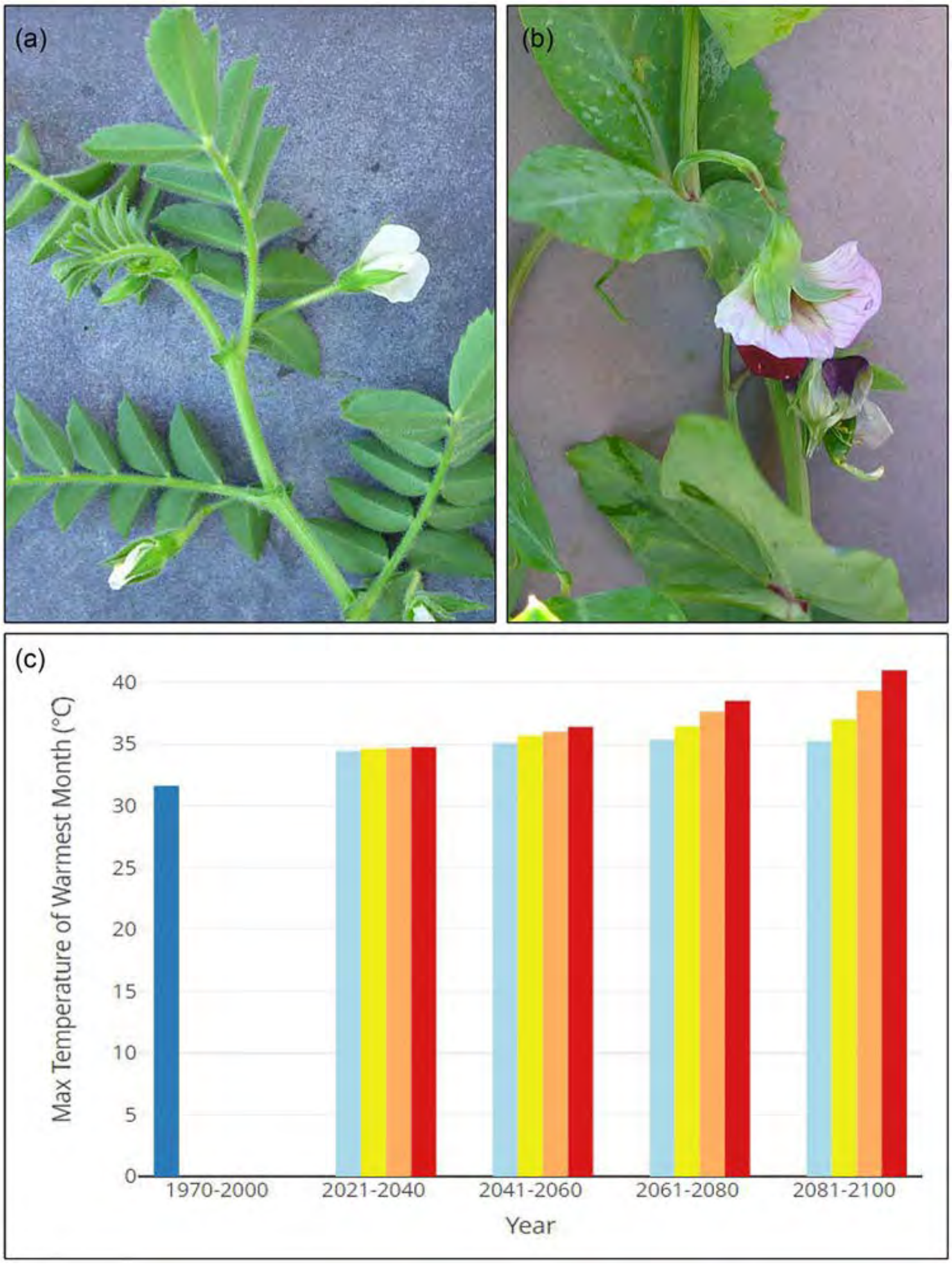

FIGURE 3 Cool-season legume plant genetic resources (PGR) maintained at the National Plant Germplasm System (NPGS) Pullman, WA genebank and regenerated at that genebank's Central Ferry, WA field site. (a) Flowering chickpea (*Cicer*) PGR and (b) Flowering pea (*Pisum*) PGR. (c) Modeled climate conditions expressed as average maximum temperature (˚C, *Y*-axis) of the warmest month (BIO5) in Central Ferry, WA for SSP1–2.6 (light blue column), SSP2–4.5 (yellow), SSP3–7.0 (orange), and SSP5–8.5 (red) emission scenarios for historic (dark blue) and four different future time intervals (*X*-axis). Data are available from the National Plant Germplasm System Climate Futures Application (https://geocentroid.shinyapps.io/npgsclimatefutures).

successful dormant bud cryopreservation. Sour cherry, maintained in Geneva, NY, and sweet cherry from Prosser, WA can be successfully cryopreserved as dormant budwood (Jenderek et al., 2022; Towill, 1999). In the coming years, *Prunus* PGR from Davis will be grown in experimental plantings at Geneva, NY for dormant bud cryopreservation as well as phenotypic evaluations.

5.4 | Pecan (*Carya* Nutt.) PGR in College Station, Texas

The NPGS pecan PGR collection is maintained in College Station and Brownwood, TX. High temperatures and drought have affected both PGR maintenance and associated pecan breeding programs. High temperatures combined

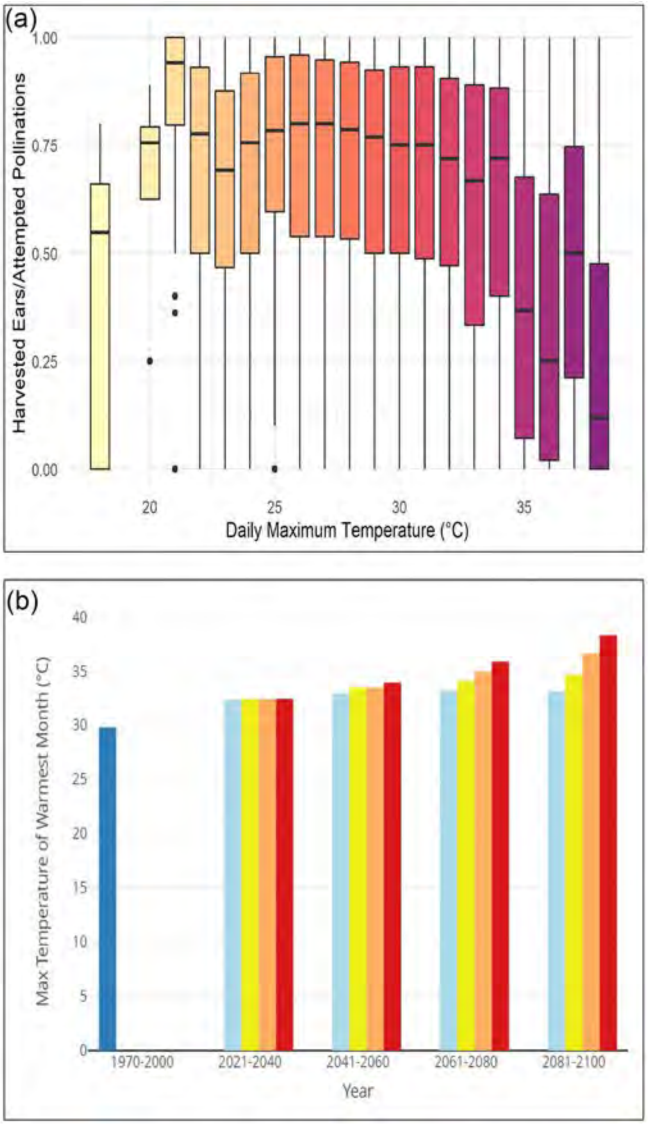

FIGURE 4 Impact of warmer temperatures on maize pollination in Ames, Iowa. (a) The effect of daily maximum temperatures (*X*-axis) on pollination success in maize (measured as harvested ears per pollinations made, *Y*-axis) at the NCRPIS, Ames, IA July to September, 2021. The 279,650 plants of 1602 different accessions were pollinated to generate these data. The colored boxes capture the ranges of 50% of the pollination success data at each temperature. The number of pollinations ranges from 719 (37˚C) to more than 52,000 (28˚C). Harvest success ranged from zero to 100% except at 18˚C (to about 80%) and at 21˚C (from about 80 to 100%, with 0% an infrequent outlier). The horizontal black bars within each of the boxes represent the data median and the black dots are outlier values. (b) The maximum temperature of the warmest month historically and what is predicted for the coming decades through 2100 under four different emission scenarios for Ames, Iowa. Modeled climate conditions expressed as average maximum temperature (˚C, *Y*-axis) of the warmest month (BIO5) at Ames, IA. Data for SSP1–2.6 (light blue column), SSP2–4.5 (yellow), SSP3–7.0 (orange), and SSP5–8.5 (red) emission scenarios for historic (dark blue) and four different future time intervals (*X*-axis) are presented. Data are available from the National Plant Germplasm System Climate Futures Application (https://geocentroid.shinyapps.io/npgsclimatefutures).

with drought have led to increased prevalence of shuck decline disease that results in poorly filled nuts and premature shuck split (W. Chatwin, personal communication, 2022). The split shucks create openings for opportunistic fungal pathogens that cause further damage (Sparks et al., 1995). In 2022, approximately 70% of the breeding crosses were lost due to high temperatures (~32˚C) at the time of hand pollination. The temperature inside the pollination bags were as much as 8˚C higher than ambient and desiccated many flowers/nutlets and leaves within a couple of weeks after pollination (Conner, 2002). The high temperature might also have impacted pollen viability. The NPGS pecan PGR collection includes both cultivars and US native CWR, which offer valuable resilience to fungal diseases that can be incorporated into breeding programs (Lovell et al., 2021). These PGR will face even warmer temperatures in the coming decades (Figure 6b). Consequently, mitigation measures such as irrigation or relocation of the collection to a cooler location might one day become necessary.

5.5 | Coffee (*Coffea* L.) PGR in Hilo, Hawaii

Although temperate regions of the world—where most of the NPGS PGR collections are located—are predicted to be affected most by higher temperatures resulting from climate change, NPGS genebanks located in US tropical and subtropical regions are also affected. Warmer temperatures and increased precipitation in the tropics have led to disease expansion to higher elevations where conditions were previously not as favorable for disease development (Tadesse et al., 2021). A new NPGS PGR collection for coffee (*Coffea arabica* L.) is under development by the NPGS to add genetic diversity needed for broadening the currently narrow genetic base of the cultivated crop (Figure 7a). Coffee leaf rust (CLR), caused by *Hemelia vastatrix* Berk. and Broome, currently the most important disease of coffee, continues to spread due to globalization, global warming, and projected trends for more rainfall (Figure 7b). The disease has recently been reported on the Hawaiian Islands, affecting most of the susceptible cultivars grown (Aristizábal et al., 2022; Keith et al., 2022). Belachew et al. (2020) found that the severity of CLR disease decreased at higher elevations where conditions were less favorable but cautioned that predicted higher temperatures and cultivation of susceptible cultivars could become problematic even at higher elevations. Future coffee PGR management must address CLR and the other predicted effects of climate changes through access to different sites in Hawaii and Puerto Rico at higher elevations and isolated from commercial coffee production.

FIGURE 5 The National Plant Germplasm System *Prunus* plant genetic resources collection at the Davis, CA genebank. (a) *Prunus* trees in field orchards; (b) Immature peach fruit from a typical tree (photo credit: G. Volk).

5.6 | Apple (*Malus* Mill.) PGR in Geneva, New York

The NPGS apple collection, maintained primarily as a field collection in Geneva, NY, is threatened by fire blight (*Erwinia amylovora*), a bacterial disease that infects flowers, fruits, shoots, and rootstocks of many Rosaceae crops. The extent of fire blight infections is determined by the presence of the pathogen under certain environmental conditions, combined with cultivar susceptibility (Kostick et al., 2019). Rain followed by warm cloudy weather, especially during bloom and young shoot growth, promotes fire blight infections. It is particularly difficult to control fire blight outbreaks in diverse PGR with a wide range of flowering times, such as the NPGS apple PGR collection (Figure 8). Higher temperatures increase bacterial pathogen levels, with an optimum around 28˚C, and moisture enhances pathogen dissemination and infection (Farkas et al., 2012; Shtienberg et al., 2015). Temperatures also affect flowering duration, with higher temperatures reducing the period when flowers are susceptible to bacterial infections (Pusey & Curry, 2004). In 2020, the NPGS apple PGR collection experienced a significant fire blight outbreak, which revealed disease resistance levels in species and cultivars (Dougherty et al., 2021). Predictions of future climates suggest warmer, wetter springs at Geneva, NY in the future could lead to additional devastating fire blight infections. Horticultural practices that can limit the severity of these outbreaks must be adopted for the apple PGR maintained at Geneva to counter the potential effects of fire blight in the future.

5.7 | Cranberry PGR maintained in situ and at the NPGS Corvallis, Oregon genebank

Cranberry CWR (large-fruited *Vaccinium macrocarpon* Aiton and small-fruited *Vaccinium oxycoccos* L.) are native to North America (Hummer et al., 2019). Both species are found in temperate forest wetlands that are particularly sensitive to environmental changes. The USDA-ARS and the University of Wisconsin recommend several high priority sites in National Forests to protect cranberry CWR populations with rich genetic diversity (Rodriguez-Bonilla et al., 2020; Figure 9). The NPGS genebank in Corvallis, OR maintains ex situ PGR from these sites, as well as many additional *Vaccinium* species and cultivars, as seeds and plants cultivated in protected structures.

Climate change will affect both in situ and ex situ cranberry conservation efforts. Throughout cranberry species' ranges, including three selected IGGRs and at the NPGS Corvallis genebank, minimum temperatures of the coldest month are predicted to increase by 1 to 8˚C (Figure 10d). This may result in earlier flowering and fruit maturation dates and lower levels of fruit production. The geographical distributions of wild cranberry populations are generally shifting north (Ellwood et al., 2014; Hirabayashi et al., 2022) and future plant collecting at those in situ sites will be complicated by the earlier fruiting times and lower yields. Wild and cultivated cranberries require a minimum number of chilling hours to complete a dormancy period and to flower. Cranberries are maintained in the Corvallis genebank's greenhouses, which need improved temperature regulation for successful cranberry

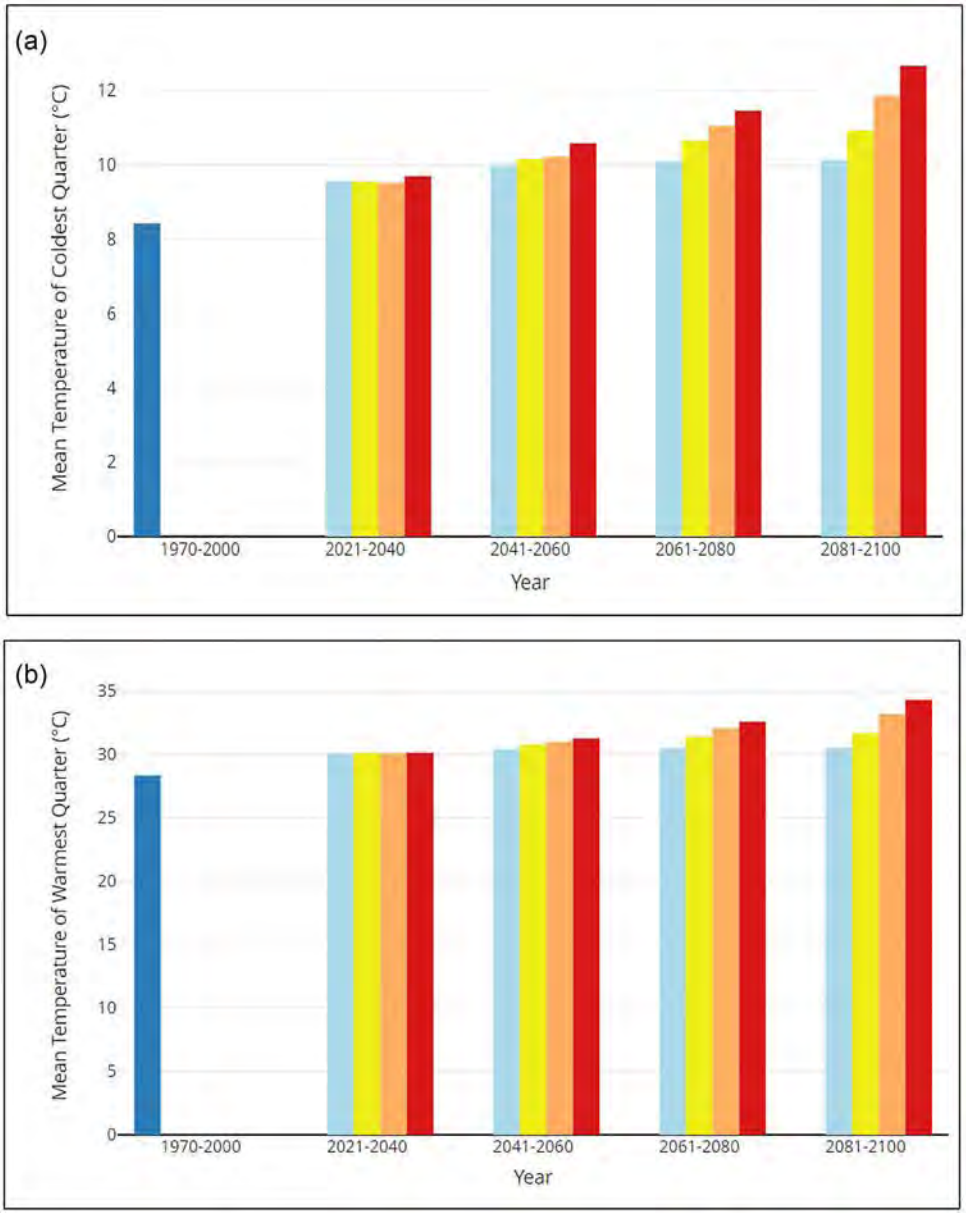

FIGURE 6 Modeled climate conditions for SSP1–2.6 (light blue column), SSP2–4.5 (yellow), SSP3–7.0 (orange), and SSP5–8.5 (red) emission scenarios for historic (dark blue) and four different future time intervals (Years, in *X*-axis). Mean temperatures (˚C) are shown on the *Y*-axis. (a) Mean temperature of the coldest quarter of the year (BIO11) in Davis, CA; and (b) Mean temperature of the warmest quarter of the year (BIO10) in College Station, TX. All figures were obtained from the National Plant Germplasm System Climate Futures Application (https://geocentroid.shinyapps.io/npgsclimatefutures).

collection maintenance, particularly with estimated future climatic conditions (J. Oliphant, personal communication, 2022).

5.8 | Acquisition and conservation of US native PGR through the Seeds of Success program

The Department of Interior, Bureau of Land Management Seeds of Success (SOS) program, in collaboration with the NPGS, collects and conserves the most comprehensive collection of native plant seeds in the United States and supports native plant restoration, management, and research. Targets for PGR collection for the SOS program include US native plant species collected for land restoration and other uses (Barga et al., 2020). The acquisition priorities for SOS thus emphasize US native species, including CWR that add important diversity to the NPGS PGR collections (Greene, Carver et al., 2019).

Climatic factors, including prolonged drought and increased temperatures, have affected collecting native plant

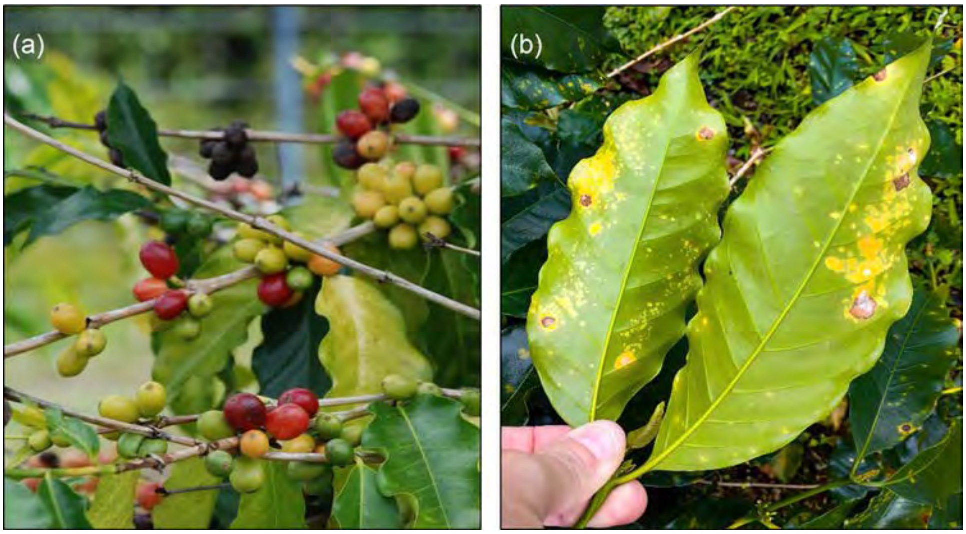

FIGURE 7 (a) Coffee plant in the National Plant Germplasm System plant genetic resources collection at the Hilo, HI genebank (photo credit G. Volk); (b) Coffee leaf rust on coffee plants in the Hawaiian Islands (photo credit L. Keith).

FIGURE 8 Removal of fire blight infected branches in the National Plant Germplasm System plant genetic resources apple collection at the Geneva, NY genebank (photo credit G. Peck).

FIGURE 9 In situ cranberry reserve at the Little Crater Meadow in Mount Hood National Forest, Oregon (photo credit K. Williams).

species because plant population sizes and seed quantities/qualities have declined, especially in the Western United States. The prolonged drought in western states and the extreme heat, especially during the summer of 2021 (Cotlier et al., 2022; Emerton et al., 2022; USDA Climate Hubs, 2021), resulted in unsuccessful field collecting due to seeds that dehisced prematurely in annual species, and reduced viabilities of seed collected of many forbs (A. Lindquist, personal communication, 2022). As noted previously in this essay, heat and drought stress also affect plant reproductive physiology of native wild species, affecting seed filing, quality, and viability. The increased number, sizes, and intensities of fires have also endangered plant populations targeted for collection. In addition, invasive species like cheatgrass often are favored by fire (Taylor et al., 2014) and frequently outcompete native grass and forbs (see the earlier discussion of potato CWR), limiting the number of populations available for field collecting.

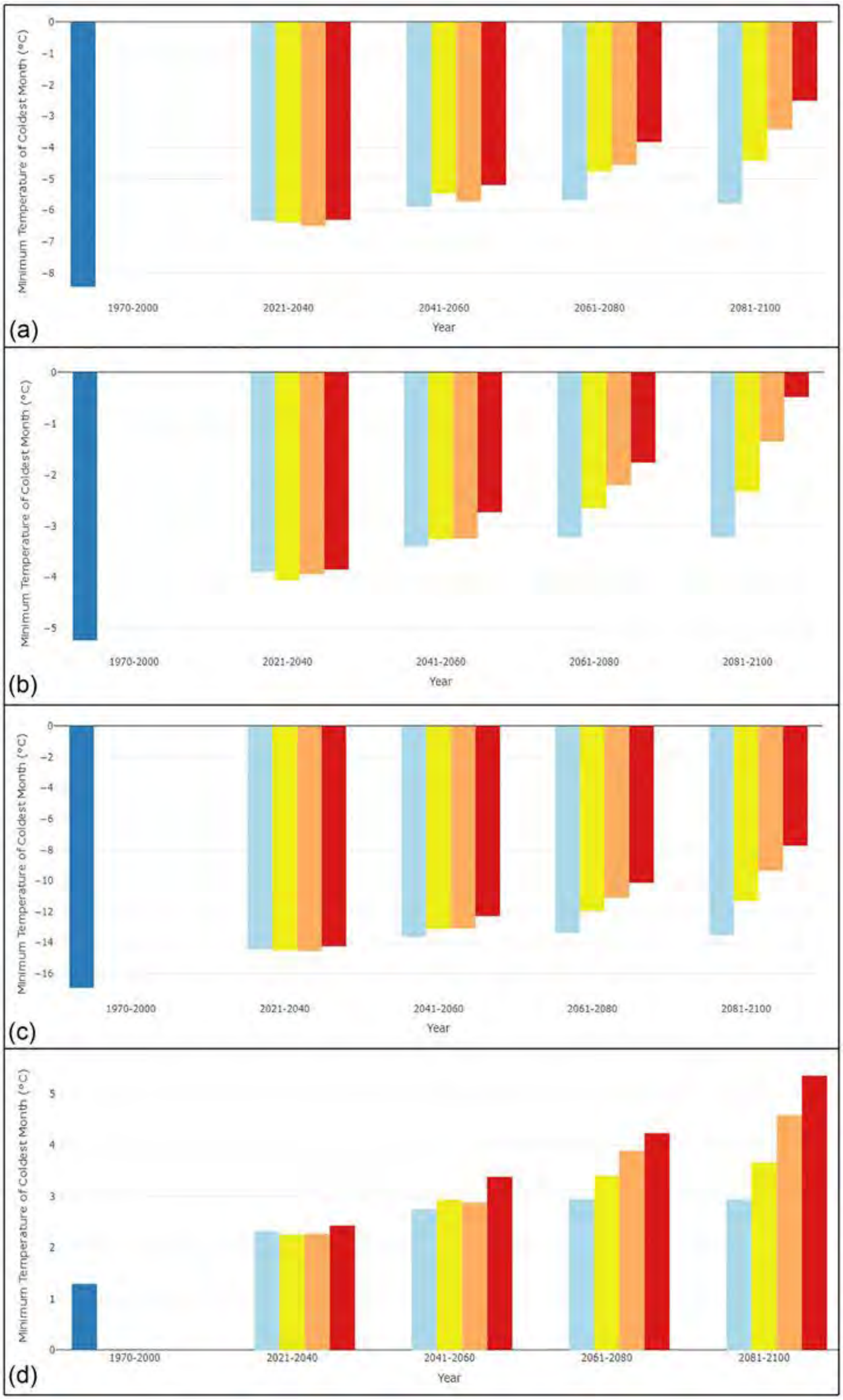

FIGURE 10 Modeled climate conditions for SSP1–2.6 (light blue column), SSP2–4.5 (yellow), SSP3–7.0 (orange), and SSP5–8.5 (red) emission scenarios for historic (dark blue) and four different future time intervals (Years, in *X*-axis). Mean temperatures (˚C) are shown on the *Y*-axis. Projected minimum temperature of the coldest month (BIO6) under the four emissions scenarios for four locations where cranberries grow in nature. The minimum temperatures at locations A–C were below 0˚C, consequently the temperature scale is inverted as compared to other histogram figures. (a) In situ reserve Cranberry Glades 1 in the Monongahela National Forest, WV, containing *Vaccinium macrocarpon* and *Vaccinium oxycoccos*; (b) In situ reserve Little Crater Meadow in the Mount Hood National Forest, OR, containing *V. oxycoccos*; (c) In situ reserve Upper Island Lake in the Chequamegon-Nicolet National Forest, WI, containing *V. macrocarpon*; (d) Ex situ cranberry plant genetic resources field planting at National Plant Germplasm System (NPGS) Corvallis, OR genebank. Data are available from the NPGS Climate Futures Application (https://geocentroid.shinyapps.io/npgsclimatefutures).

FIGURE 11 Potato CWR in nature in New Mexico. (a,c) Plants of *Solanum jamesii*; (b,d) Plants of *Solanum stoloniferum* (photo credit J. Bamberg).

5.9 | Augmenting ex situ potato PGR collections with the genetic diversity from in situ potato CWR populations

From 1992 to 2022, extensive annual expeditions throughout the Southwestern United States were performed by staff at the NPGS U.S. Potato Genebank (USPG) to collect two native US potato CWR species, the diploid outcrossing *Solanum jamesii* Torr. and the disomic tetraploid self-pollinated *Solanum stoloniferum* Schltdl. (historic name *Solanum fendleri* A. Gray) (Figure 11). These potato CWR represent two of the most common breeding systems of the nearly 100 tuber-bearing potato species (Bamberg et al., 2018). Only 46 accessions of the two native US species were included in the USPG PGR collection prior to 1992, but subsequent collecting increased that to 454 accessions. DNA marker studies suggest that the gain of diversity in the USPG collection has plateaued (Bamberg & del Rio, 2021), but after 31 annual expeditions, new collection sites with novel diversity continue to be identified.

Repeated visits to the same locations for these two potato CWR species revealed information important for PGR management. Most collections of those species capture only a snapshot of their genetic diversity from few places and times. Precise, georeferenced locality data and site-specific access information should be recorded so that the same site can be revisited in subsequent years. Populations that are readily apparent in 1 year might be difficult to identify in another because the visual appearance of some wild populations might vary with annual weather conditions and physiology. Seeds and tubers might remain in the soil for multiple seasons without germinating or producing above-ground growth (Bamberg, 2010; Bamberg et al., 2020). These conditions make it difficult to identify sparse populations, but repeated collections over three decades enable many more populations to be found compared to a single visit to each location.

The status and dynamics of genetic richness of potato CWR populations in the wild and in the genebank can contribute to predicting vulnerability to climate change. Many of the potato PGR accessions have been genotyped and provide valuable experimental material for extensive genomic studies to reveal both the structure of potato CWR populations and genomic regions that have undergone selection or local adaptation. This information can contribute to evaluating potato CWR for genotypes to incorporate into breeding programs for genomic-assisted selection (del Rio & Bamberg, 2020) for adaptation to climate change. Phenotypic and genotypic data can also help select PGR from in situ sites for long-term ex situ conservation. One outcome of this research has been identifying CWR with tuber freezing tolerance throughout the studied geographic range. This tuber freezing tolerance trait might help wild populations resist severe weather conditions that occur at those locations (Bamberg & Lombard, 2022).

6 | PREPARING NPGS PGR MANAGEMENT FOR THE EFFECTS OF CLIMATE CHANGE

The wide range of genetic diversity in NPGS PGR collections includes traits valuable for crop improvement in response to, or in anticipation of, changing climates. Nonetheless, as the preceding case studies illustrate, that diversity also complicates preparing NPGS PGR management—itself a complicated, multi-phase operation conducted over an extended timeframe (Byrne et al., 2018)—for the effects of climate change. Comprehensive planning for the NPGS's future development is already underway through the 2018 Farm Bill-directed National Strategic Germplasm and Cultivar Collection Assessment and Utilization Plan (115th Congress of the United States., 2017–2018. H. R. 2—Agriculture Improvement Act of 2018). The approaches outlined below draw on that Plan, the NPGS Climate Futures tool (Section 3) and other information included in the current essay. The approaches encompass diverse tools and strategies ranging from fairly simple, inexpensive, and short term to complicated, costly, and long term. Overall success will depend on strengthened cooperation with and support by the NPGS's diverse long term and new partners, customers, and stakeholders.

Where close cooperation with land-management agencies and organizations is feasible, the NPGS in situ PGR management program will expand to encompass additional tactics and IGRR, according to priorities described in Sections 2.2 and 4.2. The 30+ year US potato CWR field monitoring and collection program (Section 5.9) provides demographic and genetic analytical approaches that could be expanded judiciously to assist long-term, in situ conservation. For example, potato CWR sites with large "mega-populations" and substantial genetic diversity would be advantageous for repeated sampling, research, and for monitoring local weather trends, as well as conservation. In contrast, sites with few plants and reduced genetic diversity might merit ex situ conservation because of the stronger risk of local extinction. Close monitoring and analyses of PGR in situ might also identify key CWR traits—especially those recently evolved—such as tolerance to drought, higher temperatures, and resistance to pests and pathogens. Such information can guide field PGR collecting to fill gaps in ex situ PGR collections, subsequent extensive genotypic characterization, trait evaluations, and eventual incorporation of newly discovered traits into crop breeding programs. Furthermore, extensive datasets resulting from those analyses can help estimate the current and future impacts of climate change on specific species and on plant ecosystems as a whole.

Climate change has different effects on diverse crops and CWR (see preceding sections) at the dispersed geographical locations of the NPGS genebanks (Figure 1). Notably, climate change will also differentially affect the numerous components of NPGS's ex situ PGR management operations. As explained above, additional acquisitions of US CWR for ex situ conservation might be necessary, but also might become more difficult in the future because of the changing climatic conditions. Management of CWR PGR is often more complicated and costly than for cultivars, consequently additional NPGS genebank capacities and budgetary support will be needed.

NPGS genebanks and in situ reserves located in temperate zones will likely experience more pronounced temperature increases than those situated in the subtropics or tropics (Section 3). The higher temperatures might increase energy costs for maintaining PGR in cold storage. Higher temperatures might also increase substantially the energy and funds expended for cooling greenhouses to levels acceptable for maintaining PGR. Securing alternative sources of power for genebanks, including solar, wind, geothermal, or hydrological, should be investigated. Beyond the valuable climatic estimations provided by the NPGS Climate Futures Application (Section 3) adequate meteorological stations should be established at NPGS genebank locations that lack such instrumentation to both refine future predictions and document meteorological trends in growing areas before they affect PGR cold storage or field maintenance operations too greatly. Meteorological stations associated with genebank locations and evaluation sites also are needed to support priority research on plant adaptation to changing abiotic stresses.

Maintaining clonally propagated PGR in field plantings will not only require dealing with elevated temperatures but also with potentially more frequent and severe droughts, and extreme weather in the form of stronger and more frequent winds associated with hurricanes/cyclones at NPGS tropical/subtropical locations and tornadoes at NPGS continental genebank locations (Figure 1). More frequent and severe droughts will require greater and more reliable irrigation capacity at some NPGS genebanks. These elevated weather-related risks underscore the critical importance of backing up clonal germplasm at distant locales or as cryopreserved shoot tips and dormant buds at the NLGRP. More resources will be required to develop and implement additional clonal cryopreservation methods for the NPGS or to maintain duplicate plantings at multiple locations.

For PGR maintained as seeds, more frequent extreme or severe weather during regeneration represents the highest risks associated with climate change (see examples in Sections 2.1, 4, and 5). Both the costs and the risks associated with regeneration can be reduced by increasing the intervals between regenerations through improved seed storage conditions. Expanded capacity of −18˚C storage facilities and development of additional long-term preservation and seed quality monitoring methods will decrease regeneration frequency for many seed-propagated PGR endangered by failing viability due to inadequate storage temperature.

The NPGS genebank facilities and their constituent PGR collections were originally situated at particular locations because the growing conditions there met the needs of assigned crops; the sites were located in major production regions; or because of the availability of adequate PGR management capacity (Byrne et al., 2018). If environmental conditions at genebank sites shift to the extent that PGR can no longer be maintained in the field, greenhouse, or regenerated successfully, some PGR management operations, or even entire PGR collections, must be relocated to other NPGS sites where they can be grown and managed successfully. Upgrades and, when needed, relocations should start as soon as possible to avoid the worst predicted impacts of climate change on PGR collections.

Phenotypic evaluation of NPGS PGR will become more difficult but more important for generating information needed to mitigate and adapt to the effects of climate change. The PGR should be evaluated at multiple locations to assess plant performance under a wide range of current conditions and to understand better the potential future effects of climate change. Fortunately, large-scale PGR phenotyping is forecast to become more cost-effective once high-throughput technologies are more readily available and affordable (Volk et al., 2021). Phenotypic data, as well as genotypic characterizations, will reveal NPGS PGR potentially valuable for breeding programs (Byrne, 2023).

Importantly, the diverse, multi-location organization of the NPGS has bestowed the inherent resilience and flexibility so crucial for meeting the formidable challenge of climate change. In the future, the NPGS PGR operations must be even more closely coordinated across multiple locations to exploit more effectively the numerous NPGS system-wide assets. The coordination between the NPGS Davis and Geneva genebanks to generate *Prunus* buds that can be successfully cryopreserved at the NLGRP (Section 5.3) exemplifies how closely aligned cross-locational PGR management can solve NPGS operational challenges generated by climate change. The NPGS genebanks will continue to collaborate with university, private industry, and international and non-governmental partners, to ensure the safety and integrity NPGS PGR collections during the era of rapid climate change.

AUTHOR CONTRIBUTIONS

Gayle M. Volk: Conceptualization; software; writing—original draft; writing—review and editing. **Dan Carver**: Software; writing—original draft. **Brian M. Irish**: Conceptualization; software; writing—original draft; writing—review and editing. **Laura Marek**: Conceptualization; writing—original draft; writing—review and editing. **Anne Frances**: Conceptualization; writing—original draft. **Stephanie Greene**: Conceptualization; software; writing—original draft. **Colin K. Khoury**: Writing—review and editing. **John Bamberg**: Writing—original draft. **Alfonso del Rio**: Writing—original draft. **Marilyn L. Warburton**: Conceptualization; writing—original draft; writing—review and editing. **Peter K. Bretting**: Conceptualization; project administration; writing—original draft; writing—review and editing.

ACKNOWLEDGMENTS

The authors thank Profs. David Rupp and Christopher Daly at Oregon State University for their guidance on the selection of climate models, as well as NPGS crop curators and staff of the NPGS for their thoughtful input and suggestions. Maize curator Vivian Bernau provided data and graphs for the maize case study. The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the United States Department of Agriculture or the Agricultural Research Service of any product or service to the exclusion of others that might be suitable. USDA is an equal opportunity employer and provider.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Volk, G. M., Carver, D., Irish, B. M., Marek, L., Frances, A., Greene, S., Khoury, C. K., Bamberg, J., del Rio, A., Warburton, M. L., & Bretting, P. K. (2023). Safeguarding plant genetic resources in the United States during global climate change. *Crop Science*, 1–23. https://doi.org/10.1002/csc2.21003

Written Brief: NRSP1 Management Committee Update for Fall agInnovation Business Meeting 9/26/2023
Prepared by: Paula Agudelo, NRSP1 Chair

NRSP1 Management Committee Members
Paula Agudelo (Chair and AA), SAAESD Bret Hess (AA), WAAESD Jeanette Thurston (lead AA), NCRA William Miller (AA), NERA Chris Hamilton (NIMSS lead), NCRA Rick Rhodes, NERA Gary Thompson, SAAESD David Leibovitz, NERA Cindy Morley, SAAESD Jennifer Tippetts, WAAESD Alton Thompson, ARD Julie Estrada (NIMSS User), Purdue University Robin Williams (NIMSS User), Clemson University Sara Delheimer (ESS Program Coordinator), Ex-officio Faith Peppers (NIFA Director of Communications), NIFA Liaison Alexis Nazario-Negron (NIFA PARS Director), NIFA Liaison Email list: nrsp1@escop.info Committee Page: http://escop.info/committee/nrsp-1-management-committee/

The NRSP-1 management committee oversees the activities of the NRSP1 project, which includes NIMSS, led by Chris Hamilton and the Clemson Youth Learning Institute (YLI) NIMSS development team, and the Impact Writing program (https://www.mrfimpacts.org/), led by Sara Delheimer. The current incarnation of NRSP1 was approved for renewal at the Fall ESS meeting in September 2022 and officially started on 10/1/2022 and will expire on 9/30/2027.

The Committee continues to meet quarterly to discuss any updates or issues with NIMSS, presented by NIMSS lead Chris Hamilton, as provided by the Clemson University development team. Occasionally, the Clemson YLI developers join the calls, as well. Sara Delheimer presents the quarterly Impact Writing Program update and Alexis Nazario-Negron and Faith Peppers provide NIFA reporting and communications updates. NRSP1 call notes, quarterly reports, and all other materials are posted in NIMSS and at http://escop.info/committee/nrsp-1-management-committee/. Meetings are well-attended by committee membership.

Updates since the last written brief, posted online with the agInnovation Executive Committee (ESCOP) meeting draft meeting notes from July 18, 2023, at http://escop.info/event/escop-20230719/, include:

- The Clemson YLI development team for NIMSS has been working closely with the NIFA Reporting System (NRS) team on making NRS requested NIMSS data more easily accessible to NRS through the existing API (application programming interface). This is an on-going as of 9/7/2023; we don't expect any issues with this effort and hope it will alleviate some of the NRS inconsistencies some stations are seeing with multistate projects at the state level.

- The Clemson team is also preparing to significant back-end upgrades to NIMSS' Laravel framework and the newest versions of SQL (structured query language; a programming language for storing and processing information in a relational database) and other database attributes. An image of the NIMSS will be uploaded to the new framework in November/December. Chris Hamilton, David Leibovitz, Cindy Morley, and other user volunteers (TBD, likely some NRSP1 members) will be running extensive testing on NIMSS functions in the new environment before the upgrade goes live. They will communicate to regions and users regarding any possible issues or planned system outages. We hope to know more and discuss the effort during the next scheduled NRSP1 management call in October.

- NRSP1 leadership discussed and approved a recommendation for a merit and cost of living increase to Sara Delheimer's salary, thanks to Bret Hess' efforts and discussions with Colorado State University, Sara's host institution. This recommendation was forwarded to the NRSP-RC as a budget increase request for NRSP1. This increase will be voted upon at the fall agInnovation Business Meeting in Grand Rapids, MI. Sara is a highly valued member of agInnovation and we are excited to have her salary reflect her excellent work and years of experience.
  - Preface to the e-ballot that NRSP RC members received and approved: *"The Administrative Advisors for NRSP1 contacted NRSP RC with a request to change the budget for the remainder of the project's life. By way of brief background, NRSP1 funds NIMSS and the multistate research impact statement coordinator. The AAs believe the impact statement coordinator's salary is not commensurate with the quality of work being produced (for example, visit https://www.mrfimpacts.org/). The AAs are also concerned about retaining the impact statement coordinator if she does not receive an increase in compensation greater than the 3% annual COLA that 1862 SAES directors approved when the project was initiated. Therefore, the NRSP1 requests to increase the impact statement coordinator's salary following the same procedures employed by the University of Nevada, Reno. The Nevada Legislature passed a 12% COLA for FY24 and another 11% COLA for FY25. The FY24 COLA is in addition to any other known increases (e.g., merit and/or promotion). The approved FFY23 salary for the coordinator is $55,500 with a fringe of $16,150. In addition to the 3% COLA, the fringe rate was increase by 1% per year in the approved budget. The NRSP1 AAs propose following Nevada's COLA procedures with a 12% salary increase on top of the already budgeted 3% increase in FFY24 followed by another 11% salary increase in FFY25 then go back to the 3% salary increase in FFY26 and FFY27. The AAs have received preliminary indication from the institution hosting the coordinator's position that the proposed salary increases could begin in October to coincide with the start of the federal fiscal year. The approved salary, fringe and total budget are compared to the requested changes to the salary, fringe and total budget immediately below the ballot."*

  - Summary of the NRSP1 Budget Change Request:

Request Budget Change for NRSP1

	Salary	Fringe	New Total Budget (NIMSS & Impact Effort)
FFY24	$64,025	$19,272	$240,746

FFY25	$71,068	$22,102	$253,395
FFY26	$73,200	$23,497	$259,754
FFY27	$75,396	$24,965	$266,299

versus

Approved Budget for NRSP1

	Salary	Fringe	Total Budget (for NIMSS and Impact Effort)
FFY24	$57,165	$17,207	$231,821
FFY25	$58,880	$18,312	$237,417
FFY26	$60,646	$19,467	$243,170
FFY27	$62,466	$20,676	$249,083

Agenda Brief: Policy Board of Directors
September 26, 2023
PBD Representatives: Mark McGuire and Shibu Jose (alternate)

The BAA Policy Board of Directors (PBD) convened three meetings held on November 7, 2022; and February 7, 2023, and July 20, 2023. The following are highlights of the discussions and decisions of the PBD at those meetings. Marty Draper as the alternate for Mark McGuire represented the ESS at the February 7 meeting. Marty Draper retired from Kansas State University, and Shibu Jose (University of Missouri) is serving as the alternate representative to the PBD.

<u>November 7, 2022 – Hyatt Regency, Denver, CO</u>

Communications and Marketing

Update on CMC activities and content/outreach materials

- Changes – added 5 regional communicators to advise and contribute content (starting as of this meeting) as well as an ESCOP regional representative and international section representative.
- NIDB transition to CMC will be effective April 2023, support incorporated into the CMC budget.

2023 BAA Assessments

- 2022 collection rate is 92% to date - 100% achieved for the last 4 years.
- 2023 there will be no increase in the percentage paid for the assessments.
- Overall BAA budget proposal has increased but the percentage is based on amount of NIFA funding at institutions, which has increased.

Policy Board of Directors Election Process

- Recent experience with the CMC vote to be a standing committee of the Policy Board brought to light the difficulty of making changes to the rules of operation that requires a supermajority (2/3) of the membership rather than those voting.
- Elections are overseen by the Policy Board of Directors
  - Challenge is determining the actual voting members of BAA.
  - Proposed to send an annual survey of Administrative Heads to verify who is responsible for research, Extension, academics, and international programs.
- Consider the process for the election of Policy Board members and alternatives.
  - Propose that the sections represented elect rather than an election involving all the BAA membership for each PB member.
- Policy to elect PBD chair is unclear as there is no formal rotation process.
  - Consider forming a nominating committee from the Policy Board members.
- During the July 2023 Policy Board meeting will vote on membership voting requirements.
- **Action Item - Policy Board of Directors "*Rules of Operation*" Rules Committee to be appointed.**

Review and Action: 2023 BAA Budget

- PowerPoint version of the budget was presented for the 2021, 2022, and 2023 budget years.
- **Motion to adopt the 2023 BAA budget passed.**

Review and Action: 2023 CARET Budget

- **Motion to adopt the 2023 CARET budget passed.**

BAC Recommendations FY2024

- PBD is required to pass the BAC recommendations before taking to the hill at CARET/AHS
- **Motion to approve the BAC draft passed.**

Policy Board of Directors chair transition from Tom Coon (Ok State) to Ernie Minton (K State)

<u>February 7, 2023 (Members-only meeting)</u>

CLP - Farm Bill

- For Review, Discussion and Vote: 2023 Farm Bill Research Title VII Recommendations - Long-form document
- Recommend consideration of an overall funding request of $8 billion for Farm Bill Title VII over the five-year life of the authorizing legislation. Research, Extension, and facilities would be core themes of any related advocacy. Mandatory Funding Request - Research Facilities Act
- Review and discuss support for Education Grants Programs for Hispanic-Serving Institutions

BAC – Annual Appropriations Request – FY2024

- For Review, Discussion and Vote**:** Table of BAC recommended appropriations requests.

July 20, 2023 - Loew's Kansas City Hotel, Kansas City, MO

This was the first face-to-face meeting with Ernie Minton as the chair of the Policy Board of Directors. The meeting primarily focused on updates and reviews without any motions considered or votes taken.

Several topics of interest included:

- Communications and Marketing Committee update - $325k now paid from BAA assessments.
- Board of Directors elections process:
  - PBD members to be selected by the sections rather than through a vote from the full BAA membership.
  - Need for a PBD vice chair to ensure an orderly succession.
  - Both changes require modifying the BAA Rules of Operation
- A rules committee will be appointed to review the BAA Rules of Operation.
- Year-to-date BAA and CARET budgets were reviewed and are on track.
- Role of the Policy Board of Directors
  - Members are elected to act on behalf of the BAA.
  - Responsible for managing the BAA, including through its three standing committees.
  - Responsible for the management and oversight of contracts/budgets for LBA, CARET, FSLI, and LEAD21.
  - Provide oversight of the FANR Office
  - Rules of Operation states the Policy Board reports to the Council of Presidents

The next PBD meeting is scheduled for November 14, 2023, at the 2023 APLU Annual Meeting in Seattle WA.

Agenda Brief: Science and Technology Committee (http://escop.info/committee/stc/)
Date: September 26, 2023
Presenter: Nathan Slaton
Action Requested: Input on Excellence in Multistate Research Award Guidelines

Committee Members:

Chair: Nathan Slaton (SAAESD) **Past Chair:** Bernie Engel (NCRA) **Delegates:** Alton Thompson (ARD) John Yang (ARD) Frank Casey (NCRA) Shibu Jose (NCRA) Indrajeet Chaubey (NERA) George Criner (NERA) Nathan McKinney (SAAESD) Vacant (SAAESD) Gene Kelly (WAAESD) Chris Davies (WAAESD) **Executive Vice Chair:** Bret Hess (WAAESD ED) Jennifer Tippetts (WAAESD Recording Secretary)	**Liaisons:** Tara McHugh (ARS) Kevin Kephart (NIFA) Alejandro Calixto (NIPMCC) Tim Killian (SSCC)

Meetings: Virtual meetings are scheduled 1-2 pm PT/2-3 pm MT/3-4 pm CT/4-5 pm ET the first Monday of the month. Zoom connection information is:
https://us02web.zoom.us/j/88134284585?pwd=enF0NmFlY25teUNKN3k5WUVoYUI2UT09
Meeting ID: 881 3428 4585; Passcode: STC

Activities Since the Report to the agInnovation Executive Committee on July 19, 2023

Nathan Slaton began serving as chair because Bernie was appointed as the Glenn W. Sample Dean of Agriculture at Purdue.

The committee is in the process of updating the Grand Challenge templates in Canva as a more user-friendly format than InDesign. The goal is to update annually and start sharing on the new agInnovation website.

Multistate Research Award Guidelines Revisions- In addition to updating the guidelines to reflect the agInnovation name throughout, stronger language was included to encourage demonstration of relevance with the Grand Challenges. The committee is open to suggestions before voting on the revisions at 2:45-4:30 p.m. on September 26, 2023.

The committee plans to review progress on the previous two-year work plan and begin outlining the next two-year work plan during the in-person meeting on September 26, 2023.

APLU
BOARD ON AGRICULTURE ASSEMBLY

Communications and Marketing Committee (CMC)

Agenda Brief (July 10 - September 18, 2023)

To:	agInnovation Executive Committee
From:	Andrea Putman Office of Food, Agriculture & Natural Resources (FANR), APLU
Date:	September 18, 2023
Last agInnovation agenda brief:	July 10, 2023

Committee Membership (as of September 2023): see CMC page here.

Meetings: The CMC held the following zoom meetings from July – September 2023:

- July 20th (held in person at Joint COPs meeting, Kansas City, MO)
- August 17th
- Next meeting: September 21st

HIGHLIGHTS AND ACCOMPLISHMENTS

The National Impact Database (NIDB) Transition

The NIDB database, located at **Land-grant Impacts,** is a publicly accessible repository for land-grant universities' impact statements. Texas A&M University has hosted the website and database for approximately a decade. At the request of the NIDB team and the CMC, the NIDB is transitioning to APLU's Office of FANR.

The Extension Foundation is the new provider of hosting for the NIDB database. APLU finalized the contract with Extension Foundation in early September. The Extension Foundation's Aaron Weibe and his development team led by Mark Locklear are hard at work and ahead of schedule. They have updated the NIDB's software framework and fixed over 40 security issues. Aaron and Mark are working directly with Scott Cummings of Texas A&M to ensure a seamless transition. The CMC is finalizing details on its requests for the first round of improvements.

CMC Member Transition

Dr. Cynda Clary represented the Academic Programs Section (APS) on the CMC for many years. In August 2023, she stepped down from that role. The CMC is grateful for Dr. Clary's many contributions and thoughtful leadership though the CMC's growth and transitions.

Dr. Dan Moser, Associate Dean, Academic Programs, College of Agriculture, Kansas State University is the new APS representative (a voting member). The CMC looks forward to working with Dr. Moser.

Material Development and Distribution

FANR Focus

Produced FANR Focus, a monthly newsletter that is distributed to ~850 BAA stakeholders**. July 6th, August 8th, September 7th** and other past editions are here.

Monthly Communications Toolkits (July – September 2023)

The team develops and distributes a monthly communications toolkit for university communicators. Dozens of communications professionals have requested to be added to the distribution list, which has grown from approximately 140 in 2021 to over 240 people. The toolkits are now available on the AgIsAmerica site.

July – September 2023 Toolkits

- July - **Increasing Food Security and Safeguarding National Security**
- August: **Year in Review**
- September: **Building the Future: Celebrating Educators' Determination and Impact**
- October: Protecting Animal and Plant Health (Forthcoming)

APLU Blogs from FANR:

Bill Hoffman Starts as Executive Director, Cooperative Extension System and Extension Committee on Organization and Policy at APLU and Cooperative Extension - APLU
July 11, 2023

Website Updates

AgisAmerica.org

The team has updated, streamlined, and improved the AgIsAmerica website. Enhancements include:

- Added agInnovation as a partner resource **here**.
- Member Institution Directory
- Communication Toolkits
- Updated homepage video and monthly rotating content
- Blog posts linking back to NIDB and Multistate Research Fund Impacts

Land-grant.org

The team continues to update advocacy materials and uses land-grant.org as the primary resource for CARET delegates. Kim Scotto is developing a members-only portal for CARET that will host internal materials like directories, training videos, and meeting minutes.

Social Media

Campaigns:

- Workforce Development (ongoing): collected submissions from communications professionals at member institutions.

- HBCU Week + Farm Safety & Health Week (September 2023)
- Hispanic Heritage Month (September – October 2023)
- Native American Heritage Month + Thanksgiving (November 2023)

Media

July 25, 2023 / Inside Higher Ed

What's at stake for institutions, students in farm bill talks (insidehighered.com)

Excerpt:

The farm bill includes millions in funding for agriculture research and extension services for land-grant universities. The 2018 update included a number of wins for historically Black colleges and universities, and some experts had hoped to see Congress build on those changes to increase funding for the land-grant institutions created for Black students.

***The Association of Public and Land-grant Universities** has asked Congress to reauthorize a number of grant programs and allocate $5 billion over the next five years to upgrade research facilities at land-grant institutions. Public agriculture schools and colleges have outdated facilities and are facing $11.5 billion in deferred maintenance costs.*

The farm bill historically has not funded infrastructure. The 2018 update created a competitive grant program to pay for capital projects, though Congress didn't provide money for it. This current budget put $2 million toward it.

***Michael Boehm, vice chancellor for the Institute of Agriculture and Natural Resources at the University of Nebraska at Lincoln**, said facilities are key to universities' teaching, research and extension efforts.*

"It's just impossible for us to do the cutting-edge research that's needed to move the world forward and move American agriculture in facilities that were built before Watson, Crick and Rosalind Franklin figured out the structure of DNA," he said. "It's hard to do cutting-edge research on climate-smart commodities when you can't control the temperature in the greenhouses."

September 5, 2023 / Science

As shutdown looms, will U.S. Congress cut spending and restrict research? | Science | AAAS

Excerpt:

Farm bill
A 2018 law, which expires on 31 September, set funding priorities and policies at the U.S. Department of Agriculture. In addition to supplying food aid to low-income residents and crop insurance to farmers, the

law provided $694 million over 5 years for research on plant genetics, crop diseases, and soil health.

Research advocates hope the new bill will include $5 billion to repair and upgrade laboratories and other research infrastructure. "It really has to be a total overhaul of the system," says ***Doug Steele of the Association of Public & Land-grant Universities****. "We're almost at the breaking point." But progress on the bill has been slow, in part because fiscal conservatives don't want to increase the $725 billion in mandatory spending in the expiring legislation.*

2023 CMC Meeting Minutes are here.

Action Requested: For information only.

Agenda Brief: **Resolutions**
Date: **September 26, 2023**
Presenter: **Matt Wilson (Chair)**

A Resolution to Recognize the 2023 agInnovation Awardees for Excellence in National Leadership

WHEREAS, the following individuals have served their own institutions, their Regional Associations, agInnovation and the Land-grant System in various leadership positions with exemplary distinction:

- Dr. Chandra Reddy, Dean of the College of Agriculture and Director of Research /Administrator of Extension, Tennessee State University
- Dr. Jeff Jacobsen, Retired Executive Director North Central Regional Association of State Agricultural Experiment Station Directors
- Dr. Jan P. Nyrop, Retired Goichman Family Director of Cornell AgriTech at the New York State Agricultural Experiment Station and Associate Dean, College of Agriculture and Life Sciences, Cornell University
- Dr. Henry Fadamiro, Associate Vice President for Research, Strategic Initiatives, Formerly Associate Director and Chief Science Office of Texas A&M AgriLife Research and Associate Dean, College of Agriculture and Life Sciences, Texas A&M University
- Dr. Glenda Humiston, Vice President for Agriculture and Natural Resources, University of California

WHEREAS, these leaders have personified the highest level of excellence by enhancing the cause and performance of the Regional Associations and agInnovation in achieving their mission and the Land-grant ideal; and

WHEREAS, these leaders, through their many service activities exhibited by offices held, committee participation and unique assignments, have made very significant regional and national contributions that build programs and capacity; and

WHEREAS, these leaders have provided significant, dynamic and high quality performance with regional, national and/or international impacts and have a record of significant accomplishments in the agricultural sciences; and

THEREFORE, BE IT RESOLVED, the members of agInnovation assembled at their annual meeting, on September 26, 2023 congratulate Drs. Reddy, Jacobsen, Nyrop, Fadamiro, and Humiston as the 2023 agInnovation Awardees for Excellence in National Leadership; and

BE IT FURTHER RESOLVED, we express sincere appreciation and gratitude to these leaders for their dedicated service and many valuable contributions to the Regional Associations, agInnovation and the Land-grant System; and

BE IT FURTHER RESOLVED, that original copies of this resolution be provided to Drs. Reddy, Jacobsen, Nyrop, Fadamiro, and Humiston and that a copy be filed as part of the official minutes of this meeting.

Retirements/Left Positions – October 1, 2022 – September 30, 2023

Be it resolved, agInnovation thanks those administrators who have retired or left from their positions in FY 2023 and we hereby extend our congratulations to**:**

Association of 1890 Research Directors (ARD)

Edward Buckner, *Retired*, Dean and Research Director, School of Agriculture and Applied Sciences, Alcorn State University
Robert Taylor, *Retired*, Dean and Research Director, College of Agriculture and Food Sciences, Florida A&M University

Majed El-Dweik, Dean and Research Director, Cooperative Research and Extension, College of Agriculture, Environmental and Human Sciences, Lincoln University
Ralph Noble, Dean and Director. College of Agriculture, Family Sciences and Technology, Fort Valley State University

Southern Region

Susan Duncan, Associate Director, Virginia Agricultural Experiment Station, Virginia Polytechnic Institute and State University
Henry Fadamiro, Associate Director and Chief Science Office of Texas A&M AgriLife Research and Associate Dean, College of Agriculture and Life Sciences, Texas A&M University

North Central Region

Jeff Jacobsen, *Retired*, North Central Regional Association (NCRA)
Ann Dorrance, *Retired*, Associate Dean and Director of the Wooster Campus, The Ohio State University
Marty Draper, *Retired*, Associate Dean for Research and Graduate Programs, Kansas State University
Bill Gibbons, *Retired*, Associate Dean for Research, North Dakota State University
Archie Clutter, *Retired*, Dean of Agriculture Research Division and Director of the Nebraska Agricultural Experiment Station, University of Nebraska-Lincoln

Bernie Engel, Senior Associate Dean for Agriculture Research and Graduate Education, Purdue University
German Bollero, Associate Dean for Research and Director of the Illinois Experiment Station, University of Illinois-Urbana Champaign

Northeastern Region

Jody Jellison, *Retired*, Director, Center for Agriculture, Food and the Environment; Director, Massachusetts Agricultural Experiment Stations; Director, UMass Extension; Assistant Vice Chancellor, University of Massachusetts
Rick Roush, *Retired*, Dean and Director, College of Agricultural Sciences; Pennsylvania Agricultural Experiment Station, The Pennsylvania State University

Olga Padilla-Zakour, Interim Director, Cornell AgriTech, College of Agriculture and Life Sciences, Cornell University
Jessica Leahy, Associate Dean/Director, Maine Agricultural and Forest Experiment Station, University of Maine
Jane Kolodinsky, Interim Associate Dean for Research and Graduate Education, University of Vermont
Matt Wilson, Associate Dean of Research/Associate Director, West Virginia Agriculture and Forestry Experiment Station, West Virginia University

<u>Western Region</u>

Lee Yudin, *Retired*, Dean, College of Natural and Applied Sciences & Director, Western Pacific Tropical Research Center & Guam Cooperative Extension College of Agriculture & Life Sciences, University of Guam

Mary Burrows, Associate Director of Montana Agricultural Experiment Station and Research Development, Montana State University
Singeru Singeo, Director of Land-grant Programs, College of Micronesia
Steven Young-Uhk, Interim Director of Agricultural Experiment Station and Cooperative Extension, College of Micronesia
Scot Hulbert, Associate Dean for Research & Agricultural Research Center Director, College of Agricultural, Human, and Natural Resource Sciences, Washington State University

New Appointments – October 1, 2022 – September 30, 2023

Be it resolved, agInnovation thanks those administrators who have taken on new positions in FY 2023 and we hereby extend our congratulations to**:**

Association of 1890 Research Directors (ARD)

Dexter B. Wakefield, Dean and Research Director, School of Agriculture and Applied Sciences, Alcorn State University
G. Dale Wesson, Dean and Research Director, College of Agriculture and Food Sciences, Florida A&M University
Douglas D. LaVergne, Dean and Research Director, Cooperative Research and Extension, College of Agriculture, Environmental and Human Sciences, Lincoln University
Keith Howard, Dean and Director, College of Agriculture, Family Sciences and Technology, Fort Valley State University

Northcentral Region

Ron Turco, Associate Dean/Director of Agriculture Research & Graduate Education, College of Agriculture, Purdue University
Jane Schuh, Associate Dean for Research and Graduate Studies, College of Agriculture Director for Research (AES) - K-State Research and Extension, Kansas State University
James Averill, Assistant Director, AgBioResearch, Michigan State University
Derek McLean, Dean & Director, Agricultural Research Division, University of Nebraska–Lincoln
Lingying Zhao, Associate Director, Ohio Agricultural Research and Development Center, The Ohio State University
Troy Runge, Associate Dean for Research, University of Wisconsin-Madison

Northeast Region

Christine Smart, Director, Cornell AgriTech, College of Agriculture and Life Sciences, Cornell University
George Criner, Associate Dean/Director, Maine Agricultural and Forest Experiment Station, University of Maine
Lynne McLandsborough, Director, Center for Agriculture, Food and the Environment; Director, Massachusetts Agricultural Experiment Stations; Director, UMass Extension; Assistant Vice Chancellor, University of Massachusetts
Jason Hubbart, Interim Associate Dean of Research, Associate Director, West Virginia Agriculture and Forestry Experiment Station, West Virginia University

Southern Region

Leland "Sandy" Pierson, Associate Director and Chief Scientific Officer, Texas AgriLife Research, Texas A&M University
Mary Burrows, Director of the Virginia Agriculture Experiment Station and Associate Dean for Research, Virginia Polytechnic Institute and State University

Kang Xia, Interim Associate Director, Virginia Agriculture Experiment Station and Director of the Center for Advanced Innovation in Agriculture, Virginia Polytechnic Institute and State University
Michael Stout, Associate Experiment Station Director, Louisiana State University
Kurt Guidry, Associate Experiment Station Director, Louisiana State University

Western Region

Darrin Boss, Associate Director, Montana Agricultural Experiment Station, Assistant Dean of Research, College of Agriculture Superintendent/Animal Science, Northern Ag Research Center, Montana State University
Stanley Lorennij, Executive Director of Agricultural Experiment Station and Cooperative Extension Service, College of Micronesia