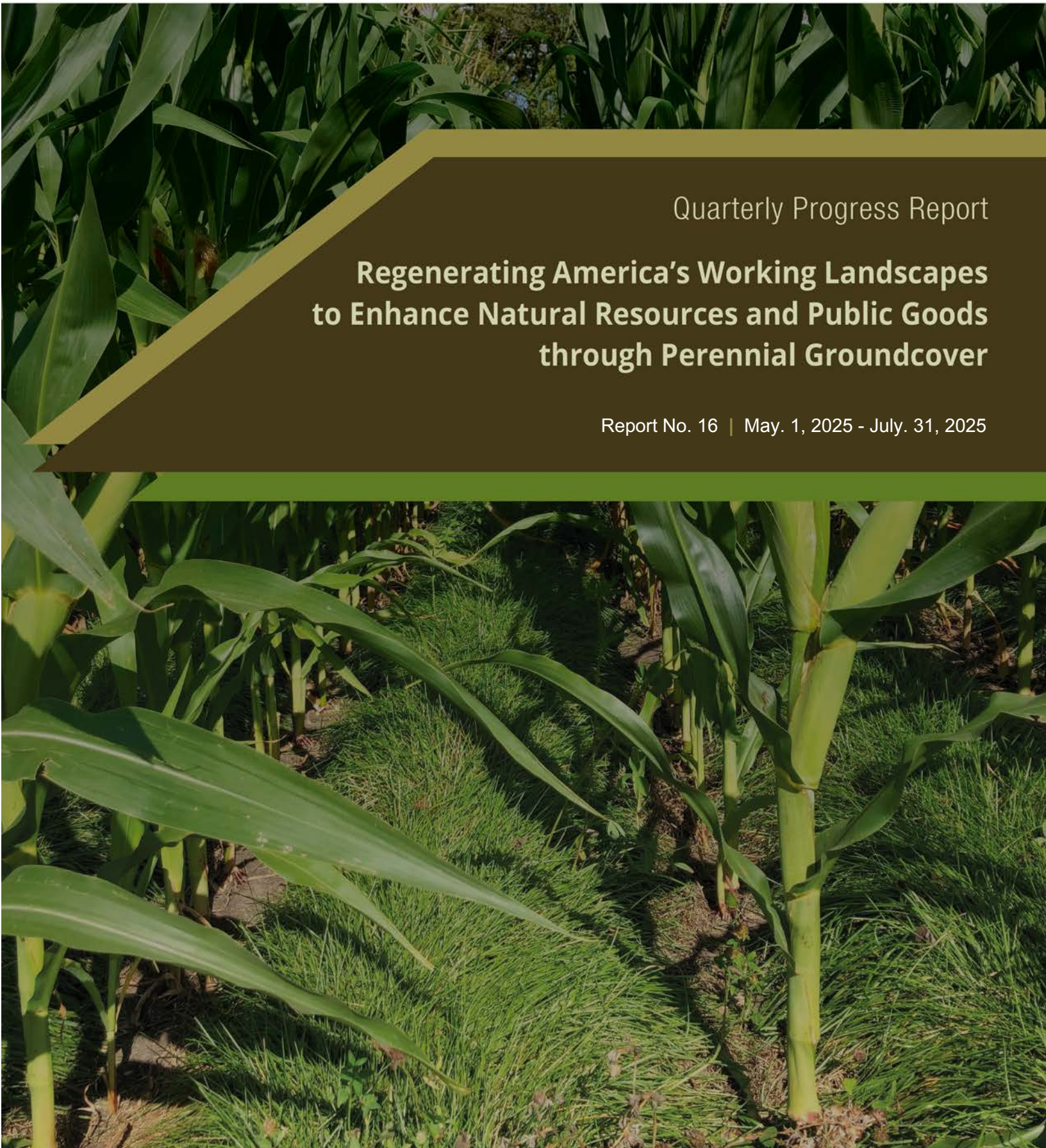
REGENPGC



Quarterly Progress Report

Regenerating America's Working Landscapes to Enhance Natural Resources and Public Goods through Perennial Groundcover

Report No. 16 | May. 1, 2025 - July. 31, 2025

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ACKNOWLEDGMENT

Regenerating America's Working Landscapes to Enhance Natural Resources and Public Goods through Perennial Groundcover (RegenPGC) is supported by Agriculture and Food Research Initiative Competitive Grant No. 2021-68012-35923 from the USDA National Institute of Food and Agriculture. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the U.S. Department of Agriculture.

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ABSTRACT

Achieving the SAS program goal of transforming the US agricultural system to sustainably increase production by 40% requires large-scale production agriculture across multiple crops to profoundly change its bare-soil winter-fallow practices. These conventional practices negatively impact soil health and natural resources conservation – the pillars of agricultural systems sustainability. A scalable solution to this challenge is the implementation of perennial groundcover (PGC) cropping systems, which use an ecologically complementary, permanent groundcover in fields where annual cash crops are grown. This transformative approach to large-scale agricultural production increases the duration and extent of groundcover on cropland, enhancing resiliency and improving the quality of water, air, and soil. Working closely with farmers, NGOs, and industry stakeholders, this project will develop and refine PGC approaches enabling high-yielding row-crop production while improving soil and water quality, providing large increases in the availability of lignocellulosic feedstocks, and preserving or increasing farm income. This project will develop best management practices for growing crops and suppressing weeds with PGC, develop improved crop and groundcover genetics, develop appropriate soil and nutrient management practices, quantify the environmental impacts, and determine the policy and socioeconomic implications of the adoption of PGC approaches. Knowledge gained through this project will be used to educate a new generation of undergraduate and graduate students who recognize the opportunities to enhance agriculture using PGCs. We will provide a multi-pronged extension effort using a combination of hands-on field days, farmer meetings, and online resources to educate practitioners about the opportunities and challenges of the system.

Regenerating America's Working Landscapes to Enhance Natural Resources and Public Goods through Perennial Groundcover (RegenPGC)

AFRI Competitive Grant No. 2021-68012-35923

Year 4 –4th Quarter Project Activities

May 1, 2025 – July 31, 2025

PROJECT ADMINISTRATION AND GOVERNANCE

With great sadness and acknowledgment of a remarkable career and life well-lived, we share the passing of one of our RegenPGC Co-Project Directors, Dr. Cornelia (Neal) Flora. Dr. Flora served as a leader of our Socioeconomic Impacts and Policy Objective, and we appreciate all that she has done to impact RegenPGC and the interests of rural communities. For information on Dr. Flora's extensive contributions to the rural sociology field, see https://en.wikipedia.org/wiki/Cornelia_Butler_Flora.

Photo 1. In memoriam, Dr. Neal Flora, RegenPGC CoPd, Socioeconomic Impacts & Policy (1945 – 2025)

1. Planned Activities

Continue regular meetings with groups of CoPds and ad hoc meetings with individual CoPds to answer questions and help create bridges across objectives.

2. Actual Accomplishments

A. Meetings

- **Stakeholder Advisory Board Meetings.** Held in June as planned. The meeting was well attended.
- **Theme Leader Meetings**. Held multiple 1:1 meetings with individual theme leaders and the Deputy Director (Kinzel).
- **Co-PD Meetings.** Organized and led two all-coPD meetings
- **RegenPGC Café**. Finished the spring sequence and paused the Cafés over the summer. We will restart in August when semesters begin at affiliated universities.
- **Year 4 Annual Face-to-Face Meeting.** Detailed planning for the Year 4 annual meeting was completed. The meeting will be held at Corteva Agrisciences in Johnston, Iowa, a central location that is readily accessible, leading to lower transportation and housing costs. The dates were set for October 1-3, 2025.

B. Project Leadership

- Worked to identify a new CoPD at Kansas State University after the passing of CoPD Flora (pg 1). Dr. Matthew R. Sanderson, Randall C. Hill Distinguished Professor of Sociology, Anthropology, and Social Work & Professor of Geography and Geospatial Sciences, Kansas State University, is replacing Dr. Flora, primarily to oversee the completion of Jacob A. Miller-Klugesherz's Ph.D. Miller-Klugesherz's was previously guided by Dr. Flora. All relevant paperwork between ISU, KSU, and USDA has been promptly completed.
- Continued ad-hoc meetings with all team members (as-needed basis), including a focused meeting with Objective 5. Socioeconomic Impacts & Policy to discuss how to proceed in light of CoPD Flora's passing.
- Continued attending and participating in weekly RegenPGC Café events organized by Education and Research Theme Leaders (Moore and Schlautman)
- Updated a company with possible PGC-relevant germplasm on project findings, including challenges with the longevity of said plant materials in Iowa conditions.

- Participated in an affiliated project (NRCS CIG) field day to discuss recent PGC findings – both positive and negative.
- Met with NIFA program manager to provide a brief update on project challenges and successes – this is very much a "what we know and what comes next" which the PD has been sharing with groups inside and outside the project.
- With input from multiple CoPDs, created a PGC "BMP" 2-page handout for recruiting the next group of on-farm trials.

3. Plans for Next Quarter

- Run a successful 4th-year annual meeting
- Continue sharing the "*What We Know Now and What Comes Next*" presentation with relevant audiences.
- Continue monthly budget meetings with ISU Finance Delivery personnel to monitor grant spending.
- Continue onboarding newcomers to the project.

4. Publications, Presentations, Stakeholder Engagement, Proposals Submitted, and Awards

A. Presentations

- Created and presented *Traversing the PGC Valley of Death,* for the 2025 NIFA SAS CAP online meeting.
- Created and presented *Key Learnings from the First Three Years of RegenPGC* – for the Iowa Soybean Association.

B. Stakeholder Engagement (Outreach Activities)

- Aforementioned CIG presentation
- Aforementioned ISA presentation.

C. Awards and Recognition

THEME 1. RESEARCH AND DEVELOPMENT

The cross-cutting Research and Development Theme focuses on establishing organizational structures for data management and modes of communication among the research teams and individual participants – the foundation of integrated research. **Brandon Schlautman** (The Land Institute) leads this theme.

Research and Development Theme Update

1. Planned Activities

- Draft and submit a manuscript to make the image analysis algorithm for monitoring PGC intensity publicly available.
- Incorporate research standard operating procedures for PGC small plot research into a web-based, publicly available format.
- Curate data from 2024 on-farm research to summarize progress towards best management practice efficacy of PGC compared to business-as-usual conventional corn production.
- Summarize the potential scalability of PGC suppression practices when using *Liberty* (glufosinate) herbicide.

2. Actual Accomplishments

- Continued work on a manuscript to make the image analysis algorithm for monitoring PGC intensity publicly available. The manuscript remains in preparation, supported by a dataset of more than 10,000 annotated images that will be released as an open-source resource for the PGC community to support future modeling efforts.
- Incorporated research standard operating procedures (SOPs) for PGC small plot research into a web-based, publicly available format hosted in a shared Zenodo web interface.
- Curated 2024 on-farm research data using Airtable tools and a custom database. These efforts are informing revisions to the data collection and storage systems that will be used for 2025 on-farm trial reporting.

1. Explanation of Variance

The work to summarize the scalability of PGC suppression practices using *Liberty* (glufosinate) herbicide has been pushed into Q4 of 2025 to align with data availability and ensure integration with ongoing field trial results.

2. Plans for Next Quarter

- Summarize the potential scalability of PGC suppression practices when using *Liberty* (glufosinate) herbicide.
- Revise data collection and storage protocols for 2025 on-farm trial reporting based on lessons learned from the 2024 curation process.
- Continue curating datasets from 2025 small-plot and on-farm trials into Zenodo and other shared repositories.
- Launch the fall RegenPGC Café series focusing on cross-objective integration and student research updates.
- Explore opportunities for cross-site comparisons of PGC image analysis datasets to strengthen algorithm validation.

3. Publications, Presentations, Stakeholder Engagement, Proposals Submitted

None this quarter.

THEME 2. EXTENSION

This cross-cutting theme extends the project's reach by developing a robust platform to share science-based knowledge, existing and potential commercial opportunities, and policy recommendations to an expanded set of stakeholders. **Dan Andersen** (Iowa State University) leads this theme.

Our comprehensive extension education efforts, which are geared towards ensuring and strengthening PGC adoption, target five stakeholder groups:

- Extension educators
- Farmers
- Technical service providers and crop advisers
- The scientific community
- The general public

1. Actual Accomplishments

Our team advanced outreach and education on perennial groundcovers (PGC) this quarter. We featured the Rhb grass and Kentucky bluegrass plots and associated research results at

the Northeast Iowa Farm Field Day. Additionally, we engaged with a group of visiting agriculturalists from Brazil, who expressed strong interest in expanding cover crop acreage in their systems.

Our efforts were recognized by *Iowa State University Ag and Natural Resources*, which presented our team with an *Innovation in Programming Award* for the *Experience Extension* initiative. Through this program, we trained graduate students in extension principles and involved them directly in programming, including our PGC webinar series (See the RegenPGC YouTube Video Channel at https://www.youtube.com/@RegenPGC.

2. Explanation of Variance

None noted.

3. Plans for Next Quarter

Looking ahead, we have begun initial planning for another PGC-focused webinar series this fall, designed to broadly share recent discoveries on how to make the system more productive.

4. Publications, Presentations, Stakeholder Engagement, Submitted Proposals

None this quarter.

Photo 2. RegenPGC Co-Project Director Dr. Dan Andersen addresses a Field Day crowd.

THEME 3. EDUCATION

The cross-cutting Education Theme coordinates educational efforts impacting students from pre-college to undergraduate and graduate students at multiple institutions. The aim of each of the educational programs is tuned to the audience. The Educational Theme Coordinator and the project Objective Leaders will ensure that these programs are not siloed and provide rich cross-disciplinary training and engagement opportunities for undergraduate and graduate students to meet the workforce education and training requirements to adopt PGC production systems successfully.

Ken Moore (ISU) leads this theme, and **Maureen Griffin** (ISU, focused on REU and RET), **Dennis Miller** (independent contractor, focused on FFA), and **Maya Hayslett** (ISU, focused on 4H) serve as collaborators.

Education Theme Progress

1. **Instructional Development (Moore)**

   Development of instructional materials related to the science and practice behind PGC systems for use at all levels of instruction.

   A. Planned Activities

   Development of instructional materials will continue. Modules will be shared in the project's Teams directory as they are finalized.

   B. Actual Accomplishments

   Maya Haslett developed instructional materials for 4H education programs, which are being posted to the shared project's Teams directory.

   C. Explanation of Variance

   No variance was noted.

   D. Plans for Next Quarter

   Development of instructional materials will continue. Modules will be shared in the Teams directory as they are finalized.

2. **Undergraduate REU Program (Griffin)**

   A. Planned Activities

Five Research Experience for Undergraduates (REU) candidates have been accepted into the summer 2025 research experience. The interns will begin their research projects on June 9, 2025, and their on-campus experience will end on August 1, 2025 (See Exhibit A for Program Calendar).

This year, our undergraduates come from four different colleges and universities, and all participants plan a future in science education. Their research projects collectively focus on improving sustainable agriculture through field experiments, soil science, sensor-based data collection, and educational outreach. Some key activities involved are as follows:

- **Perennial Groundcover (PGC) System Optimization**
    - Multiple studies will explore PGC systems, where maize is intercropped with perennial grasses to reduce nutrient leaching, soil erosion, and environmental impact.
    - Experiments include testing species-specific responses to chemical suppression and the role of shade avoidance response (SAR) on yield drag using live and artificial turf setups.
- **Soil Moisture and Water Loss Monitoring**
    - Field columns with sensors will be used to assess evapotranspiration under various groundcovers (grass, rye, bare soil) and tillage practices.
    - REU and Research Experience for Teachers (RET) participants will install and maintain sensors, collect data, and manage the field site, gaining hands-on experience in soil science and sustainable farming.
- **Soil Chemistry and Microbiology Analysis**
    - Using chemical assays and lab instrumentation, PGC soil samples will be sieved and processed to determine water retention metrics (GSWC, MWHC) and analyzed for carbon and nitrogen content (SEOC, SEON, MBC, MBN).

B. Actual Accomplishments

We have prepared a dedicated web page on the project website, which provides a brief bio for each participant and access to their research poster.
https://www.regenpgc.org/theme-3-education/2023-ret-reu-programs-copy/

This summer, we hosted five REU participants from three universities across the Midwest who were involved in four different research labs across the RegenPGC project.

We involved six mentors who rated their overall mentoring experience a 4.66/5.00 on a scale of 1-5, with 5 being the highest rating. One mentor summarized the most enjoyable part of his summer: "*What I enjoyed most this summer was the time we spent together in the field collecting data. Those long hours side-by-side gave us the chance to work as a true team—solving problems, sharing ideas, and even laughing through the tougher moments. Being out there together allowed mentees to experience the reality of research in action, while also giving us time to connect on a personal level. It was rewarding to watch their skills and confidence grow day by day, and to feel that we were all learning from each other."*

The participant feedback was equally positive. One mentee stated, "*My mentor was amazing! He had great humor, and when it came to teaching me anything, he took his time and explained it to the level I could understand. My mentor also acted human and shared many relatable stories in academia. He also made sure I ate, and was hydrated during long work days, keeping me in the loop and giving me and chance to make amazing friends during the process. I hope he continues to do the mentor program —he inspired me in so many ways, he comes to work with a positive attitude, and is able to communicate when the day isn't so good. He has a special place in my journey to my career and life as a whole."* And another commented, "*My mentor experience was superb. I was filled with gratitude at the amount of time he spent in teaching me and to make sure I understand complex procedures*."

When REU participants were asked how effective their mentor was during their summer experience, the response was 4.83/5 on a scale of 1 to 5, with 5 being the highest rating.

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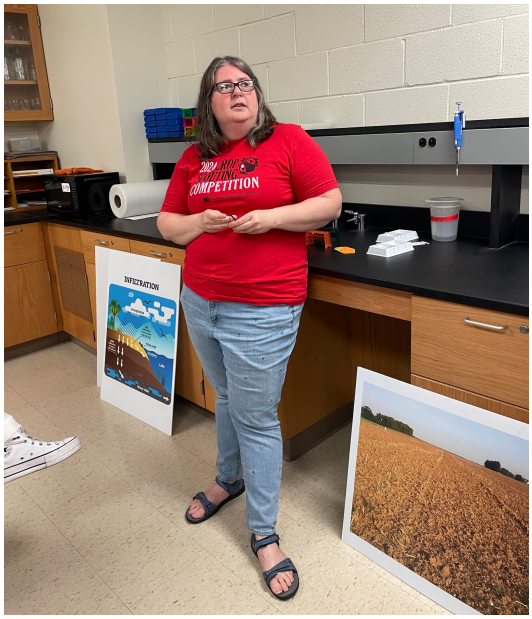

Photo 3. RegenPGC Collaborator Maya Hayslett instructs RegenPGC interns (REUs) and teachers (RETs)

Table 1. 2025 Research Experience for Undergraduates (REU) Cohort

REUs	Mentors	Research Project /Reflections
Kylie Bucholz Wartburg College	Dr. Shuizhang Fei, Patrick Galland & Cameron Krumm	• **The Effect Of PGC Species And Suppression Method On Maize Growth And Development** https://www.regenpgc.org/wp-content/uploads/2025/08/KBuchholz_2025.pdf • **Reflections** https://www.regenpgc.org/wp-content/uploads/2025/08/2025-Relections-BUCKOLZ.pdf
Alex Haus Wartburg College	Dr. Ken Moore, Patrick Galland, & Rickiel Rodrigues Franklin da Silva	**How Perennial Groundcover Affects Maize Growth: Exploring Shade Avoidance Responses** https://www.regenpgc.org/wp-content/uploads/2025/08/AHaus_2025.pdf • **Reflections** https://www.regenpgc.org/wp-content/uploads/2025/08/2025-Relections-HAUS.pdf
Apple Khalil Iowa State University	Dr. Marshall McDaniel & Modestos Modestou	• **The "S" in Sustainability Should Stand for Soil!** https://www.regenpgc.org/wp-content/uploads/2025/08/AKahlil_2025.pdf • **Reflections**

		https://www.regenpgc.org/wp-content/uploads/2025/08/2025-Relections-KAHIL.pdf
Jessica Staedtler South Dakota State University	Dr. Ken Moore, Patrick Galland, Cameron Krumm & Amina Moro	• **How Far is Far Enough for Optimal Corn Growth In PGC Systems?** https://www.regenpgc.org/wp-content/uploads/2025/08/JStaedtler_2025.pdf • **Reflections** https://www.regenpgc.org/wp-content/uploads/2025/08/2025-Relections-STAEDTLER.pdf
Audrey Tucker Wartburg College	Dr. Dan Andersen, Dr. Raj Raman & Philip Rockson	• **Assessing Corn Growth Response to Seed Placement in an RhB PGC System** https://www.regenpgc.org/wp-content/uploads/2025/08/ATucker_2025.pdf • **Reflections** https://www.regenpgc.org/wp-content/uploads/2025/08/2025-Relections-TUCKER.pdf

C. Explanation of Variance

No variance occurred.

D. Plans for Next Quarter

We have one REU participant who will be student teaching in the fall, and she has expressed a desire to meet every other week to support her transition to teaching. Also, she will collaborate with one of the RETs from this project (also a math teacher) to incorporate their research topics into her math teaching this fall.

She has also received a $500.00 mini-grant to support her in setting up her classroom and purchasing materials to support the ideas she learned from the summer professional learning. We will also facilitate this REU in staying connected to her mentor, as they both expressed in their feedback.

We will host several gatherings monthly and throughout the winter to keep the cohort connected. These sessions will be held virtually after the school day ends, allowing everyone to reconnect and continue sharing and learning.

3. Undergraduate Internship Program (Moore)

We planned on developing an undergraduate internship program focused on students at institutions engaged in the project. We have discontinued the project due to insufficient interest by undergraduate students working in the labs of the project CoPDs.

Research Experience for Teachers (RET) (Griffin)

A. Planned Activities

Two RET candidates (from VA and IA) will join the Regen project this summer as part of a larger cohort of 24 total participants on campus doing research. The research begins on June 18, 2025, and ends on August 1, 2025. In addition to the individual research projects, we have many activities planned to engage the cohort throughout the summer.

- **Early-Stage Stomatal Phenotyping in Maize**
  This study collects stomata samples from maize at different growth stages (V2 to R1) in field and growth chamber settings to assess whether early-stage traits can predict later development. If successful, it could streamline large-scale maize breeding. Participants will also collect data on plant height, growth stage, soil moisture, SPAD, and more, with optional lab and data analysis experience.

- **Nitrogen Fate in Perennial Groundcover Corn Systems**
  This project uses 15N stable isotope labeling to track nitrogen use in corn grown with perennial groundcover. The goal is to improve nutrient efficiency and sustainability. Participants will collect field data and gain experience with nutrient management strategies and the scientific research process.

B. Actual Accomplishments

We have prepared a dedicated web page on the project website, which provides a brief bio for each participant and access to their research poster.
https://www.regenpgc.org/theme-3-education/2023-ret-reu-programs-copy/

This summer, we hosted three high school teachers and one elementary teacher. They teach subjects ranging from 3rd-grade math and science to AP Statistics and AP Environmental Science. All three teachers were brand new to the RET program and ranked their overall satisfaction with the highest possible rating, 5/5. Two of the three labs were new to hosting as RET, and not unexpectedly, the mentors ranked their overall experience as a mentor a 4.33/5, noting that, "*I enjoyed guiding someone who was not confident in their research and lab skills through the scientific process and watching them grow their confidence and understanding in their research." Additionally, "Seeing my mentee grow in confidence and skill was the most enjoyable part. Watching them go from uncertainty to independently analyzing satellite data was incredibly rewarding. The mutual learning made the experience even better."*

When mentors were asked what the most valuable takeaway from the summer experience was, overall the comments echoed what this mentor said, "*My most valuable takeaway is the importance of making research accessible and relevant. Seeing how real-world data*

can inspire curiosity and learning at the K–12 level reminded me that impactful science isn't just about discovery—it's also about how well we communicate and connect it to everyday life."

Table 2. 2025 Research Experience for Teachers (RET) Cohort		
RETs	**Mentors**	**Research Project /Reflections**
Jessica Garland Crocker Elementary, Ankeny, IA	Dr. Richard Roth & Alioune Diopp	• **Investigating Sulfur Use Efficiency in Perennial Ground Cover Corn Cropping Systems** https://www.regenpgc.org/wp-content/uploads/2025/08/JGarland_2025.pdf • **Reflections** https://www.regenpgc.org/wp-content/uploads/2025/08/2025-Relections-GARLAND.pdf
Denise Rogers Huguenot High School (VA)	Dr. Thomas Lüberstedt & Memis Bilgici	**Stomatal Traits in Maize (Zea Mays L.): Can we Predict From First Leaf to Ear Leaf Across Yield-Contrasting Hybrids in Perennial Ground Cover Crops?** https://www.regenpgc.org/wp-content/uploads/2025/08/DRogers_2025.pdf • **Reflections** https://www.regenpgc.org/wp-content/uploads/2025/08/2025-Relections-ROGERS.pdf
Elisa "Ellie" Soosloff Creston High School, Creston, IA	Dr. Amy Kaleita & Mayok Soetan	• **Beyond the Green: Decoding Iowa's 2020 NDVI Spike and its Environmental Drivers** https://www.regenpgc.org/wp-content/uploads/2025/08/ESoosloff_2025.pdf • **Reflections** https://www.regenpgc.org/wp-content/uploads/2025/08/2025-Reflections-Soosloof.pdf

C. Explanation of Variance

We completed all planned activities.

D. Plans for Next Quarter

We will send teachers monthly activities to use in their classroom, modeled during the summer professional development time. All teachers received a $500.00 mini-grant to purchase equipment and materials to sustain the summer learning in their classrooms.

Teachers will also continue to meet with the entire cohort throughout the academic year on the Second Tuesday of each Month (SToM) for learning and reconnection. They will meet every other week, virtually, with collaborator Maureen Griffin to support their work more closely in the classroom. All mentors were requested to stay in touch with their teachers, and Griffin will also facilitate these efforts.

4. Graduate Student Community (Moore)

A. Planned Activities

The Graduate Student Community will not meet weekly for a seminar until the fall semester begins. Students and postdoctoral researchers will work on research projects during the summer months. We will meet as a group for at least one scheduled social event during the summer. Special professional development workshops and other activities will be organized on an ad hoc basis.

B. Actual Accomplishments

The graduate student community was on hiatus for the summer semester as students focused on carrying out their field research projects.

C. Explanation of Variance

None noted.

D. Plans for Next Quarter

The graduate student community will resume weekly meetings in the fall semester. Students will participate in the RegenPGC Café and attend professional development workshops.

5. FFA and 4H Programs (Hayslett, Miller)

Youth outreach events for the next quarter are the Cherokee 6th-grade field day on May 9, the Shelby County 6th-grade field day on May 13th, and the Washington County Junior Camp on June 11. Four lesson plans will be published and available through the ISUEO Extension Store by the end of next quarter. Planning to promote the lesson will take place next quarter. Next quarter, planning for an outreach event at the Iowa State Fair on August 9 will also be done.

A. FFA and 4H Program Planned Activities (Hayslett)

Youth outreach events for the next quarter are the Cherokee 6th-grade field day on May 9, the Shelby County 6th-grade Field Day on May 13th, and the Washington County Junior Camp on June 11. Four lesson plans will be published and available through the ISUEO

Extension Store by the end of next quarter. Planning to promote the lesson will take place next quarter. Next quarter, planning for an outreach event at the Iowa State Fair on August 9 will also be done.

B. FFA and 4H Program Actual Accomplishments (Hayslett)

Youth outreach events in the fourth quarter were successfully completed. 156 youth participated in activities at the Cherokee 6th grade field day on May 9, 170 youth participated in activities at the Shelby County 6th grade field day on May 13th, and 60 youth in grades 4-6 participated in activities at the Washington County Junior Camp on June 11. A presentation and demonstration for 20 RET participants on the youth lesson plans was given on July 17. This brings the total 4-H youth program reach to 2236 contacts (youth and educators combined). Progress continued on lesson plan publication and planning events for the next quarter.

C. FFA and 4H Program Explanation of Variance

A presentation for RET teachers was added. Due to fewer staff available to work on publications at Iowa 4-H, publication and promotion are pushed back to the next quarter.

D. 4H Program Plans for Next Quarter

Youth outreach events for the next quarter are RegenPGC Day on August 9 at the 4-H Building during the Iowa State Fair, O'Brien County Precision Ag Day on September 3, Chickasaw County Precision Ag Day on September 9, and Career Inspire on September 25 and 26. Four lesson plans will be published and available through the ISUEO Extension Store by the end of next quarter. Planning to promote these lessons will take place next quarter. (Miller) The FFA subtask program has been completed.

6. Publications, Presentations, Stakeholder Engagement, and Proposals Submitted

- **Presentations**
  - **Research Experience for Undergraduates**
    - Bucholz, Kylie. (2025, August 1). *The effect of PGC species and suppression method on maize growth and development* [Poster presentation]. Iowa State University Research Experience for Teachers and Undergraduates Virtual Celebration of Summer Learning, Ames, Iowa, United States https://www.regenpgc.org/wp-content/uploads/2025/08/KBuchholz_2025.pdf.
    - Garland, Jessica. (2025, August 1). *Investigating Sulfur Use Efficiency in Perennial Ground Cover Corn Cropping Systems* [Poster presentation]. Iowa State University Research Experience for Teachers and Undergraduates Virtual

Celebration of Summer Learning, Ames, Iowa, United States. https://www.regenpgc.org/wp-content/uploads/2025/08/JGarland_2025.pdf.

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- **Press**

- Iowa youth get their hands dirty learning about the benefits of perennial groundcover. (2025, August 3). *Morning Ag Clips*. https://www.morningagclips.com/iowa-youth-get-their-hands-dirty-learning-about-the-benefits-of-perennial-groundcover/.
- Clayworth**,** Jason & Ta, Linh. (2025, July 31). Summer research program for teachers brings ISU science to K-12 classrooms. *Axios*. https://www.axios.com/newsletters/axios-des-moines-83b50753-0ce3-4244-9e1a-eaa737552ed9.html?utm_source=newsletter&utm_medium=email&utm_campaign=newsletter_axioslocal_desmoines&stream=top.

THEME 4. COMMERCIALIZATION

Our goals are to:

- Work with Project Director Raj Raman and Deputy Director Anne Kinzel to engage stakeholders by establishing a Stakeholder Advisory Board (SAB) and a Farmer/Landowner Advisory Group (FLAG).
- Establish on-farm trials and conduct field days with producers to gain input and advice on how to make PGC approaches more practical, reliable, and profitable.
- Engage the ag sector commercial entities in research partnerships and further identification of investment and development opportunities.

Sara Lira (Corteva Agrisciences) leads this theme.

1. **Planned Activities**
   - Monitor herbicide trial deployments and collect data.
   - Summarize all 2021-2024 data.
   - Visit all OFT cooperators post-planting.
   - Collect biomass and crop stage data from on-farm trials.
2. **Actual Accomplishments**
   - The herbicide trials were well-managed, and biomass and crop stage data were collected weekly.
   - We summarized the small plot data for 2021-2024.

- We visited all on-farm trial cooperators.
- We collected biomass and crop stage data from the on-farm trials.

3. **Explanation of Variance**

   On farm-trial data was not summarized, but we got a start. The data was stored in multiple places, and we need to chat with our farmer-facing team members to give the data proper context.

4. **Plans for Next Quarter**

- Collect final data from the herbicide trial and analyze it to amend the 2026 protocol.
- Complete a summary of all data for 2021-2024.
- Prepare a final analysis of the hybrid/variety trial small plot data.

OBJECTIVE 1. CROP ECOLOGY & MANAGEMENT

This Objective focuses on developing and testing best management practices for cash crop establishment in PGC systems and managing the transition from current practices. Objective 1 will improve PGC economics by tuning and integrating groundcover and cash crop management, thereby reducing risk. The primary goal is to elucidate key mechanisms related to a) cash crop and PGC interference, b) early cash crop growth and development in PGC systems, and c) pest dynamics.

Erin Haramoto (University of Kentucky) and Scott Flynn (Corteva Agrisciences) lead this Objective. Collaborators are **Lucas Borras** (Corteva Agrisciences), **Susana Goggi** (ISU), **Ken Moore** (ISU), and **José Rotundo** (Corteva Agrisciences).

1. **Planned Activities**

   A. **Kentucky**

- **Field Trials**
  - Sample grass and weed biomass in graduate student Kiera Searcy's two experiments
  - Sample grass and weed biomass in all extra experiments and bulk-planted areas
  - Strip tillage in all PGC trials

- Corn planting in all PGC trials
- Apply herbicides in all PGC trials. Two trials receive different herbicide treatments, while others receive the same application across the entire field.
- Complete second suppression if needed
- Side dress with 50 lbs N/acre
- **Early Season Data Collection**. Repeat grass and weed biomass, corn seedling root and shoot biomass, plant height, internode length, insect herbivory, and stand counts.

- **Graduate Student Progress**
  - Graduate student Kiera Searcy will complete data analysis using Year 1 data and begin analyzing data from Year 2. She will complete drafts of her literature review, materials, and methods.
  - Graduate student Hallie Sandeen will analyze Year 2 data. She will complete the final version of her literature review, materials, and methods.

B. Iowa

- Fertilization and final tillage will be performed on the field experiments.
- Planting will take place, and herbicides and suppression agents will be applied where appropriate and with appropriate equipment.
- Plant measurements will be performed, and cover information photos will be taken for post-season analysis.
- Plots will be monitored for weeds, insects, or other factors needing corrective measures.

2. Actual accomplishments

A. Kentucky

- **Field Trials**
  - Grass and weed biomass were sampled in all experiments (May 2025).
  - All trials were strip-tilled, grass was suppressed with glufosinate, and corn was planted.

- Pre-plant herbicides were applied as appropriate to all trials, and post-emergence applied to Kiera Searcy's trial and others as needed.
- A second suppression was applied in all trials.
- Corn was side-dressed with nitrogen.
- **Early Season Data Collection**. Data was collected for grass biomass prior to sidedress, corn stand, seedling root and shoot biomass, plant height, and internode length.
- The graduate students also continued with regular photos for grass groundcover and percent suppression data.

- **Graduate Student Progress**
  - Graduate student Kiera Searcy progressed with data analysis for Years 1 and 2, writing materials and methods for the main trial.
  - Graduate student Hallie Sandeen completed the analysis of all data collected thus far, completed the draft of her literature review, and completed her materials and methods sections.

B. Iowa

- Fertilized and performed final tillage on field experiments.
- Planted plots with corn and applied applicable herbicides and suppression agents with relevant broadcast and hooded band sprayers.
- Plant measurements and soil sampling were performed, and cover information photos were taken for post-season analysis.
- Plots were monitored for weeds, insects, or other factors needing corrective measures. No corrective measures were needed.
- Iowa State University master's student Jack Moran completed his research and received his degree in August See Exhibit C).

3. Explanation of Variance

A. Kentucky

- Heavy rain and windstorms led to some corn lodging, which may influence the number of usable photos for groundcover.

- Volunteer wheat pressure in all field trials may have reduced grass survival.
- No insect herbivory was noted in the field, so this dataset was not collected.

B. Iowa

Unusually frequent rains resulting in above-average precipitation occurred throughout the period, as did above-average temperatures. However, all planned activities took place, but the results will show a drastic contrast compared to the previous year.

4. Plans for Next Quarter

A. Kentucky

- **Field Trials**
  - **Final Data Collection**. Final stand count, number of plants with barren ears, and yield collected in all trials. Yield components (kernel weight, tip fill, # kernel rows per ear) collected from key trials (Kiera PGC herbicide and Hallie species trial).
  - Maintain Kentucky bluegrass to use in subsequent experiments
- **Student Progress**
  - Graduate students will continue writing their theses and preparing manuscripts.
  - Set defense dates for November or December 2025
- **Year 4 Annual Meeting**

  All personnel will attend the annual RegenPGC project meeting in October in Johnston, Iowa.

B. Iowa

- Hand and machine harvesting will take place as crops mature.
- Final groundcover data will be taken before and after harvest.
- Several experiments will conclude after harvest, and plot areas will be abandoned.
- Post-harvest management of corn residue will take place in experiments that will go forward into 2026.
- All faculty, staff, and graduate students will attend the annual RegenPGC project meeting at the Corteva location in Johnston, Iowa, in October.

5. Publications, Presentations, Stakeholder Engagement, Submitted Proposals

- **Academic Publications**
  - Moran, Jack, Goggi, A. Susana, Moore, Ken J., Fei, Shui-zhang, & Gruss, Shelby. (2025). Improving groundcover establishment through seed rate, seed ratio, and hydrophilic seed coating. *Agronomy*, 15(8), 1927. https://doi.org/10.3390/agronomy15081927. Open Access.
- **Press**
  - Seed World U.S. (2025, August 5). *Is it Time to Reimagine Cover Crops?* https://www.seedworld.com/us/2025/08/05/is-it-time-to-reimagine-cover-crops/.
  - Iowa State University Seed Science Center. (2025, May 27). *From Ireland to Iowa: Jack Moran explores perennial ground covers in corn systems*. https://www.seeds.iastate.edu/news/ireland-iowa-jack-moran-explores-perennial-ground-covers-corn-systems.

Photo 4. RegenPGC graduate student Jack Moran (Crop Ecology & Management) was featured in an Iowa State University Seed Science Center Spring 2025 publication (Courtesy Iowa Seed Center).

OBJECTIVE 2. PLANT BREEDING & GENETICS

This Objective focuses on PGC cropping system optimization by screening for superior groundcovers and maize hybrids that minimize competition as each occupies its own temporal or spatial niche. This can enhance PGC's economic viability through yield improvement and reduced management requirements while increasing ecosystem impacts via reduced chemical inputs. Our work will also enable the design of novel breeding strategies and the development of dedicated breeding programs for PGC hybrids and varieties.

Shuizhang Fei (ISU) and **Thomas Lübberstedt** (ISU) lead this Objective, and **Brandon Schlautman** (TLI) and **Sara Lira** (Corteva Agriscience) serve as collaborators. Yu Ru Chen serves as a PostDoc Scholar, and current graduate students are Memis Bilgici (Lübberstedt Group), Prathyusha Cheguri (Fei Group), Cameron Krumm (Fei Group), and Vipul Kumar (Fei Group).

Shuizhang Fei Group

1. Current Projects

A. Evaluation of PGC Species and Chemical Suppression Method on Maize Growth and Development

A study is currently being conducted to evaluate eight PGC species to determine compatibility for maize production. The PGC species include Kentucky bluegrass (Milagro), Radix Hybrid bulbosa (PB343), two Sandberg bluegrasses (High Plains and Vale), two tall fescues (FNKY and Chisolm), Hard fescue (Tenacity), and Creeping red fescue (Boreal). The PGCs are being evaluated for percentage of ground coverage, greenness, soil moisture content, biomass, and their effects on reflective light quality, which can trigger shade avoidance response. The subsequent maize is being evaluated for plant height, leaf chlorophyll content, stem diameter, and grain yield. Once the grain yield data become available, a comprehensive analysis will be conducted.

B. Genome Sequencing of *Poa bulbosa* and *P. secunda*

A tetraploid *Poa bulbosa* accession, PI 233826, has been fully sequenced, and its genome was assembled in collaboration with Corteva. Genome annotation is currently in progress.

Meanwhile, the genome of *Poa secunda* (cv 'High Plains'), another major PGC candidate species, has been sequenced and its genome assembled in collaboration with Corteva. The genome size is 9.01 Gb. With 84 well-phased chromosomes, it is believed to be a dodecaploid, consisting of 3 subgenomes, each has four haplotypes and a basic chromosome number of 7.

C. RNA-seq to Identify Candidate Genes for Summer Dormancy in *P. bulbosa*

Leaf and basal bulb samples of *Poa bulbosa* were collected across various time points under summer dormancy-inducing conditions and during dormancy breakage. RNA isolation has been completed, and all samples have been submitted to Novogene for sequencing, which is currently in progress.

D. Genome-Wide Association Studies (GWAS) in *Poa bulbosa* and *P. secunda*

All 90 genotypes of *Poa bulbosa* in the first set have been successfully established and are currently under dormancy induction, with phenotypic data collection in progress. Flow cytometry analysis for ploidy determination has also been completed for these genotypes. The second set of 60 accessions has also been germinated and is being advanced under the same conditions in parallel.

The GWAS panel of 180 *Poa secunda* accessions was successfully re-established this year in a spaced-plant field trial, following the low survival rates and failed direct seeding attempt from last year.

E. Characterization of *Poa bulbosa* Genotypes Collected from the US West

Fifty-three new *Poa bulbosa* genotypes collected from western states (OR, WA, ID, UT, and MT) were evaluated under controlled photothermal conditions (24°C, 16-hour photoperiod) for reproductive and summer dormancy traits relevant to perennial groundcover. The experiment has been completed, and data analysis is currently in progress.

F. Evaluation of Genetic Variation for Summer Vegetative, Bulbil, and Basal Bulb Dormancy in *Poa bulbosa*

Fifty field-grown USDA accessions have been successfully phenotyped for summer vegetative dormancy and related traits (flowering time, plant height, tiller traits, greenness, and shattering) under a randomized block design. Weekly bulbil collections are in their final weeks, and germination assays under control and AOSA treatments are underway to characterize dormancy phases (pre-, true-, and post-dormancy). Basal bulb size data have been collected, and final germination tests are in progress to assess dormancy status.

2. Plans for Next Quarter

- Once RNA-seq data are received, transcriptome analysis will begin immediately to identify candidate genes associated with dormancy. Genome annotation efforts will be advanced for the *Poa bulbosa* reference genomes (both the hexaploid and tetraploid

accessions). In parallel, a de novo transcriptome assembly will be initiated to complement reference-based approaches.

- Evaluate the freezing tolerance of three *Poa secunda* cultivars ('High Plains', 'Vale', and 'Hanford') by measuring ion leakage and conducting a regrowth test.
- Ploidy level determination for the 180 *Poa secunda* accessions and perform RNAseq to identify candidate genes for summer dormancy in *P. secunda* (cv. High Plains).
- Determine reproductive mode in a group of 20 geographically diverse accessions (50 seeds each) using flow cytometry, and identify sexual vs. apomictic accessions, with highly sexual accessions prioritized to facilitate crossing and breeding efforts.

3. Publications, Presentations, Stakeholder Engagement, Submitted Proposals

CoPD Fei is a collaborator on an EU grant proposal led by José Luis Blanco Pastor at the Universidad de Cádiz, Spain, titled *"Summer-Dormant Grasses and Their Use as Grapevine Cover Crops in Dry Climates."* The project was recently selected for funding (€200,000) with a project period from September 1, 2025, to August 31, 2027.

Lübberstedt Group

1. Actual Accomplishments

- Memiş Bilgici presented a poster, *"Do We Need Dedicated Maize Varieties for Perennial Groundcover Systems?"* and received a travel grant from GDM Seed Company (https://iowasoybeancenter.iastate.edu/news/2025/gdm-announces-travel-grant-winner-napb-meeting) and the Seed Science Center at Iowa State University to attend with Dr. Thomas Lübberstedt and present his research at the National Association of Plant Breeders Meeting in Hawai'i, held May 19–23, 2025. Authors: Memiş Bilgici, Yu-Ru Chen, Thomas Lübberstedt. (See more info https://napbannualmeeting.org/wp-content/uploads/2025/07/NAPB_2025_Booklet_Digital_VF2.pdf)
- We demonstrated that the ranking of maize grain yield and plant height changed. To develop maize suitable for PGC systems, breeders should prioritize selecting genotypes/hybrids based on performance in PGC environments rather than conventional sites, with a focus on grain yield. In this situation, there would be a need to breed specifically for at least KBG systems, as performance in conventional environments may not reliably predict performance in "green PGC". However, summer dormant and summer "brown" PGC, like Poa bulbosa (or herbicide-treated KBG), appeared more

promising, and more like conventional experiments, and may not require dedicated breeding efforts.

- We hosted a *Research Experience for Teachers* participant, Denise Rogers from Richmond City Public Schools in Richmond, Virginia, in Dr. Lübberstedt's lab. Thomas Lübberstedt and Memiş Bilgici mentored Ms. Rogersi. Ms. Rogers presented her research poster *Stomatal Traits in Maize (Zea mays L.): Can We Predict from First Leaf to Ear Leaf Across Yield-Contrasting Hybrids in Perennial Ground Cover Crops?* At the conclusion of her summer intership. The poster is available at https://www.regenpgc.org/wp-content/uploads/2025/08/DRogers_2025.pdf. Her research is described in the following abstract.

  Rogers, Denise. (2025, August 1). *Stomatal Traits In Maize (Zea Mays L.): Can we Predict From First Leaf to Ear Leaf Across Yield- Contrasting Hybrids in Perennial Ground Cover Crops?* [Poster presentation]. Iowa State University Research Experience for Teachers and Undergraduates Virtual Celebration of Summer Learning, Ames, Iowa, United States. https://www.regenpgc.org/wp-content/uploads/2025/08/DRogers_2025.pdf.

  Abstract: We measured stomatal area, density, length, and width on both the first and ear leaves of maize. Significant differences were observed between the first leaf and the ear leaf. However, first-leaf measurements reliably mirrored ear-leaf traits. Close correlations were found for stomatal area and density across leaf stages. Stomatal density (r = 0.72) was strongly correlated between first and ear leaves. Low-yield hybrids had higher stomatal density but smaller stomata, while high-yield hybrids had lower stomatal density but larger stomatal area in Kentucky Bluegrass–PGC systems. These results indicate that early-leaf measurements can be used as predictors of mature-leaf stomatal traits. (See more info, https://boec.biotech.iastate.edu/research-experience-for-teachers-ret/2025-ret-participants).

- We did experiments for studying shade avoidance response (SAR) in maize using 192 DH (Doubled Haploid) genotypes under different light conditions (low red/far-red (R/FR) ratio and white light to induce and compare SAR responses) in the growth chambers. We have analysed the experiment results, which will be used for a genome-wide association study (GWAS).

- We collected 54 TC genotypes plant traits such as plant height, leaf angle, SPAD-based traits and flowering time, among others, in Conventional and PGC sites in 2025, We evaluated BS39-derived DH testcross genotypes in *Poa bulbosa* (2nd year) and Kentucky blue grass (3rd year) PGC system in the summer of 2025 to understand phenotypic

plasticity of the traits of interest in the target population of genotypes and await harvest. These data will help to further refine hybrid selection criteria based on PGC system compatibility. We will explore genomic tools and advanced breeding strategies to accelerate hybrid development for PGC systems.

- We established a genomic selection (GS) workflow for perennial groundcover (PGC) systems. Using a BS39-derived population phenotyped under conventional and organic management as the training set, we achieved predictive abilities for grain yield exceeding 0.48 when predicting performance in both conventional and Poa bulbosa systems. In contrast, cross-system predictions for KBG environments were weak, indicating that effective GS for KBG requires phenotyping and establishment of prediction models within that system. Practically, to improve genetic gain in KBG environments, we must build a KBG–specific training set. In contrast, the existing conventional/organic yield dataset is already suitable for deploying GS to select elite hybrids for Poa bulbosa systems. These results show that GS models transfer well between conventional/organic and Poa bulbosa environments but not to KBG under our experimental conditions (i.e., mowing without herbicide treatment), likely reflecting system-specific G×E.

- Graduate student Memiş Bilgici presented a poster at the 2025 National Association of Plant Breeders Annual Meeting in Kona, Hawai'i, in May 2025. Memis received a travel award ($1,000) (https://iowasoybeancenter.iastate.edu/news/2025/gdm-announces-travel-grant-winner-napb-meeting) from Iowa State University Seed Science Center industry partner GDM (GDM Seeds, https://www.gdmseeds.com) as part of its 2025 travel grant program for ISU graduate students presenting their research at national scientific conferences in 2025. The grants help cover Memis' travel expenses while recognizing his outstanding student research contributions.

  Bilgici, Memiş, Yu-Ru Chen, & Thomas Lübberstedt. (2025, May 19–23). *Do we need dedicated maize varieties for perennial groundcover systems?* [Poster]. 2025 National Association of Plant Breeders Annual Meeting, Kona, Hawai'i, United States.

  > **Abstract**: When maize is cultivated in perennial ground cover (PGC) systems, we face challenges related to competition between cash and cover crops for light, nutrients, and water. Understanding how different maize hybrids respond to these conditions, as well as the interactions between genotypes (G), environment (E), and management (M), is critical for optimizing yield and ensuring long-term sustainability. Our experiments address the question of whether dedicated breeding of maize hybrids suitable for PGC systems is needed. We screened 69 experimental hybrids (ISU) and 2 Corteva check hybrids to explore ranking differences for grain yield under conventional versus perennial ground cover (PGC) systems. Experiments were conducted

with two perennial ground cover species (untreated (mowed), Kentucky Bluegrass (KBG), and *Poa bulbosa* (PB)) near Ames.

The ranking of our hybrids for maize grain yield and plant height was substantially different under conventional and PGC conditions. However, our trials are very limited in the number of environments and, at best, preliminary. To develop maize suitable for PGC systems, breeders should prioritize selecting genotypes/hybrids based on performance in PGC environments rather than conventional ones, focusing on grain yield. Our KBG PGC system reflects the worst-case scenario: treatments to suppress the PGC failed, and corn competes with green PGC. In this situation, there would be a need to breed specifically for at least KBG systems, as performance in conventional environments may not reliably predict performance in "green PGC." However, summer-dormant and during summer, "brown" PGC, such as *Poa bulbosa* (or treated KBG), appeared more promising and similar to conventional experiments.

2. Plans for Next Quarter

- We are preparing to submit a research paper on the stomata of maize in collaboration with Corteva Agriscience. The paper title is *Trends in stomatal density and size in maize hybrids represent 100 years of long-term breeding for yield.*

- Highlights: A negative correlation was observed among the 27 ERA hybrids between stomatal density and stomatal size, length, width, and leaf area. This indicates that as stomatal density increases, the size, length, width, and leaf area decrease. Over the past 100 years, the total stomatal pore area on leaves has decreased, while stomatal density has increased. A negative correlation was found between total stomatal pore area and atmospheric CO2 concentrations, as well as temperature, over the past century.

- Memiş Bilgici will present one talk and two posters at the CANVAS 2025 conference, which will take place from November 9-12, 2025, in Salt Lake City, Utah. CANVAS, formerly known as the ASA, CSSA, and SSSA International Annual Meeting, is a venue where crop, agronomic, environmental, and soil sciences unite to inspire change and promote scientific advancement.

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Photo 5. RET participant Denise Rogers, accompanied by her graduate student mentor Memis Bilgici (Breeding & Genetics), presented her poster at the end of the RET mentorship program.

OBJECTIVE 3. SOIL HEALTH & NUTRIENT MANAGEMENT

Objective 3 focuses on understanding how and quantifying the degree to which different PGC approaches impact soil health and nutrient use/loss. Because soil health drives crop productivity and environmental impacts, this knowledge is crucial to better managing PGC systems and characterizing the indirect economic benefits associated with PGC, which inform policy and deployment. **Marshall McDaniel** (Iowa State University) and **Morgan Davis** (University of Missouri) lead this Objective. Daniel Andersen (ISU) serves as a collaborator.

3. Actual Accomplishments

- **Modestos Modestou (Graduate Student)**
    - Modestou has completed the extraction and quantification of DNA from all 810 PSHARD (perennial groundcover soil health and root distribution) soil samples.
    - Modestou is currently conducting several enzyme assays with the 810 PSHARD soil samples to characterize microbial activity and nutrient availability in PGC (perennial groundcover) systems compared to the control.
- **Malcolm St Cyr (Graduate Student)**

- Successfully conducted N_2O flux measurements following N-fertilizer application, capturing the expected annual emission hotspot.
- Produced the first rough draft comparison of N_2O fluxes by year.
- Completed spring and summer soil sampling.
- Processed spring soil samples for nitrate (NO_3^-) and ammonium (NH_4^+) concentrations.

4. Explanation of Variance

No variance occurred.

5. Plans for Next Quarter

- **Iowa State University (McDaniel)**
  - Some soil analyses from intensive sampling will take place in the next 2-3 months.
  - Data analysis, visualization, and writing up results will occur over the next 6-8 months.
- Modestou plans to send one set of the DNA from the PSHARD soil samples for 16sRNA (bacterial) sequencing and another for ITS (fungal) sequencing by December 2025.
- Modestou will start processing and analyzing the data as soon as he receives the DNA sequencing results.

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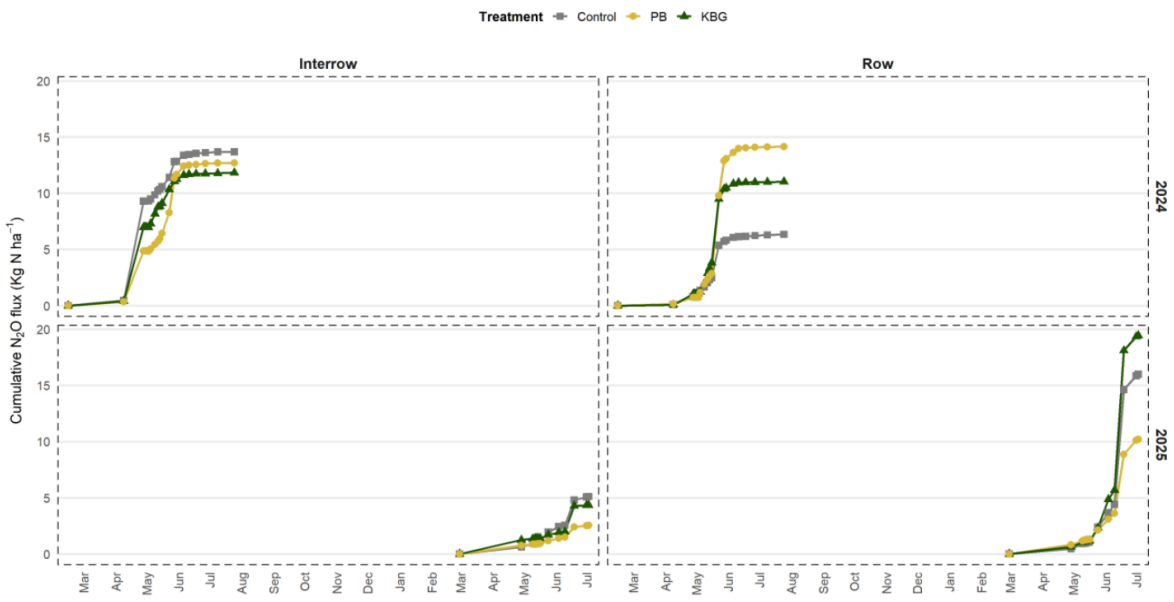

Figure 1. Sorensen Cumulative N_2O fluxes (kg N ha^{-1}) measured in 2024 and 2025.

6. Publications, Presentations, Stakeholder Engagement, Submitted Proposals/Funded Grants

- **Manuscripts in Review**
  - Galland, Patrick D., Dutter, Cole R., McDaniel, Marshall D., Moore, Ken, Thoms, A., Fei, Shuizhang. (2025). Summer-dormant, perennial groundcover has minimal effect on plant-available nutrients and no effect on maize yield. *Submitted to the Agronomy Journal*.
  - McDaniel, Marshall D., Dutter, Cole R., Eness, Max, Cecil, A., Miller, B.A., & Modestou, Modestos. (2025). Strategically Sampling Row Crops to Create 2-Dimensional Soil and Root Maps. *Submitting to Plant & Soil by 1 October 2025*.
  - Mendis, S.S., Davis, Morgan P., Ansari, J., McDaniel, Marshall D., & Flater, J. (2025). Comparing soil nitrous oxide fluxes from in field optical feedback – cavity enhanced absorption spectroscopy to laboratory gas chromatography. To be *submitted*.

OBJECTIVE 4. ECOSYSTEM SERVICES AND MODELING

This Objective focuses on quantifying the provision of ecosystem services derived from PGC implementation. We consider a wide range of ecosystem services, including improved water quality, flood and drought mitigation, protection from soil erosion, carbon sequestration, and biofuel feedstock and/or fodder provision. Quantification is crucial to incentivize farmers for ecosystem services. **Amy Kaleita-Forbes** (ISU) and **Rob Anex** (University of Wisconsin-Madison) lead this Objective. An additional participant is **Randy Clark** (Corteva Agrisciences). In the fall of 2025, the Objective team will add graduate student Ralph Danquah-Acquah (Kaleita).

Objective 4 Tasks

1. **Quantify Decreased Flood Risk and Improved Drought Resiliency Compared to Conventional Cropping Systems**

   A. Planned Activities

   - Complete writing for the paper on 'Simulated effect of PGC on erosion and runoff.'
   - Prepare Readme documents that will guide the reproducibility of runoff and erosion modeling under the Perennial Groundcover (PGC) system.

   B. Actual Accomplishments

   - Completed and submitted full dissertation.
   - Documentation of model running is complete – instructions, organized data files, etc.

   C. Explanation of Variance

   None noted.

   D. Plans for Next Quarter

   Onboard new graduate student, Ralph Danquah-Acquah.

2. **Quantify PGC Impacts on Water Quality**

   A. Planned Activities

   - In EPIC, simulate soil erosion under all identified grass combinations for the PGC system.
   - Simulate PGC for different climate regime and their corresponding effect on erosion in the EPIC model.

   B. Actual Accomplishments

In conjunction with the runoff modeling described in **Quantify Decreased Flood Risk and Improved Drought Resiliency Compared to Conventional Cropping Systems**, above, simulated additional runs of PDG under different grasses and a range of climate regimes.

C. Explanation of Variance

We did not complete the climate study thoroughly; we will leave this task for the next student.

D. Plans for Next Quarter

Onboard a new graduate student.

E. Publications, Presentations, Stakeholder Engagement, Submitted Proposals

None this quarter.

3. Quantify PGC Ecosystem Service Sustainability Indicators and Compare them with Conventional Systems (C.4.3)

A. Planned Activities

None: Funds are being de-obligated in this sub-objective. We will continue supporting the project through regular coordination and annual project meetings.

4. Quantify the Limits on PGC Maize Stover Removal

A. Planned Activities

- Continue exploring modeling opportunities using GREET. We will work with CoPd Dan Andersen (Iowa State University) to advance the use of GREET.

B. Activities & Accomplishments

- Predicting sustainable stover removal under PGC requires parameterizing the GREET model, as it does not have a perennial ground cover input. This quarter, we extracted data from the literature and limited field trials to modify GREET parameters describing: PGC carbon inputs; yield adjustments due to resource competition; and adjustments to nutrient cycling to account for immobilization in PGC biomass.

C. Plans for Next Quarter

- Support Iowa State University in developing baseline and sustainable PGC stover removal estimates through GREET model parameterization.

Photo 6. RegenPGC's first graduate student, Oluwatuyi "("Tuyi") Olowoyeye**,** celebrates receiving his doctoral degree with his mentor, RegenPGC Co-PD Dr. Amy Kaleita.

OBJECTIVE 5: SOCIOECONOMIC IMPACTS AND POLICY

This Objective evaluates the conditions under which the proposed practices are economically sustainable for farmers and input suppliers in the PGC supply chain and well-being enhancing for farmers and consumers. It integrates them by considering how PGC fits into existing policy frameworks. Functionally, the Objective synthesizes information from other Objectives and quantifies the overall value proposition for various versions of PGC. **Keri Jacobs** (University of Missouri) leads this Objective, and **Amani E. Elobeid** (ISU) and **Cynthia A. Bartel** (ISU) serve as collaborators.

Our overall team direction focuses on continuing data discussion and working toward finalizing the data, then communicating it to the Data Management Team.

1. Evaluate the Economic Feasibility of PGC Systems for Maize and Soybean Producers

A. Planned Activities

- Present on enterprise budget findings at RegenPGC field days.
- Continue cataloging the on-farm and downstream environmental benefits generated by the project to quantify and assign value to them from economic literature. This research is expected to take several quarters before submission.

B. Actual Accomplishments

- A manuscript cataloging RegenPGC's key unpriced benefits sources, which derive from production practice changes, is in development. The challenge – and delay – in this manuscript is in identifying which unpriced benefits belong in the manuscript, their interrelatedness, and valuation methods for these benefits from perennial groundcover.
- To complement the technoeconomic findings, a groundcover intensity scale is in development, where intensity is a shorthand to describe the width, color, and stand density or frequency of a PGC. A manuscript is in development to propose standard intensity measures informed by prior PGC research, discuss their use in small-plot research and larger scale on-farm-trials, and suggest steps for future work.
- Preparation of a presentation including RegenPGC for 55,000-75,000 attendees at World Dairy Expo. A farm site with a companion project to PGC trials was selected as one of the four best farms in the United States as a 2025 World Dairy Expo virtual farm tour (selection was made during this quarter). The farm tours showcase the top farms in the nation each year, based on environmental stewardship, quality genetics, technology advancements, diversification, and more.

C. Explanation of Variance

None noted.

D. Plans for Next Quarter

- Finalize and submit the unpriced benefits manuscript to an environmental or land-use economics journal.
- Prepare for the Year 4 annual meeting, which will include a presentation on work progress, future objectives, and upcoming activities.
- Finalize intensity scale manuscript for submission.
- Offer an invited presentation, including RegenPGC and perennial groundcover conservation practices, to the World Dairy Expo on September 30, 2025.

2. **Evaluate the Market and Aggregate Welfare Effects of PGC Approaches.**

   A. Planned Activities

   Start work on welfare effects based on scenario runs. This work will require the use of the IMPLAN model, which will require some time to align with the output of the agricultural modeling system.

   B. Actual Accomplishments

   - Alternative yield and cost change scenarios associated with PGC adoption in the US corn and soybeans production systems were simulated using the CARD Long Run Land Use model and the IMPLAN model to evaluate impacts on production, prices, exports, and per-capita consumption, as well as on the national economy in terms of value added, labor income, job changes, and industry output.
   - Results were presented in a poster session at the AAEA & WAEA Joint Annual Meeting 2025 in Denver, CO.
   - A manuscript documenting the impacts of PGC adoption on U.S. production, trade, and the economy is in development. A key challenge in its preparation is the limited availability and consistency of field trial data on yield and cost impacts of PGC adoption.
   - A manuscript examining the global production and trade impacts of U.S. PGC adoption is under development.

   C. Explanation of Variance

   None noted.

   D. Plans for Next Quarter

   - Finalize and submit the manuscript on U.S. production, trade, and economic impacts to the *Applied Economic Perspectives and Policy* journal.
   - Finalize and submit the manuscript on global production and trade impacts to the *Agricultural Policy Review* journal.
   - Run additional scenarios based on field trial data and cost information.

3. **Identify the Socioeconomic Barriers and Potential Facilitators to PGC Adoption**

   A. Planned Activities

Finish last R&Rs for 2 JAFSCD articles. Submit *Predictors of county-level cover crop adoption in the U.S. Corn-Soybean Belt* to the journal *Frontiers in Sustainable Food Systems.*

B. Actual Accomplishments

Finished one R&R and submitted the *Frontiers in Sustainable Food Systems* paper.

C. Plans for Next Quarter

Have accepted for publication the article: *Cover Crops, Chemicals, and Emissions in Pottawatomie County, KS*" in the *Journal of Agriculture, Food Systems, and Community Development*.

D. Explanation of Variance

Reviewers took longer than anticipated to respond.

4. Explore the Role of Input Supply Agribusinesses in the PGC Supply Chain.

A. Planned Activities

Continue exploring the roles and dynamics in ag retail investments and capabilities to inform an empirical strategy.

B. Actual Accomplishments

None to report for this quarter.

E. Plans for Next Quarter

Work with stakeholders from the RegenPGC SAB and key leadership to revisit the supply chain priorities for investments, deployments, and education.

F. Explanation of Variance

None noted.

5. Publications, Presentations, Stakeholder Engagement, Submitted Proposals

- Dahal, Sagar, Elobeid, Amani Emani., & John M. Crespi. (2025). *Integrating perennial groundcover in corn and soybean acres: Impacts on U.S. production and trade* [Poster presentation]. 2025 AAEA & WAEA Joint Annual Meeting, July 27–29, Denver, CO, United States. https://doi.org/10.22004/ag.econ.361216.

PROJECT EVALUATION

Dr. Heather Dantzker is the RegenPGC External Evaluator. PD Raman and Deputy Director Kinzel meet with Dr. Dantzker regularly to review her work and plan future evaluation activities. Our goal is to use these activities to fine-tune the performance of the RegenPGC team.

1. **Planned Activities**

   A. **RegenPGC – Overall Project Activities**

   - Participate in RegenPGC leadership calls (Co-PDs and SAB) and evaluation calls with the project director and deputy director as scheduled.
   - Ongoing monitoring/review/analysis of project progress and milestones in relation to the main project logic model.
   - Continue evaluation planning across project objectives and themes (other than the Education Theme) for the remainder of the project.

   B. **Regen PGC – Education Theme Focus**

   - Continue to meet in monthly planning meetings with Education Theme leaders.
   - Ongoing monitoring/review/analysis of Education-related progress and milestones in relation to the Education-specific logic model.
   - Continue Education Theme focused evaluation planning for the remainder of the project.

2. **Actual Accomplishments**

   A. **RegenPGC – Overall Project Activities**

   - Participated in RegenPGC All Co-PD leadership call (July 17, 2025).
   - Continued ongoing monitoring/review/analysis of project progress and milestones in relation to the main project logic model.
   - Continued evaluation planning across project objectives and themes (other than the Education Theme) for the remainder of the project.

   B. **Regen PGC – Education Theme Focus**

   - Continued to meet with Education Theme leaders as scheduled.

- Continued ongoing monitoring/review/analysis of Education Theme-related progress and milestones in relation to the Education Theme-specific logic model.
- Continued Education Theme focused evaluation planning for the remainder of the project.

3. Explanation of Variance

None noted.

4. Plans for Next Quarter

A. RegenPGC – Overall Project Activities

- Participate in RegenPGC leadership calls (Co-PD and SAB) and evaluation calls with the project director and deputy director as scheduled.
- Continue ongoing monitoring/review/analysis of project progress and milestones in relation to the main project logic model.
- Continue evaluation planning, including planned data collections, analysis, and any formative and summative reporting, through discussions with project leadership, across project objectives and themes (other than Education) for the remainder of the project (August 2025 – July 2026).
- Travel to and participation in RegenPGC Annual Meeting, Oct 1-3, 2025, Johnston, IA.

B. Regen PGC – Education Theme Focus

- Continue to meet in monthly planning meetings with Education Theme leaders, as scheduled.
- Continue ongoing monitoring/review/analysis of Education-related progress and milestones in relation to the Education-specific logic model.
- Continue Education Theme focused evaluation planning, data collection, and analysis through the remainder of the project.

5. Publications, Presentations, Stakeholder Engagement, and Proposals Submitted

None this quarter.

Exhibit A
Summer Lab Calendar
June 2025

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
25	26	27	28	29	30	31
1	2	3	4	5	6	7 **REU – apartments available to move in.**
8	9 **REU Begins (PD)** *1330 ATRB* *9:00 am start*	10 **REU (PD)** *1330 ATRB* *9:00 am start* *12pm Lunch with mentors* *Afternoon in labs*	11 **REU in labs**	12 **REU in labs**	13 **REU in labs**	14 **RET – apartments available to move in.**
15	16 **REU in labs**	17 **REU in labs**	18 **RET Begins (PD)** **REU PD** *1330 ATRB* *8:30 arrival time,* *9:00 am start time*	19 **RET PD** **REU PD** *1302 ATRB* *8:30 arrival time,* *9:00 am start time*	20 **RET PD** **REU PD** *1330 ATRB* *8:30 arrival time,* *9:00 am start time* Meet n' Greet Hach Hall 11am Mentor luncheon MBB atrium 12pm	21
22	23 **RET/ REU in labs**	24 **RET/ REU in labs**	25 **RET/ REU in labs**	26 **Adventures in Science: Lynn Fuhrer Lodge, 1635 Amherst Dr, Ames** 4:00 – 5:30 pm	27 **PD Day** *1330 ATRB* *8:30 arrival time,* *9:00 am start time* Lunch w/ Raj, Jeanne, and Laura	28

Biotechnology Outreach

Summer Lab Calendar
July 2025

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
29	30 RET/ REU in labs EH & MG Lab Visits	1 RET/ REU in labs EH & MG Lab Visits	2 RET/ REU in labs EH & MG Lab Visits	3 **Holiday** 	4 **Holiday** 	5
6	7 RET/ REU in labs	8 RET/ REU in labs	9 RET/ REU in labs	10 RET/ REU in labs **Adventures in Science: Brewery, 1951 Food Sciences Bldg.** 4:00 – 5:30 pm	11 **PD Day** *1330 ATRB* *8:30 arrival time,* *9:00 am start time*	12
13	14 RET/ REU in labs EH & MG Lab Visits	15 RET/ REU in labs EH & MG Lab Visits	16 RET/ REU in labs EH & MG Lab Visits	17 RET/ REU in labs **Adventures in Science: ISU Extension 1320B MBB** 4:00 – 5:30 pm	18 **PD Day** *1330 ATRB* *8:30 arrival time,* *9:00 am start time*	19
20	21 RET/ REU in labs	22 RET/ REU in labs **Chemurgy Poster Submission Deadline 12 pm**	23 RET/ REU in labs	24 RET/ REU in labs **"Story" Deliverable Submission Deadline 12 pm** **Chemurgy Annual Meeting - UNI**	25 RET/ REU in labs **Final Day with Lab Team** **Poster Submission Deadline 12 pm**	26
27	28 **PD Day** Dog-Eared Books 9:00 – 11am 11:30 - Lunch & practice poster session w/mentors MBB Atrium	29 **Poster Session** MBB Atrium **Lunch & End-of-Summer Reception** MBB Atrium 11:30am – 2pm	30 **Travel Day**	31 **Travel Day**	1 **Learning Presentations (virtual)** *9am – 12:30pm*	32 **Virtual Focus Groups + Surveys (August 4 – 8, time TBD - Participants) (August 11 -15, time TBD – Mentors)**

Iowa Youth Get Their Hands Dirty Learning about the Benefits of Perennial Groundcover

Exhibit B

August 1, 2025, 3:53 pm | Sydney Peterson, Maya Hayslett

AMES, Iowa – From environmental science classes to Girl Scout troop meetings, over 2,000 Iowa youth have had the chance to participate in "Where the Grass Is Greener." This statewide program, from Iowa 4-H and Iowa State University Extension and Outreach's Agriculture and Natural Resources program unit, provides youth with hands-on educational experiences demonstrating the benefits of perennial groundcover.

Iowans can experience the program at the Iowa State Fair on Aug 9 at the Bruce L. Rastetter 4-H Exhibits Building.

"Where the Grass Is Greener" showcases Iowa agriculture, Iowa State science and innovative conservation practices. Activities include erosion simulations, observation of soil microbes, identification of insects and games about weed suppression. These programs have been funded by the USDA-NIFA project RegenPGC.

RegenPGC stands for Regenerating America's Working Landscapes to Enhance Natural Resources and Public Goods through Perennial Groundcover. This initiative is led by a transdisciplinary team of scientists and engineers who share a vision of making year-round groundcover on working lands the norm, rather than the exception, for Midwestern U.S. agriculture and beyond.

Central to the approach is developing and de-risking perennial groundcover systems, where a perennial cover crop is planted once and then persists for multiple years alongside annual crops such as corn and soybean. By providing year-round groundcover, perennial groundcover can deliver numerous ecosystem services, including conserving soil resources, reducing nutrient export, enhancing carbon sequestration and suppressing weeds, thereby reducing herbicide requirements. Compared to conventional cover cropping, a PGC approach has lower management requirements, which could facilitate widespread adoption of cover cropping systems critical to achieving measurable differences in large-scale environmental issues.

"Four new lesson plans were created to demonstrate the benefits of perennial groundcover," said Maya Hayslett, Integrated Pest Management and 4-H crop sciences specialist, leading the 4-H youth outreach component of the project. "Using best practices in teaching, lesson plans were developed with hands-on, experiential learning activities that allow youth to explore the different topics. We are emphasizing the potential benefits of this agricultural innovation, but also the role of science in developing solutions."

The lessons have been implemented in Iowa with youth in grades K-12. In these activities, youth learn about perennial groundcover for reducing soil erosion, increasing weed control, enhancing insect communities for improved insect pest management, and promoting soil microbial diversity for better soil health.

In post-lesson surveys, youth reported a better understanding of how different crop management practices, like perennial groundcover, affect the environment, and a better understanding of how science can help solve real-world problems.

"Today, our youth, as well as many families, are getting further removed from living on the farm themselves, so it helps having the opportunity to learn about land stewardship and understand where our fuel, our food and our fibers come from," said Kendra Crooks, 4-H youth program specialist. "As consumers on this earth, we are also land stewards, and so we are helping future generations understand the importance of caring for the soil through the use of cover crops."

"Where the Grass is Greener" lesson plans are available for any Iowa educator by contacting Maya Hayslett, hayslett@iastate.edu.

To learn more about Regen PGC, visit the Regen PGC website. A video summary of the Regen PGC youth program also is available.

Photo caption: High school youth collect and identify insects at the Southeast Research Farm in Crawfordsville as part of a discussion about perennial groundcover. Photo courtesy of Maya Hayslett.

Category: Crops, Kids and Teens-4-H, STEM

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IOWA STATE UNIVERSITY
Department of Agronomy

I'M AN AGRONOMIST
Feeding the World. Fueling the Globe.

"Improving the Establishment of Kentucky Bluegrass as a Perennial Groundcover"

Exhibit C

Jack Moran

Masters Defense Seminar

Tuesday, June 17, 2025, 10:00 – 11:00 AM

191 Seed Science Center

Join online on Teams

Jack Moran is a master's student in Dr. Susana Goggi and Dr. Ken Moore's lab at Iowa State University. He holds a B.S. in animal and crop production from University College Dublin. Jack is a part of the Regenerative Perennial Ground Cover research group where transdisciplinary team of scientists and engineers, funded by USDA-NIFA, have a shared vision of having year-round groundcover on working lands across Midwestern US agriculture and beyond. Jack's research work focuses on improving the establishment of perennial ground covers in a corn system.

Abstract: Kentucky bluegrass (KBG) is a promising perennial groundcover species for corn production due to its seasonal growth cycle, which complements corn's growth period. However, KBG's poor fall establishment limits its widespread adoption by corn farmers in the Midwest. To address this, we conducted two controlled studies to improve KBG establishment. In the first study, various seed treatments and soil amendments were tested under drought and non-drought conditions stimulated in a growth chamber. We found that germination and shoot dry weight were influenced by irrigation regime and seed treatment. The second study, carried out in the field, examined the effects of hydrophilic polymer treatment (Hydroloc™), seeding rate, and seed ratio in a perennial ryegrass/KBG mix (PRG:KBG) on groundcover establishment and grass canopy development over the first year of growing. It was found that optimizing seed ratio and seed rate, along with the use of Hydroloc™-treated seed, can improve KBG field establishment. Together, these studies provide practical insights for enhancing the success of perennial groundcover systems in corn production.

REGENPGC

The long-term goal of this project is to develop and de-risk a transformative method for increasing groundcover on working landscapes, thereby realizing urgently-needed environmental benefits.

Our vision is to develop a perennial cover-cropping system that requires less labor, provides equal or more ecosystem benefits, and increases resiliency while having an overall economic profile that is equivalent to, or better than conventional row-crop practices.

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