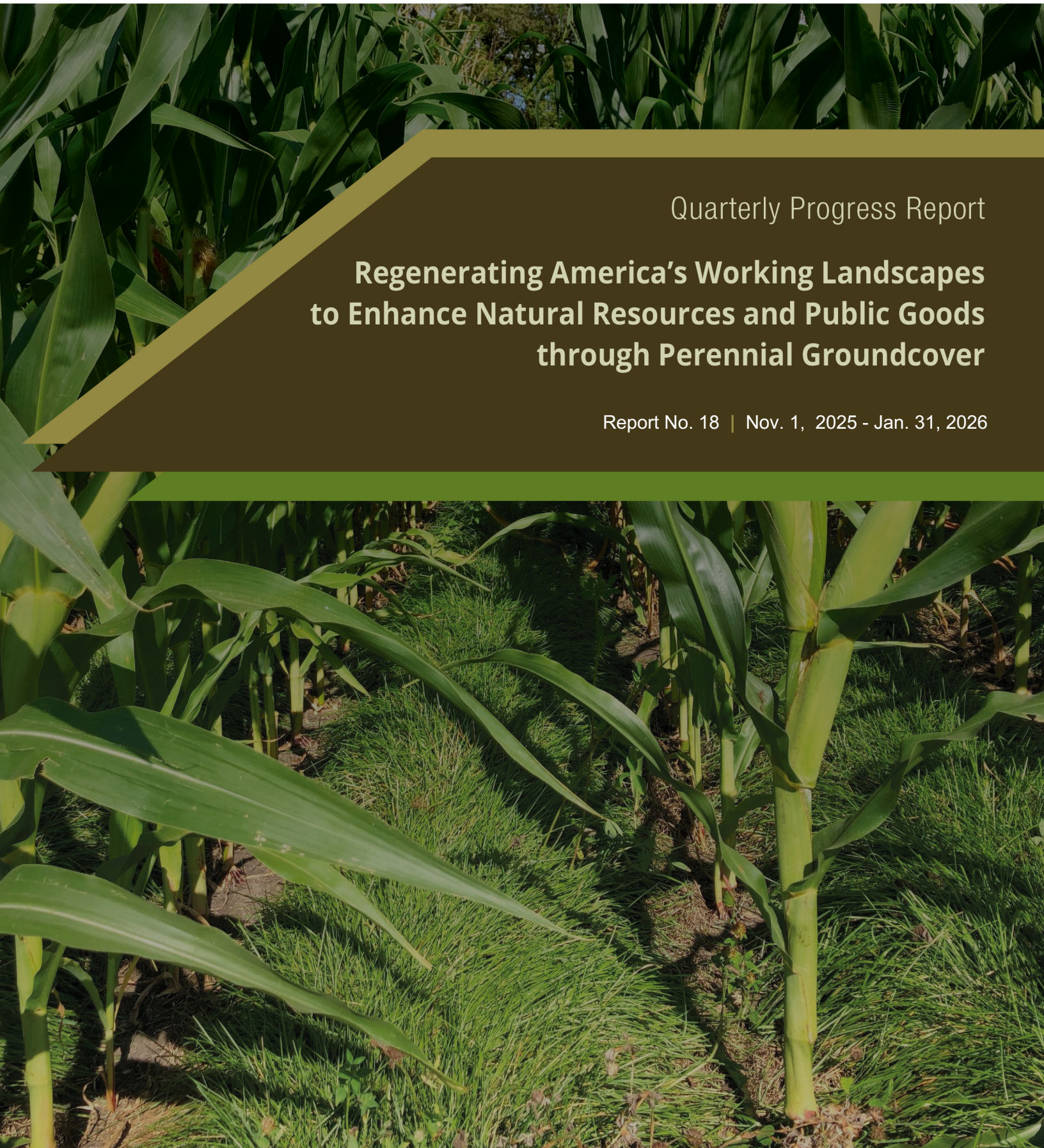
REGENPGC



Quarterly Progress Report

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

Report No. 18 | Nov. 1, 2025 - Jan. 31, 2026

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- For more information, visit the RegenPGC website at http://www.regenpgc.org/
- Previous RegenPGC Progress Reports are available at https://www.regenpgc.org/resources/reports/

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 U.S. 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 5 –2nd Quarter Project Activities

November 1, 2025 – January 31, 2026

PROJECT ADMINISTRATION AND GOVERNANCE

1. Planned Activities

Continue regular meetings with CoPds groups and ad hoc meetings with individual CoPds.

Begin conversations with team about NCE plans – solicit budgets and specific goals; communicate requirements.

2. Actual Accomplishments

A. Meetings

- **Stakeholder Advisory Board Meetings.** Met with the Stakeholder Advisory Board for SAB-11 to discuss: 1) Project Timeline, Updated FAQ, No Cost Extension (NCE), Video summary of key project findings, Zenodo status, Expanded PGC Café, and End-of-project activities and a potential CANVAS session
- **Theme Leader Meetings.** At this stage of the project, the meetings are generally one-on-one.
- **Co-PD Meetings.** The Cafés have become a CoPD meeting ground; a handful of focused e-mails went out to keep CoPDs abreast of NCE planning.
- **RegenPGC Café.** The Cafés continue to be highly attended and with significant engagement among participants, with approximately nine total meetings during this quarter. In the last month of the quarter (January), we began a new semester of meetings, and with support from the Research and Development Theme Leader and the Education Theme Leader (who co-organize), we expanded the Cafés beyond RegenPGC members-only, inviting other PGC-related investigators from around the country to attend. A handful of them have come thus far.

B. Project Leadership

- The Project Director and Deputy Director meet regularly.
- Continued to regularly meet with the data manager re: pipeline efforts and Zenodo
- Did several 1:1 meetings with CoPDs re budget plans and NCE

3. Plans for Next Quarter

- The NCE will be drafted and submitted to NIFA.
- The café program will continue.

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

None at this time

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.

1. Planned Activities

- Complete modeling and inference related to the scalability of PGC suppression practices using Liberty (glufosinate) herbicide. Results will be used to initiate preparation of a peer-reviewed manuscript and to inform updates to the design of ongoing and future PGC suppression studies.
- Continue curation and synthesis of on-farm trial datasets to assess the current "State of PGC" at scale, including system functionality and performance across locations and management contexts.
- Begin analysis of PGC image datasets using an improved modeling framework to evaluate the ability to estimate PGC intensity and characterize PGC recovery dynamics following suppression events.

2. Actual Accomplishments

- Modeling efforts related to the scalability of PGC suppression practices using Liberty (glufosinate) herbicide progressed during this quarter. Analytical frameworks were

refined to incorporate environmental constraints (e.g., weather windows suitable for application), and preliminary outputs were generated to support inference about operational feasibility across regions. These results are being synthesized to inform manuscript development and guide future experimental design.

- Curation and synthesis of on-farm trial datasets continued, with an emphasis on integrating datasets across locations to evaluate system performance under diverse management and environmental conditions. Progress was made toward defining key metrics for assessing the "state of PGC," including measures of crop performance, PGC suppression efficacy, and system stability.

- Initial analyses of PGC image datasets were initiated using an improved modeling framework. Efforts focused on data standardization, alignment of image-derived features across sites, and early-stage model development to estimate PGC intensity. Preliminary work also explored approaches for quantifying PGC recovery dynamics following suppression events, setting the stage for more robust cross-site comparisons.

- Weekly RegenPGC Café meetings continued throughout the quarter, maintaining strong communication across research teams. These meetings supported coordination of data analysis efforts, troubleshooting of methodological challenges, and continued integration across objectives.

3. Explanation of Variance

None noted.

4. Plans for Next Quarter

- Finalize modeling and inference related to the scalability of PGC suppression practices using Liberty (glufosinate) herbicide and initiate preparation and submission of a peer-reviewed manuscript.

- Continue expanding and refining the synthesis of on-farm trial datasets, with a focus on developing comparative analyses across sites and identifying key drivers of system performance and variability.

- Advance modeling of PGC image datasets to improve estimation of PGC intensity and recovery dynamics, including validation of model outputs across locations and integration with agronomic datasets.

- Refine and document standardized data pipelines for ongoing and future data collection, curation, and analysis to support long-term scalability and cross-site comparability.

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

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. Research Progress and Preliminary Outcomes

- Field research at the Nashua research site was highly successful during this reporting period. Lessons learned from prior-year management were incorporated, with particular emphasis on achieving effective early-season ground cover control. As a result, plots with Rhizomatous herbaceous ground cover (RHb) produced significantly greater corn and soybean yields compared to control plots. We provided a virtual field day for the Iowa Nutrient Research Center, discussing our results.

- Preliminary observations indicate that RHb contributed to improved early-season water management, which likely supported crop establishment and yield performance. Water quality data from the site are currently being compiled and analyzed, and will be summarized in a future reporting period.

- We have initiated a study on groundcover water use as related to suppression timing and have two undergraduate students who, over the winter, established both RHb and Kentucky Bluegrass (and cereal rye), as well as a bare soil control, and a soil cover stover-covered control. We have been evaluating whether we can detect differences in

evapotranspiration by weighing the buckets, and are currently installing soil moisture sensors to improve data robustness. Water balancing and budgeting impact will start being collected on a weekly basis in the first week of April.

2. **Overall Impact**

Collectively, these activities advanced both the technical understanding and practical risk management framework for perennial ground cover systems. Outreach efforts are increasingly focused on equipping advisors and producers with the tools needed to responsibly evaluate, adapt, and implement PGC systems while minimizing agronomic and economic risk. Ideas that research work has coalesced around as key themes we need to address for wider implementation.

3. **Explanation of Variance**

None noted.

4. **Upcoming Programming and Planning**

Building on momentum from prior efforts, we are planning a virtual webinar series to be delivered in August of 2026, modeled after the previous PGC webinar program. This series will culminate in two to three field days across Iowa and the broader project region, leveraging established demonstration and research sites.

Key features of the planned program include:

- Continuing Certified Crop Adviser (CCA) credits for educational content.
- Expanded framing around "why perennial ground covers and why now," including alignment with federal and state regenerative agriculture and conservation frameworks.
- Detailed guidance on ground cover selection, management strategies to optimize system performance, and approaches to limit yield exposure during establishment and early-season crop development.
- A strong focus on the information advisors need to de-risk implementation and support informed, site-specific decision-making by producers.

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

None this quarter.

THEME 3. EDUCATION

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

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

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 become available.

   B. Actual Accomplishments

   The development of instructional materials is ongoing, and materials are being posted to the shared Teams directory as they become available.

   C. Explanation of Variance

   No variance encountered

   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)**

   Undergraduate interns who will participate in a coordinated summer research experience.

   A. REU Planned Activities

   We planned to accomplish the following during the quarter:

   - Present a session at the 2025 National Science Teachers Association meeting in Minneapolis November 2026) on the work we do with REUs.

- Provide a full-day of learning on November 8, 2025, for all participants in the summer program. Materials for the day were delivered in early November. The focus of the session is on work from the summer, particularly the Disengagement Gap study by Brookings Institute. The plan is for students to respond to the survey, and we will analyze the data to inform our work.

- Ongoing Zoom meetings to continue, as do *Second Tuesday* cohort gatherings. We will begin a book club with Daniel Coyle's book *Culture Code* in December for all participants. Recruitment for 2026 participantswillbegin in late November and extend through March.

B. REU Actual Accomplishments

All activities described above were accomplished over the course of the quarter.

C. REU Explanation of Variance

No variance encountered. We completed all planned activities.

D. REU Plans for Next Quarter

Final professional learning day takes place on February 7th. All REUs are participating in this event via Zoom with the RETs. Also, the final SToM takes place on January 13th. Recruitment of both the hosting labs and participants for the summer of 2026 is underway. The recruitment window closes on March 20, 2026, and final decisions for participants will be made by March 31, 2026. Planning for the 2026 professional learning is ongoing.

3. Research Experience for Teachers

A. RET Planned Activities

We planned to accomplish the following during the quarter:

- Presenting a session at the 2025 National Science Teachers Association meeting in Minneapolis in November on the program and the work we do with REUs.

- Provide a full day of learning on November 8th for all participants from the summer program. Materials for the day were delivered in early November. The focus of the session is on work from the summer, particularly the Disengagement Gap study by the Brookings Institute. The plan is for students to respond to the survey, and we will analyze the data to inform our work.

- Ongoing Zoom meetings will continue, as will the *Second Tuesday* cohort gatherings. Also, *Curiosity Cycles* start with teachers in December 2025.
- Starting a virtual book club in December with the book Culture Code, Daniel Coyle for all participants. 2026 participant recruitment will begin in late November and extend through March 2026.

B. RET Actual Accomplishments

All activities described above were accomplished over the course of the quarter.

C. RET Explanation of Variance

No variance encountered.

D. RET Plans for Next Quarter

Final professional learning day takes place on February 7, 2026. All RETs are participating in this event via Zoom with the RETs. Also, the final SToM takes place on January 13, 2026. Recruitment for both the hosting labs and participants for the summer of 2026 is underway. The recruitment window closes on March 20, 2026, and final decisions for participants will be made by March 31, 2026. Planning for the 2026 professional learning is ongoing.

4. Undergraduate Internship Program (Moore)

We have discontinued the project due to insufficient interest among undergraduate students working in the project CoPDs' labs.

5. Graduate Student Community (Moore)

A. Planned Activities

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

B. Actual Accomplishments

The RegenPGC Café/graduate student seminar was the primary community activity for the quarter.

C. Explanation of Variance

No variance encountered.

D. Plans for Next Quarter

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

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

A. 4H Program Planned Activities (Hayslett)

Youth outreach events for the next quarter are Kirkwood STEAM Institutes on December 11, 2025; Washington, Iowa, on December 15; Hiawatha, Iowa, on December 16, and on December 17 in Monticello, Iowa. A training for county 4-H and youth staff on the lessons will be provided by ISUEO Region 23 on January 6, 2026. Maya Hayslett will continue to work with 4-H State Staff on lesson publication.

B. Actual Accomplishments (Hayslett)

Youth outreach events for Kirkwood STEAM Institutes were successfully completed on December 15 and 16, 2025, in Hiawatha, Iowa, and on December 17, 2025, in Monticello, Iowa. The program on December 1, 2025, in Washington, Iowa, was canceled due to the weather. Training for county 4-H and youth staff on the lessons was held for ISUEO Region 23 on January 6, 2026, with eight county or regional extension staff from seven counties attending and receiving a kit of materials to implement lesson plans. Maya Hayslett continues to work with 4-H State Staff on lesson publication. (Miller) The FFA subtask program has been completed.

C. Explanation of Variance

The program on December 11, 2025, in Washington, Iowa, was cancelled due to the weather.

D. Plans for Next Quarter

A training for county 4-H and youth staff on the lessons will be provided for ISUEO Region 20 on February 3 and for Region 19 on March 19. Maya Hayslett will continue to work with 4-H State Staff on lesson publication.

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

None this quarter.

THEME 4. COMMERCIALIZATION

Sara Lira (Corteva Agrisciences) leads this theme.

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). We specifically will:

- 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.

1. Plans for Next Quarter

We are continuing the following work:

- Completing the 2026 herbicide trial protocol.
- Finalizing the data QC for upload to Zenodo database

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

None this quarter.

OBJECTIVE 1. CROP ECOLOGY AND 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 include Lucas Borras (Corteva Agrisciences), Susana Goggi (ISU), Ken Moore (ISU), and José Rotundo (Corteva Agrisciences). Hallie Sandeen (UK) and Kiera Searcy (UK) are the graduate students (Master's) involved in this objective.

1. Planned Activities

A. Kentucky

- HallieSandeen will defend her Master's thesis in November 2025, with a December 2025 graduation date.
- Kiera Searcy will defend her Master's thesis in January 2026, with a May 2026 graduation date.
- Hallie Sandeen is analyzing rooting depth data collected in November 2024 to write a short report.
- Hallie Sandeen is preparing and will submit two manuscripts: (additional submissions planned for subsequent quarters).
    - A methods paper for analyzing herbicide deposition on KBG (fine blades but dense clumps) will be submitted as a short paper to the journal *Weed Technology*.
    - A study on alternative cool-season grasses for PGC adoption will be submitted to the *Agronomy Journal.*
- CoPd Erin Haramoto will attend CANVAS 2025 (formerly called Tri Societies) and present summary findings from student trials.

B. Iowa

- Hand-harvested ear samples will continue to be hand-shelled for determining yield components in appropriate experiments.
- Data sets and analyses will be made available to corporate partners.
- Planning for the final season of experiments will focus on PGC establishment.

2. Actual accomplishments

A. Kentucky

- Hallie Sandeen successfully defended her Master's thesis in November 2025 and graduated in December 2025
- Kiera Searcy defended her Master's thesis in January 2026.
    - Hallie Sandeen and Erin Haramoto worked on two manuscript drafts.
    - Hallie Sandeen analyzed rooting depth data and wrote a methods report for studying herbicide deposition on clump grasses.

- Erin Haramoto attended CANVAS and presented summary findings from student trials.

  - **Haramoto, Erin**, Sandeen, Hallie, Searcy, Kiera, Allen, Matthew, Legleiter, Travis, Schlautman, Brandon, Fei, Shui-zhang, & Phillips, Tim. (2025, November 11). *Establishing perennial grasses for permanent groundcover in corn* [Abstract]. CANVAS 2025, Salt Lake City, UT, United States. https://scisoc.confex.com/scisoc/2025am/meetingapp.cgi/Paper/170731. ABSTRACT (PDF): https://www.regenpgc.org/wp-content/uploads/2025/12/Erin-Haramoto-Abstract.pdf.

B. Iowa

- Hand-harvested ear samples were hand shelled to determine yield components in appropriate experiments.
- Data sets and analyses were made available to corporate partners.
- Two experiments, with an emphasis on establishing PGC using a cover crop seeder in spring and fall, were designed and will be rolled out this spring.

3. Explanation of Variance

A. Kentucky

Certain issues delayed manuscript preparation, so they are not yet ready for submission.

B. Iowa

None noted

4. Plans for Next Quarter

A. Kentucky

- Continue working on publications from Sandeen and Searcy's theses.
- Kiera Searcy will submit her Master's thesis to the KU graduate school.

B. Iowa

- Material resources will be acquired for the remaining experiments.
- The final field season for evaluating short-stature corn performance in PGC will begin at the same location, with changes to the randomizations for Year 2.

- Areas for establishment studies will be identified, field preparations will take place, and initial plantings will occur.

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

- Sandeen, Hallie. (2025). *Evaluation of Poaceae Species and Suppression Application Methods for Perennial Groundcover in Corn* [Masters Thesis, University of Kentucky]. University of Kentucky Library Link: https://uknowledge.uky.edu/pss_etds/200]. https://doi.org/10.13023/etd.2025.541. Available for download on Sunday, May 31, 2026.

- RegenPGC CoPd Dr. Erin Haramoto received the University of Kentucky's Martin-Gatton College of Agriculture, Food and Environment Master Teacher Award (Jan 2026). The award honors UK Award faculty members who exhibit exceptional dedication to teaching.

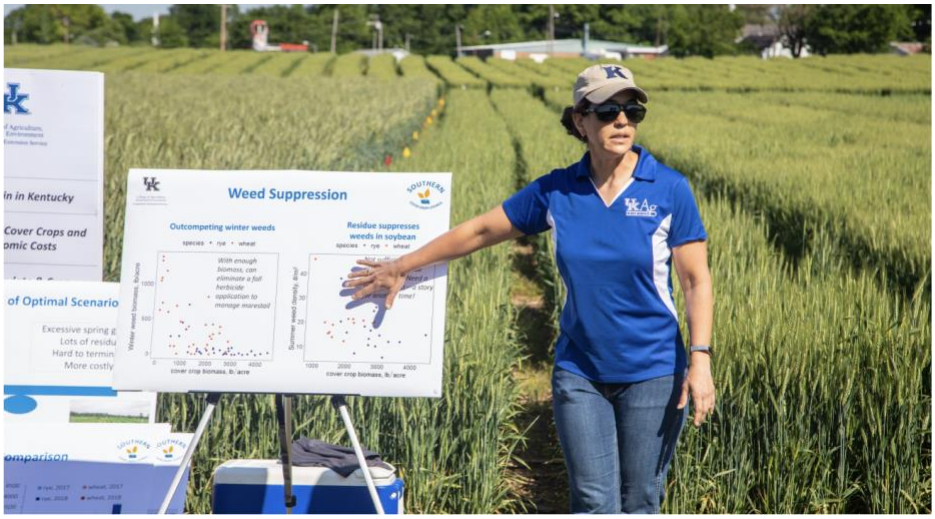

Photo 1. Dr. Erin Haramoto teaching weed management (Steve Patton, University of KY)

OBJECTIVE 2. PLANT BREEDING AND 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 improvements and reduced management requirements, while also increasing ecosystem impacts through 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. RNA-seq to Identify Candidate Genes for Summer Dormancy in *P. bulbosa*

P. bulbosa is shown to be a strong candidate species as a perennial groundcover for corn production. We have received the sequencing information from the sequencing company and are currently conducting bioinformatics analyses to identify candidate genes associated with summer dormancy in *Poa bulbosa*. Because it is a newly assembled genome, genome annotation was first completed to enable downstream analyses. Differential gene expression analysis is currently underway to identify candidate genes involved in the regulation of summer dormancy in *P. bulbosa*. Identification of genes responsible for dormancy will facilitate the development of dedicated *P. bulbosa* cultivars for PGC-based cropping systems.

B. Characterization of USDA GRIN Accessions for Summer Dormancy in *P. bulbosa*

A controlled environment study (27°C, 16-hour photoperiod) evaluating a subset of 50 *Poa bulbosa* genotypes *obtained* from USDA GRIN has concluded. Data on plant height, tiller numbers, greenness rating, growth habit, and flowering response were collected. We are now conducting the second study evaluating the remaining 50 accessions for the same traits. Once data collection is completed across all accessions, analysis will be performed to quantify the variation for these important traits, which could be used for genome-wide association studies (GWAS).

C. Evaluation of freezing tolerance in *Poa secunda*

P. secunda is another strong candidate as a perennial groundcover due to its summer dormancy. However, its winter hardiness remains to be determined. Previously, we evaluated the freezing tolerance of three *Poa secunda* cultivars, 'High Plains', 'Vale', and 'Hanford', by measuring ion leakage. We are now conducting a regrowth test with and without cold acclimation to validate the ion leakage results. We have started a study to characterize the 180 *Poa secunda* accessions and estimate their ploidy level.

2. **Plans for Next Quarter**

- The second-year evaluation of PGC species and chemical suppression method on maize growth and development will start in the spring of 2026.
- We will continue the bioinformatic analysis of *Poa bulbosa* to identify candidate genes responsible for summer dormancy.
- Ploidy level determination for the 180 *Poa secunda* accessions will continue in spring 2026, and mRNA sequencing to identify candidate genes for summer dormancy in *P. secunda* cv. High Plains will start late spring 2026.
- A study of the reproductive mode in a group of 20 geographically diverse accessions using flow cytometry will also be conducted in the spring of 2026.

3. **Awards, Publications, Presentations, Stakeholder Engagement, Submitted Proposals**

Galland, Patrick D., Dutter, Cole R., Chen, Allen, **Moore, Kenneth J., Fei Shui-zhang**. (2026). Summer-dormant, perennial groundcover has minimal effect on plant-available nutrients and no effect on maize yield. *Agronomy Journal*, 118, e70333. https://doi.org/10.1002/agj2.70333 Open Access

LÜBBERSTEDT LAB

1. **Actual Accomplishments**

- Graduate student Memiş Bilgici presented one oral presentation and two posters at CANVAS 2025, held November 9-12, 2025, in Salt Lake City, Utah. CANVAS, formerly the ASA, CSSA, and SSSA International Annual Meeting, brings together crop, agronomic, environmental, and soil scientists to foster collaboration, inspire change, and advance scientific discovery.

2. **Plans for Next Quarter**

- In related work, we are preparing a manuscript in collaboration with Corteva Agriscience titled “Phenotypic Response to Low Red/Far-Red Light Ratio (Shade Avoidance Response) in Maize Hybrids Representing 100 Years of Long-Term Breeding for Yield.” This research focuses on shade avoidance and stomatal traits in ERA maize hybrids.
- We are also analyzing and synthesizing results from three years of field trials on perennial ground cover crops in maize, including conventional systems, RHB-*Poa bulbosa*, and Kentucky bluegrass. A major objective of this work is to determine whether

a dedicated maize breeding program is needed for production systems using perennial ground cover crops, such as *Poa bulbosa*.

- Memiş Bilgici will also present one talk and two posters at the 2026 Maize Genetics Meeting, which is scheduled for February 26 to March 1, 2026, at the Maritim Hotel Köln in Cologne, Germany. The meeting features scientific talks, networking opportunities, and presentations focused on maize genetics. He gave one talk at a pre-conference event at the same location, the Corn Breeding Research Meeting, February 24-26, 2026.

- Yu-Ru Chen conducted the statistical analysis to understand if genotype × environment interactions (G×E) are critical for breeding decisions: 1, If G×E is large and driven by planting system (G×PS), breeders must select genotypes separately for each system. 2, G×E is driven by year-to-year weather (G×Year) but not by PS, a single selection pipeline suffices across all systems. A formal G×E analysis was used on complementary models on two data sources (plot-level and SpATS-adjusted BLUPs), with boundary-corrected likelihood ratio tests for variance component significance.

Table 1: Summary of GxE Analysis Across Models and Data Sources

Question	Model	Data	Result	Conclusion
Is overall GxE significant?	A	Plot	$p < 0.001$	Yes , for all traits
Is overall GxYear significant?	B	Both	$p = 0.50$	No
Is GxPS significant (Yield)?	B	Both	$p = 0.50$	No
Is GxPS significant (PH)?	B	SpATS	$p = 0.015$	Marginal
Con ≈ PB for yield?	B	Both	$p > 0.35$	Yes
KBG yield penalty?	B	Both	$p < 0.001$	Yes (—3,000 – 3,500

- No PS-specific selection for yield. G×PS ~= 0. Enable selection of genotypes based on overall mean performance.

- PB is a viable system. Yield is statistically equivalent to conventional ($p = 0.74$). The perennial biomass intercrop does not impose a yield penalty.

- KBG requires attention. The 3,000–3,500 kg/ha yield deficit (≈27% of conventional) is substantial and consistent. KBG competition may require different management (e.g., suppression timing) or genotypes with stronger competitive ability, although G×PS ~= 0 suggests current genotypes do not differ in their response.

- PH may warrant PS-aware selection. The marginal G×PS for plant height ($p = 0.015$, SpATS) suggests some genotypes grow relatively taller or shorter depending on the system. This could be relevant if plant height affects lodging risk or light competition dynamics in intercrop systems.

- Focus CERIS on the overall environment. Since G×E is environment-specific rather than PS- or Year-structured, the CERIS environmental characterization approach (correlating PS-adjusted yields with weather parameters across the full environment range) is the appropriate framework for identifying critical weather drivers.

According to the results of GxE analysis, Yu-Ru Chen conducted the results of a Critical Environmental Regressor through Informed Search (CERIS) analysis applied to the RegenPGC breeding dataset spanning 8 environments (2~3 plant-systems ×3 years, 2023–2025).

- Temperature-only search (5 parameters: DL, GDD, PTT, PTR, PTS) — Identified photo thermal time (PTT) during late grain fill (DAP 112–119) as the strongest yield predictor ($r = 0.885$).

- Expanded parameter-related rainfall search (10 parameters: adding PRECIP, PRECIP CUM, RH, WS, VPD) — Early-season precipitation (DAP 5–22, $r = -0.916$) surpassed PTT for yield.

- Planting-system-adjusted search after removing the planting system (PS) confounding via fixed-effect adjustment, the yield-critical window shifted to grain-fill precipitation (DAP 87–94, $r = -0.953$), and wind speed emerged as the dominant driver for plant height ($r = -0.960$), ear height ($r = 0.815$), and SPAD ($r = 0.929$).

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

- **Bilgici, Memiş** Chen, Yu Ru & **Lübberstedt, Thomas**. (2025, November 10). *Do we need dedicated maize varieties for perennial groundcover systems?* [Poster presentation]. [Abstract]. CANVAS 2025, Salt Lake City, UT, United States. https://scisoc.confex.com/scisoc/2025am/meetingapp.cgi/Paper/166427. ABSTRACT (PDF): https://www.regenpgc.org/wp-content/uploads/2025/11/2025-11-10-Tri-Societies-Bilgici-Poster.pdf. POSTER: https://www.regenpgc.org/wp-content/uploads/2026/01/2025-11-20-Memis-Poster.pdf

- **Bilgici, Memiş** & **Lübberstedt, Thomas**. (2025, November 10). *Trends in stomatal density and area size in pioneer era maize hybrids representing a period of 100 years* [Oral presentation: Abstract]. CANVAS 2025, Salt Lake City, UT, United States.

https://scisoc.confex.com/scisoc/2025am/meetingapp.cgi/Paper/167504. ABSTRACT (PDF): https://www.regenpgc.org/wp-content/uploads/2025/11/2025-Tri-Societies-Bilgici-Oral.pdf.

OBJECTIVE 3. SOIL HEALTH AND NUTRIENT MANAGEMENT

1. Actual Accomplishments

- Graduate student Malcom St Cyr is currently writing up his master's thesis. His defense is set for April 2026.
- Some soil results are pending and are currently underway for a separate PGC project.

2. Explanation of Variance

None noted.

3. Plans for Next Quarter

- One manuscript is under review for the journal Plant & Soil on 2-dimensional mapping of roots and soil properties.
- CoPD Marshall McDaniel and graduate student Max Eness are working on another manuscript draft, with Cole Dutter as the author. We're hoping to have it close-to-ready for submission by late spring 2026.

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 against 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. In the fall of 2025, the Objective team will add graduate student Ralph Danquah-Acquah (Kaleita).

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

A. Planned Activities

Begin ALMANAC setup and runoff-focused comparisons for conventional corn and PGC.

B. Actual Accomplishments

- Set up and ran initial ALMANAC scenarios for conventional corn and PGC, and reviewed runoff and water balance outputs.
- Compared five rainfall datasets and selected NASA POWER for long-term simulations.
- Tested runoff sensitivity by adjusting CN2, slope, and slope length inputs.
  Began paired EPIC and ALMANAC setup under consistent Nashua weather and soil inputs for runoff and erosion comparisons.

C. Explanation of Variance

Earlier EPIC runs used different rainfall inputs, so additional paired runs were needed to separate weather effects from model behavior.

D. Plans for Next Quarter

- Complete paired EPIC and ALMANAC runs under the validated rainfall series and expand diagnostics using soil water components and daily stress outputs.
- Begin plot-level validation as field datasets become available.

2. Quantify PGC Impacts on Water Quality

A. Planned Activities

Begin erosion-focused comparisons using model outputs and prepare for field validation.

B. Actual Accomplishments

- Summarized erosion outputs and compared EPIC versus ALMANAC erosion behavior for conventional corn and PGC.
- Identified key erosion mismatches between models to guide calibration targets.
- Started coordination to obtain plot-level datasets and field records needed for Nashua validation.

C. Explanation of Variance

Field validation depends on access to plot-level erosion datasets and on consistent interpretation of erosion pad measurements versus modeled erosion outputs.

D. Plans for Next Quarter

- Obtain and organize erosion pad data and field operation records for the Nashua Research Farm.
- Define a defensible comparison approach for observed versus modeled erosion.

3. Quantify PGC Ecosystem Service Sustainability Indicators and Compare them with Conventional Systems

A. Planned Activities

Begin yield and system indicator evaluation using available observed references and improve PGC management representation.

B. Actual Accomplishments

- Compared simulated yields from ALMANAC and EPIC against the USDA Floyd County yield as an initial reference.
- Reviewed crop and management parameter settings for corn and fescue to support calibration and suppression representation.

C. Explanation of Variance

County yield is a broad reference and limits plot-scale matching for Nashua.

D. Plans for Next Quarter

None at this time.

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

None at this time.

OBJECTIVE 5: SOCIOECONOMIC IMPACTS AND POLICY

This objective evaluates the conditions under which the proposed practices are economically sustainable for farmers and input suppliers within the PGC supply chain, while also enhancing well-being for farmers and consumers. It integrates these practices by examining how PGC aligns with existing policy frameworks. Essentially, the objective combines information from

other objectives and evaluates the overall value proposition for different versions of PGC. Keri Jacobs (University of Missouri) leads this objective, with Amani E. Elobeid (ISU) and Cynthia A. Bartel (ISU) serving as collaborators. Our overall team direction focuses on continuing data discussions, finalizing the data, and communicating it to the Data Management Team.

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

A. Planned Activities

- Begin quantifying the on-farm and off-farm agro-enviro-economic system changes that occur under the maize PGC system, and identify appropriate valuation strategies from the economic literature.
- Developing a policy paper regarding the discussion of a roadmap for administratively developing USDA support to de-risk conservation program adoption, with a case study of perennial groundcover systems under the USDA SAS CAP RegenPGC grant.

B. Actual Accomplishments

- The manuscript that catalogs RegenPGC's key unpriced benefits has now been updated with quantitative data from scientists and collaborators working on the project. Economic valuation strategies and estimates are also being included. We anticipate submission by May 2026
- Submitted paper on quantifying groundcover intensity for PGC metrics standardization to advance system development (paper still in review). Bartel, C. A., Moore, K. J., Andersen, D. S., Raman, D. R. 202_. Quantifying and characterizing groundcover "intensity" in perennial groundcover (PGC) systems. In review at Agronomy Journal. Submitted January 9, 2026.
- Developed a policy paper regarding the discussion of a roadmap for administratively developing USDA support to de-risk conservation program adoption, with a case study of perennial groundcover systems under the USDA SAS CAP RegenPGC grant.

C. Explanation of Variance

Regarding the role of input supply agribusinesses in PGC supply chain activities, the value to this project of identifying a unique role, capability, or investment by ag retailers is being reassessed. As the project has matured, there is no compelling rationale for exploration of this dimension as initially envisioned. Instead, more time and attention are focused on expanding the evaluation of the economic feasibility of the PGC system. We believe this brings significantly greater value to the project. We will reassess the role of

input supply agribusinesses in the PGC supply chain going forward and seek potential related but alternative analyses to complement the overall project.

D. Plans for Next Quarter

- Finalize and submit the unpriced benefits manuscript to an environmental or land-use economics journal.
- Finalize and submit the policy paper outlining a roadmap for administratively developing USDA support to de-risk conservation program adoption, with a case study of perennial groundcover systems under the USDA SAS CAP RegenPGC grant.
- Present for USDA SARE "Farming Matters" on perennial intercropping. The segment is a national feature piece for USDA.
- Complete interview with Hoard's Dairyman on preparation for World Dairy Expo Virtual Farm Tour 2025, including overview of on-farm research for perennial intercropping systems.

2. Publications, Presentations, Ag Press, Stakeholder Engagement, and Submitted Proposals

A. Publications

- Bartel, Cynthia A., Moore, Kenneth J., Andersen, Daniel S., Raman, D. Raj. Quantifying and characterizing groundcover "intensity" in perennial groundcover (PGC) systems. In review at *Agronomy Journal*. Submitted January 9, 2026.

  This submission is based on a white paper previously shared with the RegenPGC team: *Characterizing Groundcover "Intensity" in Perennial Groundcover (PGC) Systems – History and Paths Forward.* A white paper for consideration and discussion by the members of RegenPGC & FABPGC. Cynthia A. Bartel & D. Raj Raman, August 13, 2025.

B. Stakeholder Engagement

Continued engagement with USDA RMA, FSA, and NRCS for program development. Lots of farmer outreach on prices and their impact on conservation practice adoption.

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 RegenPGC team's performance.

1. **Planned Activities**

   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.
   - Ongoing monitoring/review/analysis of project progress and milestones in relation to the main project logic model
   - Evaluation planning, including planned data collections, analysis, and any formative and summative reporting across project objectives and themes (other than Education) for the remainder of the project (November 2025 – July 2026).

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

   - Meet with Education theme leaders, as needed.
   - Ongoing monitoring/review/analysis of Education-related progress and milestones in relation to the Education-specific logic model
   - Education-theme focused evaluation planning, data collection, and analysis through the remainder of the project.

2. **Actual Accomplishments**

   A. **RegenPGC – Overall Project Activities**

   - Participated in RegenPGC leadership calls (Co-PD and SAB) and evaluation calls with project director and deputy director, as scheduled (Not applicable this Q)
   - Ongoing monitoring/review/analysis of project progress and milestones in relation to the main project logic model
   - 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 (through July 2026) (postponed to Q3).

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

   - Met with Education theme leader and objective collaborators, as needed.

- Continued ongoing monitoring/review/analysis of Education-related progress and milestones in relation to the Education-specific logic model
- Continued Education-theme focused evaluation planning, data collection, and analysis.

3. Explanation of Variance

Meetings with leadership/SAB and evaluation planning meetings were postponed to Q3.

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.
- Participate in RegenPGC Friday "Cafes" as scheduled to gather information on integrated project findings, activities, and outputs.
- Ongoing monitoring/review/analysis of project progress and milestones in relation to the main project logic model
- Evaluation planning, including planned data collections, analysis, and any formative and summative reporting across project objectives and themes (other than Education) for the remainder of the project (Feb 2026 – July 2026 and any NCE year activities, if applicable).

B. Regen PGC – Education Theme Focus

Education-theme focused evaluation planning, data collection, and analysis are now integrated into overall evaluation activities for the remainder of the project.

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

None this quarter.

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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