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Agricultural Resilience

2023-2024: Annual Report

Fostering Resilience and Ecosystem Services in Landscapes by Integrating Diverse Perennial Circular Systems

This work is supported by AFRI Sustainable Agricultural Systems Coordinated Agricultural Project (SAS-CAP) grant no. 2021-68012-35917 from the USDA National Institute of Food and Agriculture.

Project Overview

U.S. agriculture is dominated by annual crop monocultures lacking resilience, making them vulnerable to catastrophic losses due to weather extremes and market volatility. Alternatively, diverse perennial circular systems of agricultural production are more resilient to weather extremes and shocks to markets (Fig. 1). More resilient agriculture has greater social, economic, and environmental benefits at farm, community, society, and global levels.

We're the **Resilience Coordinated Agricultural Project**, or Resilience CAP (RCAP). We're a large, diverse team of researchers, outreach specialists, educators, and farmers working together to develop and communicate strategies for farmer adoption of more resilient agricultural systems across the US. This will help ensure better outcomes for producers, consumers, communities, and the land.

Our project is a multi-year, federally funded effort (see funding statement on title page). Our team spans 23 states and 30+ organizations. We're conducting on-farm research with a national network of farmers and ranchers. We're also conducting experiments at multiple universities. We're analyzing policy and socioeconomic conditions that support more resilient agriculture. Our Extension activities reach farmers across the U.S. and our education activities reach students in K-12 and higher education.

Diverse Perennial Circular Systems have more acres in perennial crops and forages compared to other agricultural systems. They also integrate livestock with diverse cropping systems.

This report describes the RCAP structure and purpose, highlights our main activities and provides a compendium of the products we completed in project year three, September 2023 - August 2024.

Diverse Perennial Circular Systems

Figure 1. Diverse perennial circular systems of agricultural production have multiple crop types, include plants that are long-lived and have living roots in the ground all year, and recycle soil nutrients within fields. These systems also include forages for livestock that are integrated into production where the forages are grown.

Project Organization

Our large team is divided into six working groups to address six major objectives (Fig. 2). Each working group is further subdivided to address specific needs and questions. Working groups include experts from crop and soil sciences, social and economic sciences, ecological science, and team-science management. The project is designed so working groups can share knowledge. Knowledge sharing helps produce a wide array of solutions to help farmers, policymakers, and consumers better understand how agricultural resilience leads to multiple benefits for all, and how farmers can increase their farm resilience.

Our project leadership is shared among the leaders of the six main objectives, plus our project director and our project coordinator (see Appendix).

We are also dedicated to continuous improvement. An evaluation team provides valuable feedback to support our accountability and success (see Appendix).

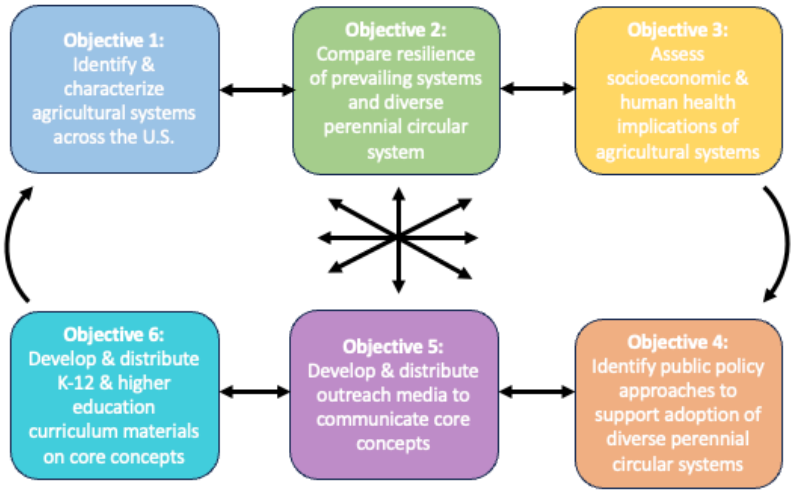
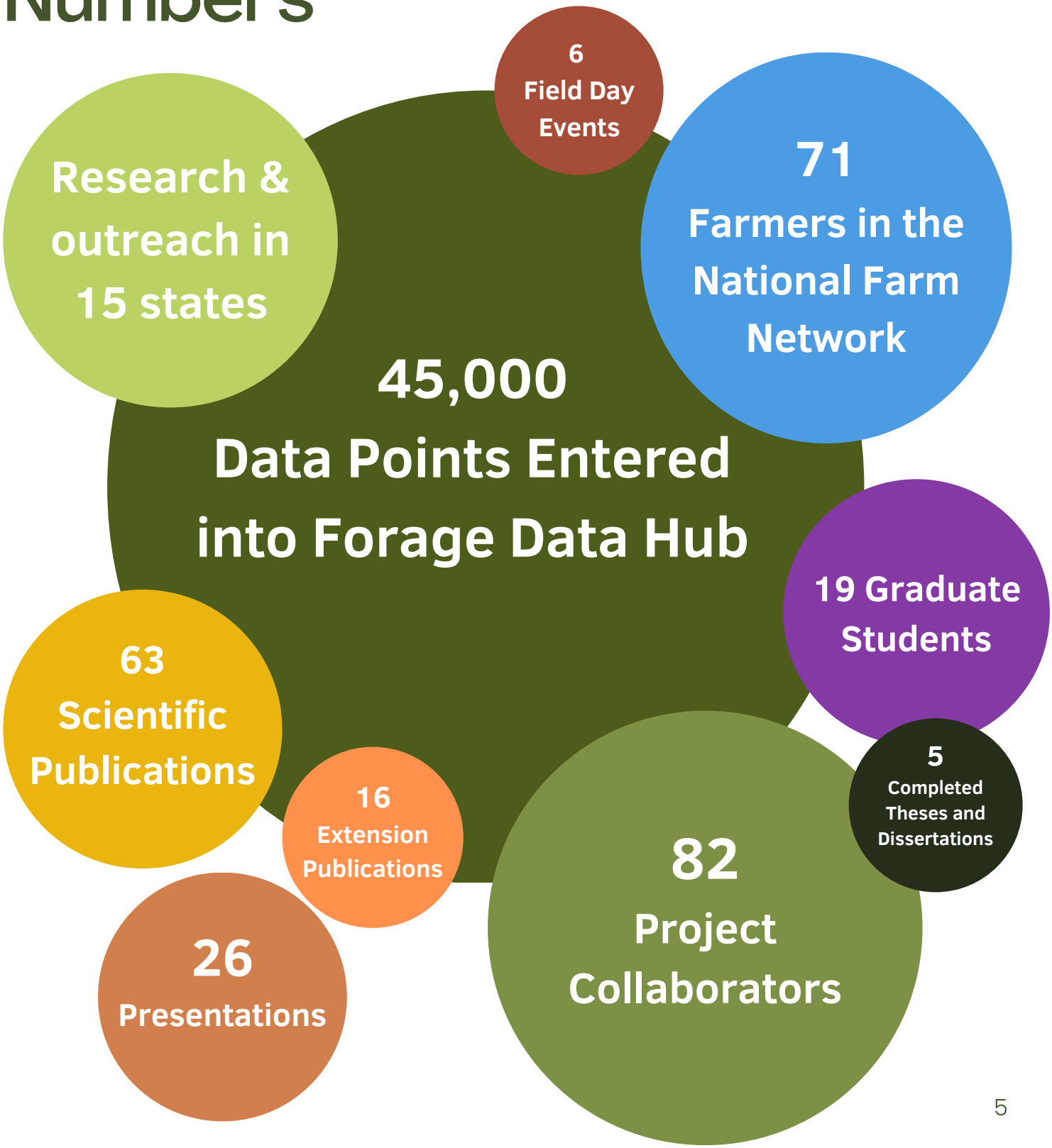


Figure 2. The Resilience CAP has six working groups focusing on different questions. Through knowledge sharing and information exchange the entire team is identifying integrated solutions for more resilient agricultural systems.

2023-24 By the Numbers



National Farm Network

In our first year we initiated a ***National Farm Network*** for collaborative research involving academic researchers, farmers, and extension experts among multiple states. The Network includes farmers who produce different crops, use different types of livestock production, and who use different types of crop and soil management.

Our Network now has 71 farms among 15 states (Fig. 3). We're collecting soil samples on Network farms and conducting farmer interviews. Farmers are also completing agronomic surveys that include questions about crop types, yields, crop management, livestock production, and challenges in the production cycle. With information collected through the Network, we're able to make comparisons among agricultural systems from the farm level to the national level.

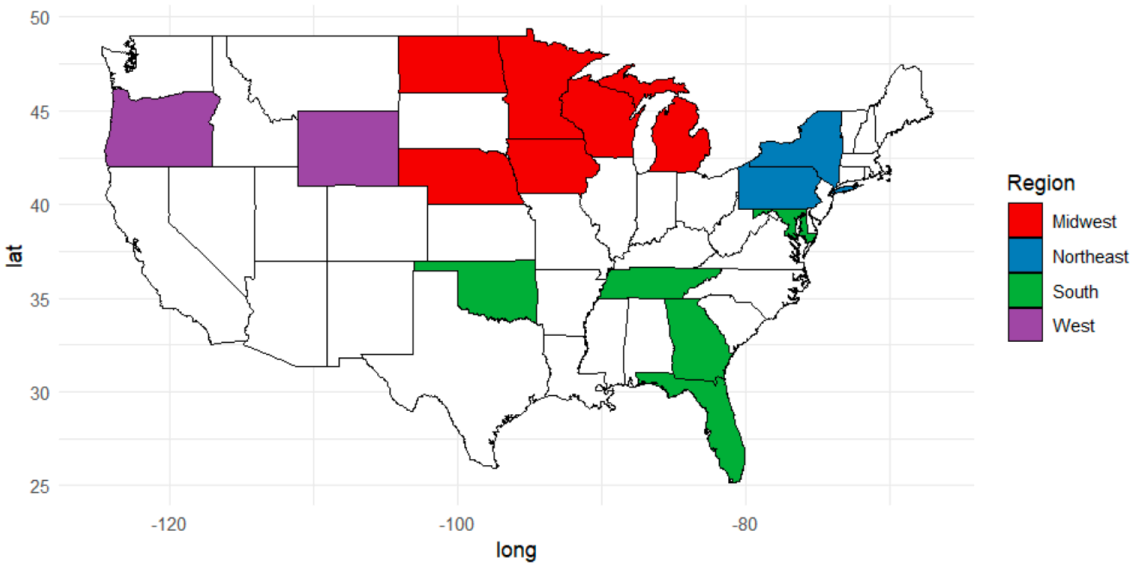


Figure 3. States with farms in the RCAP Farm Network among four geographic regions in the U.S. Data collected on these farms is used to evaluate agricultural resilience among differing types of crop and livestock production.

Base map: U.S. Department of Commerce, Economics and Statistics Administration,

Forage Data Hub

To minimize research redundancy and optimize regional agricultural systems, we created an online national forage crop database, known as the **Forage Data Hub**. The Hub enables multiple sources of forage data to be stored and accessed through a public online tool. Sources of data include forage experiments and field trials across the U.S. Data includes information collected in single year and across multiple years. The Hub includes historical data and recent data. With cloud-based computing and innovative visualization and AI-enhanced data query tools, the Hub enables systems-level research, and supports decision-making (Fig. 4).

The Hub has standardized nomenclature, units of measure (e.g., yields), and other vital data characteristics. This ensures easy use of keyword searches and other forms of database query. Stringent metadata protocols are observed and a template is provided for easy and accurate data uploads. The Hub currently contains more than 45,000 data entries from across the US, with most entries from states in the Upper Midwest (Fig.5).

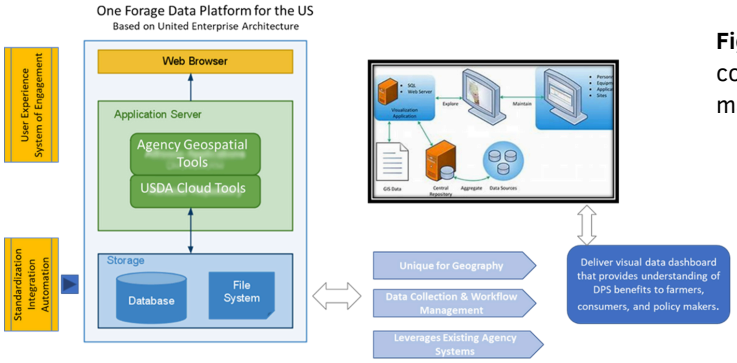


Figure 4. The Hub Data Hub architecture was designed and constructed as a user-friendly interface for uploading data, making queries, and downloading datasets.

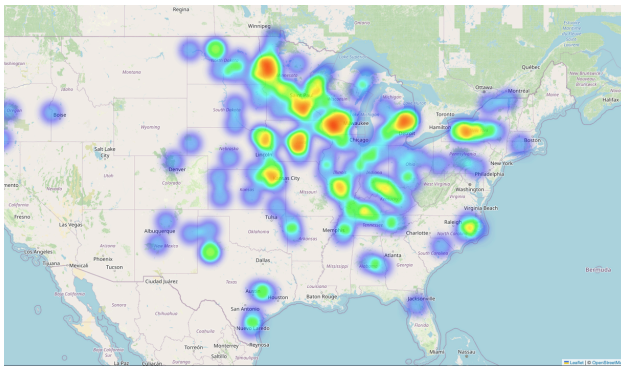


Figure 5. The colors in this map illustrate the locations and relative amounts of data contributed to the Forage Data Hub. Warm colors indicate most data in the Hub database are from the Upper Midwest. Cool tones indicate less data from the Plains and Pacific Northwest states.

The Hub is now being beta-testing while we continue data curation. Public launch is scheduled for Summer 2025.

Forage Experiments

In addition to on-farm research through the National Farm Network, we're conducting experiments in multiple states (Fig. 3). These controlled experiments help us understand how different agricultural systems effect soil and ecological resources. Information from these experiments is included in life cycle assessment and socioeconomic analyses. Our soil testing includes analysis of soil carbon, soil protein, organic carbon, total nitrogen, soil bulk density, soil texture, soil organic matter, and soil aggregate stability. Forage and plant samples are also collected across all experiments, with testing for yield and quality.

RCAP co-PI Marilia Chiavegato and her Ph.D. student Alexandre Mammana are examining differences among pasture types and grazing regimes. Their preliminary results suggest that balancing grazing heights and removal rates to maximize leaf proportion and promote regrowth can significantly enhance forage quality and grazing frequency. Their findings indicate that grazing at shorter heights results in higher availability of green, nutrient-dense forage (Fig. 6). Leaving 50% of the forage as post-grazing residual can help maintain faster regrowth and long-term pasture persistence.

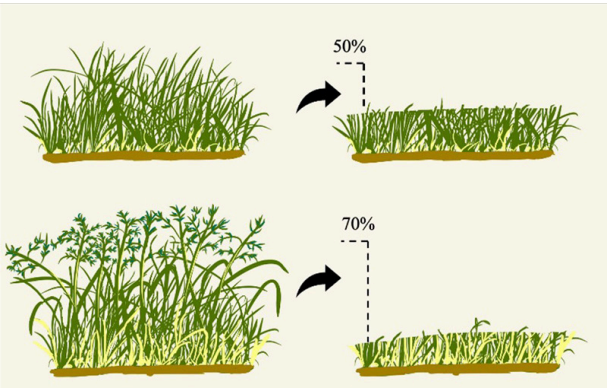


Figure 6. Grazing shorter and leaving 50% of pasture height residue supports faster regrowth and improves long-term pasture persistence, compared to removal of 70% of the pre-grazing height. Graphic by Alexandre F. Mammana.

Graduate students at North Dakota State University describe their crop rotation experiments near Prosper Research Site, ND.

One of the experiments at North Dakota State University compared integration of alfalfa and *camelina* into other cropping systems. Findings indicate that integration of alfalfa or winter camelina into annual rotations may be beneficial for enhancing cropping system resilience.

Social and Economic Dimensions

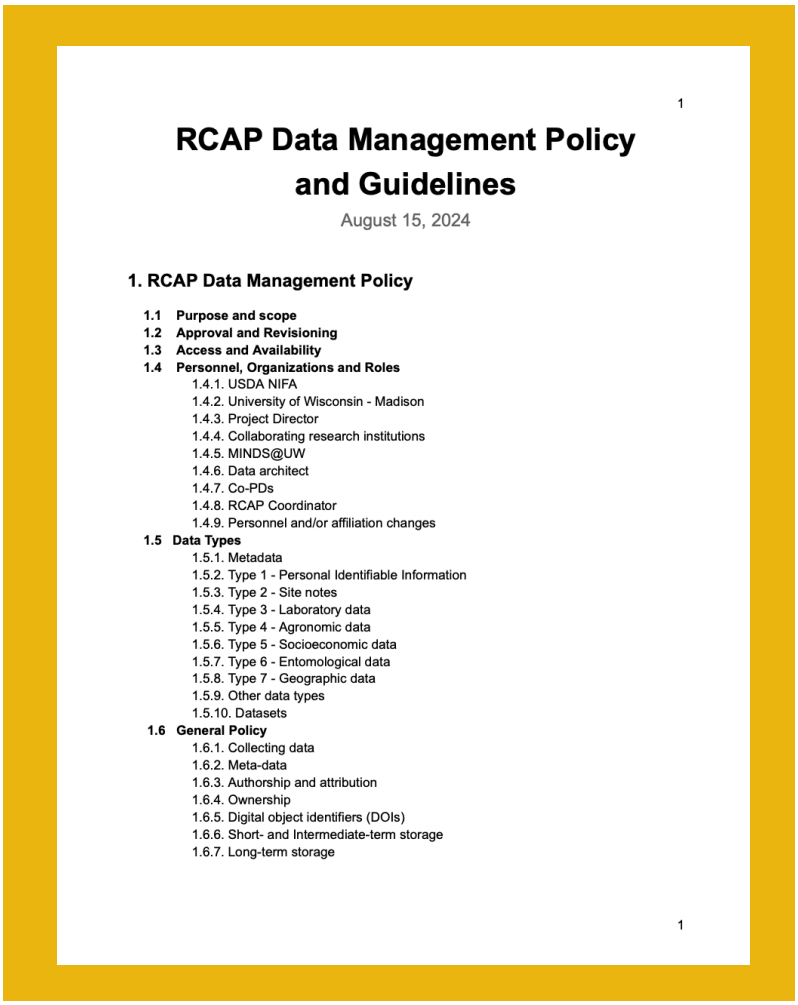
Policy, socioeconomic conditions, and lack of access to information can inhibit farmers from changing to new or different crops and livestock production systems. Through stakeholder focus groups and surveys, and farmer interviews we are identifying these barriers more specifically and discovering ways to overcome them (Fig. 6). As part of our socioeconomic outreach, we have given presentations at annual meetings of the American Society of Agronomy, the Crop Science Society of America, and Soil Science Society of America held in St. Louis (2023). We also participated in the "Growing Outreach" conference hosted by The National Wildlife Federation, in Madison (2024). Additional data collection and analyses will expand during the fourth year of the project.

Figure 6: Socioeconomic conditions and public policies inhibit adoption of forages and diverse perennial circular systems of agricultural production. We aim to better understand these barriers and discover pathways for reducing these barriers.

Data Management Plan

Accurate data, appropriate analyses, data sharing, and data distribution are essential activities for conducting, verifying, replicating, and communicating science. Accurate and appropriate identification of data authorship and attribution for use are also essential in the doing of science. For these reasons, USDA-NIFA grant funding requires creation and use of a data management plan.

Because of our existing commitments to science integrity, and to fulfill USDA-NIFA requirements, we crafted the **RCAP Data Management Policy and Guidelines**. The Policy and Guidelines define data and associated terminology, provide standards for describing data (i.e., metadata), and describe protocols and workflows for creation, access, use, storage, preservation, and sharing of data and related products of the RCAP. All collaborators associated with the RCAP must follow the Policy and Guidelines.



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RCAP Data Management Policy and Guidelines

August 15, 2024

1. RCAP Data Management Policy

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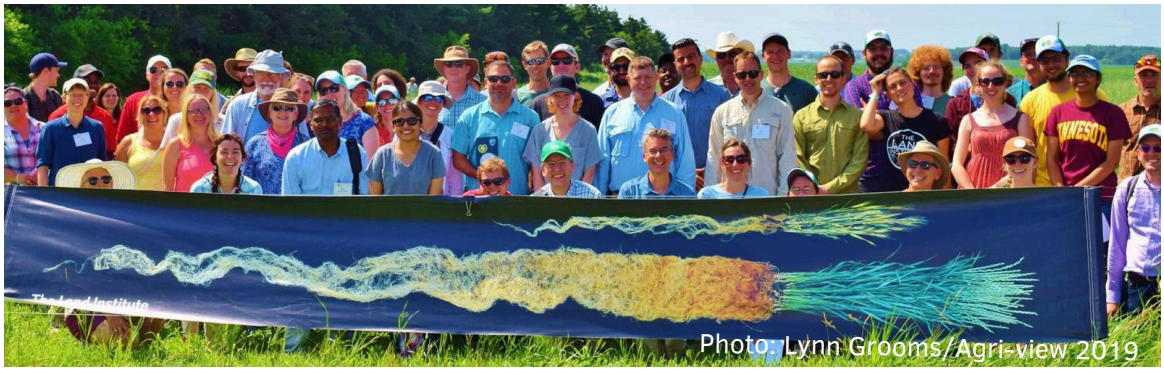
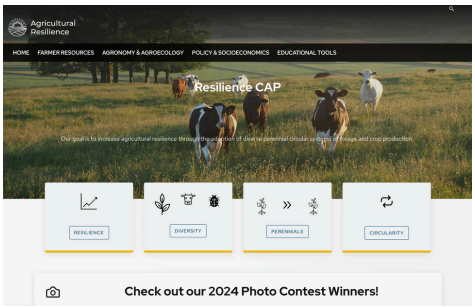
Extension, Outreach & Education



We're raising awareness of diverse perennial circular systems and the many benefits they offer. We're also providing teaching and learning tools for students K-12 and in higher education.



We launched The ResilienceCAP public website, *Ag-Resilience.org*, and the ResilienceCAP Facebook Group, Agricultural Resilience. We're engaging farmers, ranchers, extension professionals, and researchers to share the concepts and practices to support adoption of diverse perennial circular systems of agricultural production.

We support undergraduate research through our national Undergraduate Summer Internship. Undergraduate students from multiple universities actively participate in research by developing their own projects and giving presentations to peers and mentors. The program gives students understanding of sustainable agriculture, including diverse perennial circular systems, and the various scientific approaches and methodologies for addressing relevant questions.

The RCAP Graduate Forum is a student-led virtual space for graduate students and others to share their research progress and to engage in professional development. In the third year of the project, the Forum created and implemented an undergraduate mentoring program to support student learning in research projects; and developed outreach materials to be distributed through RCAP social media and public website.

RCAP graduate students presented posters during the annual All-hands Meeting in Madison, 2023.

RCAP graduate students during their poster session at the 2024 Annual All-hands Meeting in Fargo, ND.

SCHOLARLY & OUTREACH PRODUCTS

Peer Reviewed Publications

Scientific Journal Articles

Ashworth, A.J., L. Marshall, J.J. Volenec, M.D. Casler, M.T. Berti, E. van Santen, C.L. Williams, V. Gopakumar, J.L. Foster, T. Propst, V. Picasso, and J. Su. 2023. Framework to develop an open-source forage data network for improving primary productivity and enhancing system resiliency. Agronomy Journal. 115, 3062–3073. doi.org/10.1002/agj2.21441.

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Ballerstedt, Peter J., Hannaway, David B., and Noakes, T.D. 2023. Why We Need a Ruminant Revolution: Combating Malnutrition and Metabolic Illnesses to Enable Sustainable Development. International Grassland Congress. Theme 3-1, 19. Univ. Kentucky: UKnowledge. https://uknowledge.uky.edu/cgi/viewcontent.cgi?article=4265&context=igc

Igboke, O., Bortolon, E.S.O., Asworth, A., Tallksen, J., Picasso, V., and Berti , M.T*. 2024. Perennial forage systems enhance ecosystem quality variables compared with annual forage systems, Sustainability (under review).

Jacobs, A.A., M.D. Flythe, D.G. Ely, L. Munoz, J.B. May, J.A. Nelson, V. Stanton, R.K. McGrail, K. Pham, and R.L. McCulley. 2024. Biochanin A feed supplementation alters dynamics of trace gas emissions from lamb urine-amended soil. Journal of Environmental Quality. DOI: 10.1002/jeq2.20628.

Jacobs, A.A., R.S. Evans, J.K. Allison, W.L. Kingery, R.L. McCulley, and K.R. Brye. 2024. Tillage and cover crop systems alter soil particle size distribution in raised-bed-and-furrow row-crop agroecosystems. Soil Systems 8(1): 6. doi.org/10.3390/soilsystems8010006.

Jaramillo, D., J.C.B. Dubeux, Jr., A.R.S. Blount, J. Cavadini, S. Harrison. 2023. Black oat (Avena strigosa) as an alternative forage species for the US upper Midwest. Crop, Forage, & Turfgrass Management 9(2):e20249 https://doi.org/10.1002/cft2.20249.

Jenkins, M., Hillhouse, H., and J.A. Guretzky. Interseeding sorghum sudangrass into glyphosate-suppressed pastures: forage yield and smooth bromegrass recovery. Agrosystems, Geosciences & Environment. https://doi.org/10.1002/agg2.20552.

MacDougall, A., E. Esch, Q.Q. Chen, O. Carroll, C. Bonner, T. Ohlert, M. Siewert, J. Sulik, A. Schweiger, E.T. Borer, D. Naidu, S. Bagchi, Y. Hautier, P. Wilfahrt, K. Larson, J. Olofsson, E. Cleland, R. Muthukrishnan, L. O'Halloran, J. Alberti, T.M. Anderson, C.A. Arnillas, J.D. Bakker, I.C. Barrio, L. Biederman, E.H. Boughton, L.A. Brudvig, M. Bruschetti, Y. Buckley, M.N. Bugalho, M.W. Cadotte, M.C. Caldeira, J.A. Catford, C. D'Antonio, K. Davies, P. Daleo, C.R. Dickman, I. Donohue, M.E. DuPre, K. Elgersma, N. Eisenhauer, A. Eskelinen, C. Estrada, P.A. Fay, Y. Feng, D.S. Gruner, N. Hagenah, S. Haider, S. Harpole, E. Hersch-Green, A. Jentsch, K. Kirkman, J.M.H. Knops, L. Laanisto, L.S. Lannes, R. Laungani, A. Lkhagva, P. Macek, J.P. Martina, R.L. McCulley, B. Melbourne, R. Mitchell, J.L. Moore, J.W. Morgan, T.O. Muraina, Y. Niu, M. Partel, P.L. Peri, S.A. Power, J.N. Price, S.M. Prober, Z. Ren, A.C. Risch, N.G. Smith, G. Sonnier, R.J. Standish, C.J. Stevens, M. Tedder, P. Tognetti, G.F. Veen, R. Virtanen, G.M. Wardle, E. Waring, A.A. Wolf, L. Yahdijian, and E.W. Seabloom. 2024. Widening global variability in grassland biomass since the 1980s. Nature Ecology & Evolution 8:1877-1888. https://doi.org/10.1038/s41559-024-02538-x.

McGrail, R.K., A.E. Carlisle, J.A. Nelson, R.D. Dinkins, and R.L. McCulley. 2024. Tall fescue and endophyte genetics influence vertical transmission and seed characteristics under climate change scenarios. Phytobiomes. https://doi.org/10.1094/PBIOMES-09-23-0102-R.

Picasso, V.D. & Pizarro, D. 2024. Silvopastoral transitions in Latin America: toward diverse perennial systems. Agroforestry Systems. https://doi.org/10.1007/s10457-024-01023-5.

Pizarro, D.M., Zarza, R., Boggiano, P., Cadenazzi, M, Picasso, V.D. 2024. Botanical composition gradients in silvopastoral systems on temperate native grasslands of Uruguay. Agroforestry Systems. https://doi.org/10.1007/s10457-024-01027-1.

Rusch, H., J.C.B. Dubeux, Jr., L.M.D. Queiroz, M.O. Wallau, C.H. Wilson. 2023. Species richness and functional diversity enhance winter annual forage productivity and nutritive value. Crop Science 2023; 63:3136-3150. https://doi.org/10.1002/csc2.21071.

Salazar, R., Alegre, J., Pizarro, D., Duff, A.J., García, C., Gómez, C.2024. Soil carbon stock potential in pastoral and silvopastoral systems in the Peruvian Amazon. Agroforestry Systems. https://doi.org/10.1007/s10457-024-00969-w.

Santos, E.R.S., J.C.B. Dubeux, Jr., L.E. Sollenberger, C.L. Mackowiak, C.C. Vela Garcia, G.M. Silva, M.C.B. Siqueira, D.M. Jaramillo, F.O.S. van Cleef, L. Zagato, D.S. Abreu, N. DiLorenzo. 2023. Grazing intensity effects on sward responses of UF Riata bahiagrass. Crop Science 2023; 63:3122-3135. https://doi.org/10.1002/csc2.21069.

Santos, E.R.S., J.C.B. Dubeux, Jr., C. Mackowiak, L.E. Sollenberger, G.D. Farias, B.G. Homem, D.M. Jaramillo, L. Zagato, L.M.D. Queiroz, D.L. Wright, N. DiLorenzo, M. Ruiz-Moreno. 2023. Above and belowground litter decomposition of cover crops grazed at different intensities. Grass & Forage Science, 2023, 78:376-389. https://doi.org/10.1111/gfs.12617.

Santos, E.R.S., J.C.B. Dubeux, Jr., C. Mackowiak, D. Wright, G. Anguelov. 2023. Integrated crop-livestock systems result in less nitrate leaching than ungrazed crop systems in North Florida. Journal of Environmental Quality, 52(4):847-858. https://doi.org/10.002/jeq2.20474.

Siebert, J., M. Sünnemann, Y. Hautier, A.C. Risch, J.D. Bakker, L. Biederman, D.M. Blumenthal, E.T. Borer, M.N. Bugalho, A.A.D. Broadbent, M.C. Caldeira, K.F. Davies, A. Eskelinen, N. Hagenah, J.M.H. Knops, A.S. MacDougall, R.L. McCulley, J.L. Moore, S.A. Power, J.N. Price, E.W. Seabloom, R. Standish, C.J. Stevens, S. Zimmermann, and N. Eisenhauer. 2023. Drivers of soil biological activity across global grasslands. Communications Biology 6, Article number: 1220.

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Wei Yang, Di Fang, Jada Thompson, and Rudy Nayga. 2024. Public Acceptance of Beef Carbon Tax Earmarks. Food Policy. Available at https://doi.org/10.1016/j.foodpol.2024.102733.

Book Chapter

Dubeux, J.C.B., Jr., I.L. Bretas, D.M Jaramillo, D. Camelo, L.M.D. Queiroz, B.G. Homem. 2023. Ecosystem services in tropical pastures. In: M.V.F. dos Santos (ed.); Pastagens tropicais (livro eletrônico]: dos fundamentos ao uso sustentável. Visconde do Rio Branco, MG: Suprema Gráfica, 2023. ISBN 978-85-8179-199-9 p.321-354. Available at https://www.ppgz.ufrpe.br/media/3/download .

Thesis/Dissertation

Kurth, A. 2024. Integrating Alfalfa and Winter Camelina Into Wheat-Sunflower-Soybean Rotations Enhances Biodiversity and Cropping System Resilience. North Dakota State University, Plant Science M.S. thesis. https://ezproxy.library.wisc.edu/login?url=https://www.proquest.com/dissertations-theses/integrating-alfalfa-winter-camelina-into-wheat/docview/3106367587/se-2?accountid=465.

Jenkins, Jonathon Matthew. 2024. Using Annual Forages to Replace Declining Cool-Season Grass Pasture Availability. Department of Agronomy and Horticulture: Dissertations, Theses, and Student Research. University of Nebraska-Lincoln. https://digitalcommons.unl.edu/agronhortdiss/260/.

Hartman, Margaret. 2024. Odonata species composition in agroecosystems: Preliminary surveys with an emphasis on potential for biological control on farms. Master's thesis, University of Maryland.

Portuguez-Acuña, J. 2024. ECOSYSTEM SERVICES AND LIFE CYCLE ASSESSMENT OF DIVERSE GRASS-LEGUME SYSTEMS. University of Florida, Agronomy Department, July 2024. 140 p.

Shokoohi, Alireza. 2024. Enhancing biological control by ground beetles (Coleoptera: Carabidae) through agricultural drainage ditch management practices. Master's thesis, University of Maryland.

Databases & Datasets

Ashworth, A.J., L. Marshall, J.J. Volenec, M.D. Casler, M.T. Berti, E. van Santen, C.L. Williams, V. Gopakumar, J.L. Foster, T. Propst, V. Picasso, and J. Su. 2023. *National Forage Data Hub: a public repository of forage data across the U.S.* (https://doi.org/10.15482/USDA.ADC/1529174).

Conference Papers

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Dubeux, J.C.B., Jr., D.M. Jaramillo, E.R.S. Santos, L. Garcia, L.M.D. Qeuiroz, K.R. Trumpp. 2023. Sustainable intensification of livestock systems using forage legumes in the Anthropocene. Proceedings of the XXV International Grassland Congress, 14-19 May 2023, Covington, Kentucky, USA. Print ISBN: 978-1-7138-8028-8. eISBN: 978-1-7138-8029-5. https://doi.org/10.52202/071171-0022 p.98-101.

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Finan, A.S. and Margaret Kroms 2024. Resilience CAP Project: Insights from our social science investigations. Aug.22. Presented at the Growing Outreach Conference, hosted by the National Wildlife Federation, Madison, WI.

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Mammana, A.F., Stachler, C., Chiavegato, M.B. 2023. Identifying Grazing Targets for Improved Forage Quality in Ohio. In Proceedings of ASA, CSSA, SSSA International, St Louis, MO, Oct 29-Nov 1, 2023.

Portuguez, J., J.C.B. Dubeux, Jr., A. Martin-Ryals, L. Garcia, L. Sollenberger, N. DiLorenzo, M. Ruiz-Moreno, K.R. Trumpp, L.D. Queiroz, I.L. Brêtas, K. Oduor, B. Bizzuti, M.A. Lira, Jr., F. Simili, R. Sartori, M. Bernardini. 2024. Tracking nitrogen pathways on contrasting cropping systems utilizing 15N-labeled urea. American Forage and Grassland Council (AFGC) Annual Meeting, Mobile, AL, 7-10 January 2024.

Queiroz, L.M.D., J.C.B. Dubeux, Jr., L.E. Sollenberger, M.O. Wallau, D.R.S. Loures, M.A. Bernardini, I.L. Bretas, S.F. Novo, K.R. Trumpp, K.T. Oduor, J.D. Pereira neto, M. Ruiz-Moreno. 2023. A novel technique to label cover crop biomass using stable isotopes. Proceedings of the XXV International Grassland Congress, 14-19 May 2023, Covington, Kentucky, USA. Print ISBN: 978-1-7138-8028-8. eISBN: 978-1-7138-8029-5. https://doi.org/10.52202/071171-0263 p.1088-1091.

Queiroz, L.M.D., J.C.B. Dubeux, Jr., L.E. Sollenberger, M.O. Wallau, K.Oduor, I.L. Bretas, J.D. Pereira neto, K.R. Trumpp, J.P. Acuna, M.A. Bernardini, M.A. Lira, Jr., B.E.B. Cremostim, F.F. Simili, M. Ruiz-Moreno. 2023. Tracking cover crop nutrient decomposition in integrated crop and livestock systems using stable isotopes. ASA/CSSA/SSSA International Annual Meeting Abstracts, St. Louis, MO.

Queiroz, L.M.D., J.C.B. Dubeux, Jr., M.A. Lira, Jr., L.E. Sollenberger, M.O. Wallau, J.M.B. Vendramini, H.L. Liao, L. Garcia-Jimenez, M. Ruiz-Moreno, K. oduor, I.L. Bretas, J.D. Pereira Neto, K.R. Trumpp, M.A. Bernardini, J.P. Acuna. 2023. Belowground responses of cool-season grass-legume mixtures using enriched 15N2 and 13CO2 as tracers. ASA/CSSA/SSSA International Annual Meeting Abstracts, St. Louis, MO.

Queiroz, L.M.D., M.A. Lira, Jr., A.S. Erhunmwunse, P.T.S. sena, C.L. Mackowiak, M. Ruiz-Moreno, H.L. Liao, J.C.B. Dubeux, Jr. 2023. Further evidence for legume-grass direct N transfer. ASA/CSSA/SSSA International Annual Meeting Abstracts, St. Louis, MO.

Santos, E.R.S., J.C.B. Dubeux, Jr., B.G.C. Homem, C. Mackowiak, L.E. Sollenberger, D. Wright. 2023. Short-term soil organic matter and carbon responses to contrasting grazing intensities in integrated crop-livestock systems. Proceedings of the XXV International Grassland Congress, 14-19 May 2023, Covington, Kentucky, USA. Print ISBN: 978-1-7138-8028-8. eISBN: 978-1-7138-8029-5. https://doi.org/10.52202/071171-0020 p.88-92.

Simili, F.F., J.C.B. Dubeux, Jr., L.M.D. Queiroz, B.E.B. Cremostim, I.L. Bretas, M.A. Lira, Jr., R.S. reis, J.P. Acuna, K.R. Trumpp, M. Ruiz-Moreno, D.M. Jaramillo, K. Oduor, M.A. Bernardini. 2023. Can sunn hemp intercropping with corn improve yield, nitrogen cycling, and nematode control? ASA/CSSA/SSSA International Annual Meeting Abstracts, St. Louis, MO.

Stachler, C., Mammana, A.F., Chiavegato, M.B. 2023. Associated Effects of Grazing and Inundation in Greenhouse Gas Emissions in Southern Ohio. In Proceedings of ASA, CSSA, SSSA International, St Louis, MO, Oct 29-Nov 1, 2023.

Zubieta, A., M. Wallau, J.C.B. Dubeux, Jr., E. Matcham, L.M.D. Queiroz. 2024. Grazing management on cover crops – how intensity can affect productive and environmental outcomes. American Forage and Grassland Council (AFGC) Annual Meeting, Mobile, AL, 7-10 January 2024.

Presentations

Ashworth, A.J., Marshall, L., Volenec, J., Berti, M., van Santen, E. Williams, C., Gopakumar, V., Foster, J. 2024. Invited to present to the Ecosystem Services and Market Consortium (ESMC) Non-Profit on “Creating a National Forage Database for Resiliency and Carbon”, 2023.

Akins, M.S., J.S. Cavadini, K.G. Wells, D.M. Pizarro, V.D. Picasso, M.A. Wattiaux. 2024. Effect of nitrogen fertilization on yield and nutritive value of fall-stockpiled tall fescue, meadow fescue, or orchardgrass. ADSA Annual Meeting. June 16-19th 2024. West Palm Beach, Florida, USA.

Berti, M.T. 2024. What is the value of alfalfa in a diverse multicrop rotation? ND Soil and Water Conservation Society Annual Meeting. Dickinson, ND, 19 September, 2024 Invited speaker YES Chiavegato, M.B., Mammana, A.F., Rodriguez, C.Y. 2023. Productive Grasslands – The Role of Adapted Species to Increase Ecosystems resilience. International Grassland Congress, Covington, KY, 14-19 May, 2023. (invited presentation).

Brucchieri, A. 2024. From pond to pest patrol: Enhancing dragonfly habitats for sustainable agriculture. The University of Maryland 3-Minute Thesis Competition, College Park, MD

Brucchieri, A. and W. Lamp. 2024. Use of farm ponds to promote dragonfly reproduction for conservation biological control. Dragonfly Society of the Americas Annual Meeting, Marietta College, Marietta, OH.

Craig, H., Tiwari, A., Kohn, R., Rico, E., Lamp, W. 2024. Black soldier fly larvae (Hermetia illucens) as a climate mitigating protein supplement: Preliminary data. Department of Entomology Annual Retreat. University of Maryland.

Craig, H., Kraemer, J., Lamp, W. 2023. Undergraduate research within a multistate, transdisciplinary project: Integration with principal investigators and graduate students. Entomological Society of America Annual Meeting. National Harbor, DC.

Dhariwal, A. 2024. "Rooting for Perennials: Evaluating Silflower as an Intercrop & a Forage". September 28, 2024. Presented at the Perennial Grains Early Career Workshop, hosted by The Land Institute in Salina, Kansas.

Dubeux, J.C.B., Jr., D.M. Jaramillo, E.R.S. Santos, L. Garcia, L.M.D. Qeuiroz, K.R. Trumpp. 2023. Sustainable intensification of livestock systems using forage legumes in the Anthropocene. Proceedings of the XXV International Grassland Congress, 14-19 May 2023, Covington, Kentucky, USA. Print ISBN: 978-1-7138-8028-8. eISBN: 978-1-7138-8029-5. https://doi.org/10.52202/071171-0022 p.98-101. Presented at the XXV International Grassland Congress.

Dubeux, J.C.B., Jr., E.R.S. Santos, J.E. Portuguez-Acuna, L.M.D. Queiroz. 2023. Nutrient cycling and crop responses on integrated crop-livestock systems. Proceedings of the XXV International Grassland Congress, 14-19 May 2023, Covington, Kentucky, USA. Print ISBN: 978-1-7138-8028-8. eISBN: 978-1-7138-8029-5. https://doi.org/10.52202/071171-0272 p.1123-1126. Presented at the XXV International Grassland Congress.

Fang, Di and Posey, Sean. 2024. Misperceptions and Strategic Firm Response. Southern Economic Association Meetings Nov. 26th. Washington, D.C.

Igboke, O., Berti, M.T., Mosqueda H/, Lindell, H., Islam, Md.S., Morocho-Lema, M., and Omeye, F. 2024. Comprehensive life cycle assessment of forage cropping systems for sustainable agriculture. Annual meeting NCCC31 Forage committee and R-CAP, Fargo ND, 12-15 August, 2024.

Igboke, O., Bortolon, E.S.O., and Berti, M.T. 2024. Terrestrial acidification, ecotoxicity, eutrophication potential are reduced in production systems that include perennial forages. North American National Alfalfa Improvement Conference, Pasco, WA, 24-26 June 2024.

Islam, Md.S., and M.T. Berti. 2024. Intercropping alfalfa and sainfoin with sunflower boosts forage production, soil health, and biodiversity. North American Alfalfa Improvement Conference, Pasco, WA, 24-26 June 2024.

Jenkins, Jonathon Matthew. 2024. Using Annual Forages to Replace Declining Cool-Season Grass Pasture Availability. Thesis Defense. Department of Agronomy and Horticulture. University of Nebraska-Lincoln. April 12, 2024.

Lamp, W., Craig, H., Brucchieri, A., Evans, K.C., Kerner, L., ni Chochlain, L., Saenz, A.M., Salerno, R.J., Shokoohi, A. 2023. Does management of plant diversity enhance arthropod-mediated ecosystem services in agricultural landscapes? Entomological Society of America Annual Meeting. National Harbor, DC.

Mammana, A.F., Stachler, C., Chiavegato, M.B. 2023. Identifying Grazing Targets for Improved Forage Quality in Ohio. In Proceedings of ASA, CSSA, SSSA International, St Louis, MO, Oct 29-Nov 1, 2023. (oral presentation).

Mammana, F.A., Chiavegato, M.B. 2023. Identifying Grazing Targets for Improved Forge Quality in Ohio. 16th Annual Horticulture & Crop Science Research Symposium, Wooster, OH. (oral presentation).

Marshall, L., 2024. National Forage Data Hub: a platform for sharing valuable datasets for resilience. May 21. Presented at NIFA Grant Development and Grant Management Training for HSI Universities, hosted by the University of Texas at Arlington.

McGrail, R.K., R.C. Pearce, S.T. Lucas, L. Moe, and R.L. McCulley. Fall 2023. Nutrient dynamic considerations for fiber dew retting. ASA-CSSA-SSSA Annual Meeting, St. Louis, MO.
McGrail, R.K., R.C. Pearce, S.T. Lucas, L. Moe, and R.L. McCulley. Fall 2023. Inclusion of industrial hemp in Kentucky's cropping rotation: effects on agroecosystem function. ASA-CSSA-SSSA Annual Meeting, St. Louis, MO.

Mosqueda H., M.T. Berti, S. Bibby, A. Kurth, and H. Lindell. 2023. Integrating Alfalfa into Corn or Forage Sorghum to Increase System Diversity and Perenniality. [Abstract] ASA-CSSA-SSSA International Annual Conference, St, Louis, MO, 29 Oct-1 Nov, 2023.

Pizarro, D.M., D.A. Plata-Reyes, C.G.Martínez-García, C.A. Gómez-Bravo, V.D. Picasso, and M.A. Wattiaux. 2024. Perception of changes in agroecological practices of dairy farms by smallholders in Peru and Mexico. ADSA Annual Meeting. June 16-19th 2024. West Palm Beach, Florida, USA.

Salerno, R., and Brucchieri, A. 2024. Graduate student forum: Past, present, and future. RCAP Annual Meeting. Fargo, ND.

Salerno, R., and Lamp, W. 2024. Assessment of soil properties under different land use types on a cattle farm in central Maryland. NCCC31 Ecophysiological Aspects of Forage Management. Fargo, ND.

Salerno, R. 2024. Beneath our feet: Cultivating resilience with agriculture’s hidden heros. 3 Minute Thesis Competition. University of Maryland, College Park, MD.

Wolfe, A.J., A.A. Jacobs, J.A. Nelson, A.E. Carlisle, R.K. McGrail, and R.L. McCulley. Fall 2023. Effect of grass-endophyte symbiotic diversity on pasture soil health in Kentucky. ASA-CSSA-SSSA Annual Meeting, St. Louis, MO.

Extension Materials

Bretas, I.L., J.C.B. Dubeux, Jr. 2023. Southeast Grazing Exchange Website: A New Tool to connect livestock producers and landowners throughout the Southeastern US. NIFA Support Acknowledged: NO Available at Southeast Grazing Exchange Website: A New Tool to Connect Livestock Producers and Landowners throughout the Southeastern US | Panhandle Agriculture (ufl.edu)

Craig, H. 2024. Creative Displays – Starting the Conversation About Insect Ecosystem Services. Maryland Grows Blog. https://marylandgrows.umd.edu/2024/05/27/creative-displays-starting-the-conversation-about-insect-ecosystem-services/.

Craig, H., Lamp, W. 2024. UMD Libraries as a resource in educating and empowering students on the importance of insect ecosystem services. UMD Libraries' STEAM Salon. University of Maryland, College Park.

Dubeux, J.C.B., Jr., K. Waters, and N. DiLorenzo. 2023. Road map to develop forage-based systems. Progressive Forage, March 7, 2023. NIFA Support Acknowledged: NO Available at Road map to develop forage-based systems | Ag Proud.

Dubeux, J.C.B., Jr., L.D. Queiroz, D. Jaramillo, L. Garcia, E.R.S. Santos, I.L. Bretas, M. Bernardini, K.R. Trumpp, J. Portuguez, H. Koury, K. Oduor, M. Ruiz-Moreno. 2023. Is a year-round grazing system feasible in North Florida? NIFA Support Acknowledged: NO Available at Is a Year-Round Grazing System Feasible in North Florida? | Panhandle Agriculture (ufl.edu).

Dubeux, J.C.B., Jr., K.R. Trumpp, L.D. Queiroz, I.L. Bretas, M. Bernardini, J. Portuguez, L. Garcia, K. Oduor, F. Simili, B. Bizzuti, M.A. Lira, Jr., M. Ruiz-Moreno. 2024. Forage Legumes: A Potential Way to Reduce N Fertilizer Inputs. The Florida Cattleman and Livestock Journal, February 2024. V. 88, n.5, p .42-44.

Dubeux, J.C.B., Jr., I.L. Bretas. 2023. Southeast grazing exchange: a new tool to help integrating crop and livestock systems. The Florida Cattleman and Livestock Journal, November 2023, v. 88, n. 2, p.12-20.

Gruss, S. (July 2024). "Forage Assessment and Recovery Following Flooding." Iowa Beef Center Press Release.

Gruss, S. (June 2024). "Forage Options with Prevented Planting Fields." ICM News.

Gruss, S. (2024). Exploring Tactics with Warm-season annual forage. (Oral Presentation). Iowa Learning Farms. Online.

Gruss, S. (June 2024). "Forage Options with Prevented Planting Fields." ICM News.

Gruss, S. (2024). Pasture Pay in Many Ways. (Oral Presentation). Cornbelt Cow-Calf Conference, Ottumwa, IA.

Mammana, A., F., Otaviano, E.K., Ribeiro, R.H., Chiavegato, M.B. 2024. Maximizing Forage Quality Through Targeted Grazing of Native Warm-season Grasses. Factsheet. Ohio State University Extension. In press.

Pizarro, D.M., Akins, M.S., Picasso, V.D., Wattiaux, M.A. 2024. Use of Kernza Intermediate Wheatgrass Straw on Dairy Heifer Diets. Forage Focus. Midwest Forage Association. August 2024. Page 9.

Wallau, M., A. R. Blount, E. Rios, J. M. B. Vendramini, J.C.B. Dubeux, M. A. Babar, K. E. Kenworthy, and K. H. Quesenberry. 2023. 2023 Cool-season forage variety recommendations for Florida. EDIS SS-AGR-84 https://doi.org/10.32473/edis-aa266-2023.

Wallau, M., A. R. Blount, J. M. Campos-Krauer, M. A. Lashley, E. Rios, J. M. B. Vendramini, J.C.B. Dubeux, Md. A. Babar, C. L. Mackowiak, and K. H. Quesenberry. 2023. A Walk on the Wild Side: 2023 Cool-Season Forage Recommendations for Wildlife Food Plots in North Florida. NIFA Support Acknowledged: NO EDIS SS-AGR-28 https://doi.org/10.32473/edis-ag139-2021.

Non-Extension Outreach

Berti M.T. 2023. Weed control in established alfalfa and terminating a stand. Forage Focus Magazine December 2023. Midwest Forage Association, St. Paul, MN p. 14.

Craig, H., Lamp, W. 2024. Insects as Feed for Dairy Cattle?. Undergraduate Guest Lecture to BSCI145 “Insect Apocalypse; real or imagined” course. University of Maryland.

Posters

Atiemo, Kniss and Islam. 2024. Evaluating the effect of management practices on soil health in different cropping systems in Wyoming. RCAP and NCCC31 meeting, August 12, 2024, Fargo, North Dakota.

Akins, M.A., Cavadini, J.S., Wells, K.G., Pizarro, D.M., Wattiaux, M.A., Picasso, V.D. 2024. Effect of nitrogen fertilization on yield and nutritive value of fall-stockpiled tall fescue, meadow fescue, or orchardgrass. Journal of Dairy Science. 107(Suppl. 1): 366.

Brucchieri, A. and Lamp, W. 2024. Characteristics of farm ponds that promote dragonfly reproduction for conservation biological control. EntoQuest, Entomological Society of America Meeting, Jefferson Township, NJ.

Brucchieri, A. and Lamp, W. 2023. Characteristics of Farm Ponds that Promote Dragonfly Reproduction for Biological Control. Entomological Society of America Annual Meeting, National Harbor, MD.

Brucchieri, A. and Lamp, W. 2023. Characteristics of Farm Ponds that Promote Dragonfly Reproduction for Conservation Biological Control. EntoQuest, Entomological Society of America Meeting, DE.

Craig, H. and Lamp, W. 2023. Educating and empowering University of Maryland students on the importance of insect biodiversity in sustainability. Entomological Society of America Annual Meeting. National Harbor, DC.

Denyer, H., Salerno, R., and Lamp, W. 2024. Bait lamina strips reveal lower rates of decomposition in corn-soy rotation fields compared to perennial forage pastures. EntoQuest, Entomological Society of America Meeting, Jefferson Township, NJ.

Dhariwal, Murrell, Pinto and Picasso. 2024. Perennial silflower (Silphium integrifolium) biomass is not affected by intercrop species. Resilience CAP Conference, August 13, 2024, Fargo, ND.

Kurth, A. 2023. Integrating Alfalfa and Winter Camelina Into Wheat-Sunflower-Soybean Rotations Enhances Biodiversity and Cropping System Resilience. ASA, CSSA, SSSA Annual Meeting, October 30, 2023, St. Louis, MO.

Kurth, A. 2023. Integrating Alfalfa and Winter Camelina Into Wheat-Sunflower-Soybean Rotations Enhances Biodiversity and Cropping System Resilience. North Dakota State University Graduate Student Research Day, April 10, 2024, Fargo, ND.

Jenkins, M., H. Hillhouse, and J. Guretzky. 2023. Resilience of grazed double cover crops versus diverse perennial circular systems. ASA, CSSA, SSSA International Annual Meeting. St. Louis, MO. November 1, 2023.

Jenkins, M., H. Hillhouse, and J. Guretzky. 2023. Resilience of grazed double cover crops versus diverse perennial circular systems. Resilience CAP Annual Meeting. Building Transdisciplinarity in Team Science for Diverse Perennial Circular Systems. Madison, WI. October 9, 2023.

Orcasberro, M.S., C.L. Williams, and V. D. Picasso. A Transdisciplinary Framework for Promoting Diverse Perennial Circular Forage Systems. Cuarto Congreso de Investigación y Educación Superior Interdisciplinaria (IEI) 2024, Montevideo, Uruguay, 23-26 July, 2024.

Pizarro, D.M., Plata-Reyes, D.A., Martínez-García, C. G., Gómez-Bravo, C.A., Picasso, V.D., Wattiaux, M. A. 2024. Perception of agroecological performance of dairy farms by smallholders in Mexico and Peru. Journal of Dairy Science. 107(Suppl. 1): 373.

Plata-Reyes, D.A., Martínez-García, C. G., Pizarro, D.M., Wattiaux, M.A. 2024. Agroecological performance of smallholder dairy cattle systems in Aculco, Mexico. Journal of Dairy Science. 107(Suppl. 1): 374.

Ronk, E., Erickson, M.G., Pizarro, D.M., Wattiaux, M.A. Careers and Curricular Topics that Interest Introductory Animal and Dairy Science Students. NACTA Journal. Volume 68, Supplement 1: 94.

Salerno, R., Denyer, H., and Lamp, W. 2024. Bait lamina strips reveal lower rates of decomposition in corn-soy rotation fields compared to perennial forage pastures. RCAP Annual Meeting, Fargo, ND.

Salerno, R., Brucchieri, A. 2023 Resilience CAP grant graduate forum: Our beginning and what's next. RCAP All-Hands Meeting 2023, Madison, WI.

Salerno, R., Shokoohi, A., and Lamp, W. 2023 Evaluating ground beetle (Coleoptera: Carabidae) movement between agricultural drainage ditches and arable fields: A case history for conservation biological control. RCAP All-Hands Meeting 2023, Madison, WI.

Salerno, R., and Lamp, W. 2023. Subterranean arthropod sampling of agroecosystem semi-natural habitats: A comparison of techniques. Entomological Society of America National Meeting. National Harbor, MD.

Shechtman, F.J., Craig, H., Righter, R., Lamp, W. 2023. Use of sticky traps to compare patterns of flying insect biodiversity on farms: taxa diversity and ecological roles. Entomological Society of America Annual Meeting. National Harbor, DC.

Stachler, C., Mammana, A.F., Chiavegato, M.B. 2023. Associated Effects of Grazing and Inundation in Greenhouse Gas Emissions in Southern Ohio. ASA, CSSA, SSSA International, St Louis, MO, Oct 29-Nov 1, 2023. (poster).

Events

Atiemo, M. UW. Field Research Stop Talk. 2024 Weed Science Field Tour. UW-SAREC, Wyoming June. 20, 2024. (Field day event.)

Dhariwal, A. "Archipelago - Art. Agriculture. Sustainability". Allen Centennial Garden, Madison, WI. September 24, 2024. (Field day event.)

Jones, G and D. Hannaway. Introduction to RCAP. Oregon Forage and Grassland Council Annual Meeting, Corvallis, OR. November 9, 2023.

Tautges, N. 2024. Perennial Crops. Illinois Grain Conference. February 7, 2024, Champaign, IL. 25 attendees.

Tautges, N. Weatherproofing Your Farm: Using Federal Funding to Protect Your Farm From Extreme Weather Events; June 13, 2024, 50 attendees, State Farm, East Troy, WI. (Field Day Event.)

Tautges, N. Crops for Our Future, August 2, 2024, 50 attendees, Michael Fields Agricultural Institute, East Troy, WI. (Field Day Event.)

Appendix: Advisory Committee & Collaborators

RCAP Advisory Board

Cornelia Butler Flora	Professor Emerita of Sociology and Agriculture	Iowa State University
Chuck West	Professor Emeritus of Plant and Soil Sciences	Texas Tech University
Cristine Morgan	Chief Scientific Officer	Soil Health Institute
Peter Ballerstedt	Forage Ambassador	Barenbrug, USA
David Hinman	Alfalfa Farmer (WY)	Hardrock Farms Inc.
John Ruedinger	MFA board member and Dairy Farmer (WI)	Ruedinger Farms Inc.
Dan Cornelius	Technical Assistance Specialist and Oneida Farmer (WI)	Inter-Tribal Agricultural Council
Alison Eagle	Sustainable Agriculture Scientist	Environmental Defense Fund

RCAP Collaborators

Amanda Brucchieri, Graduate student, U. of Maryland
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Aaron Reser, Associate Dir., Green Lands Blue Waters
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Walter Baethgen, Senior Res. Scientist, Columbia U.
Jasmine Bontrager, Graduate student, Mich. State Univ.
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Marilia Chiavegato, Assist. Professor, Ohio State U.
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Coral Weinstock, Outreach Coord., Michael Fields Ag. Inst.
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Erika Everest, Graduate student, Cornell University
Edzard van Santen, Professor, U. of Florida
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Fred Iutzi, Dir. of Res. & Commercialization, Savanna Inst.
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Heidi Hillhouse, Research Scientist, U. of Nebraska
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Jennifer Tucker, Assistant Professor, U. Georgia
Jamie Foster, Research Professor, Texas A&M University
James Lee Mitchell, Assistant Professor, U.of Arkansas
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Marisol Berti, Professor, N. Dakota State University
Michael Casler, Plant Geneticist & Biometrician, USDA-ARS
Mrill Ingram, Scientist, Michael Fields Agricultural Institute
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Appendix Cont'd

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Erin Meier, Director, Green Lands Blue Waters
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10 MARCH 2025
This report was prepared by Carol L. Williams, University of Wisconsin - Madison
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