**Annual Report for NC1195 for 2021-2022**

**Publications, Conference papers, and Grants**

**Project/Activity Number:** NC1195

**Project/Activity Title:** Enhancing nitrogen utilization in corn based cropping systems to increase yield, improve profitability and minimize environmental impacts

**Period Covered:** March 4, 2021 to February 28, 2022

**Date of this Report:** March 21, 2022

**Annual Meeting Date(s):** March 1-2, 2022

**Journal Publications**

1. Middleton, T.E., A.L. McCombs, S.R. Gailans, S. Carlson, D.L. Karlen, K.J. Moore, M.Z. Liebman, T.C. Kaspar, M.M. Al-Kaisi, D.A. Laird, M.H. Wiedenhoeft, K. Delate, C.A. Cambardella, M.L. Thompson, E.A. Heaton, **M.D. McDaniel**. 2021. Assessing biological soil health through decomposition of inexpensive household items. *Applied Soil Ecology* 168, 104099.
2. Studt, J.E., **M.D. McDaniel**, M.D. Tejera, A. VanLoocke, A. Howe, E.A. Heaton. 2021. Soil net nitrogen mineralization and leaching under Miscanthus × giganteus and Zea mays. *Global Change Biology Bioenergy* 13(9), 1545-1560.
3. Weisberger, D.A., **M.D. McDaniel,** J.G. Arbuckle, M. Liebman. 2021. Farmer perspectives on benefits of and barriers to extended crop rotations in Iowa, USA. *Agricultural and Environmental Letters* 6, e20049.
4. Nunes, M.R., M. De, **M.D. McDaniel**, J.L. Kovar, S.J. Birrell, D.L. Karlen. 2021. Science-based maize stover removal can be sustainable. *Agronomy Journal* 113(4), 3178-3192.
5. Dhaliwal, JK., D. Panday, **D. Saha,** J. Lee, **S. Jagadamma**, S. Schaeffer, A. Mengistu. Predicting and interpreting cotton yield and its determinants under long-term conservation management practices using machine learning. (under review in *Computers and Electronics in Agriculture*)
6. Hu, J., J. Richwine, P. Keyser, F. Yao, **S. Jagadamma,** and J.M. DeBruyn. 2021. Nitrogen fertilization and native C4 grass species alter abundance, activity and diversity of soil diazotrophic communities. *Frontiers in Microbiology* 12: 1872.
7. Tosi, M., W. Deen, R. **Drijber**, M. McPherson, A. Stengel, K. Dunfield. 2021. Long-term N inputs shape microbial communities more strongly than current-year inputs in soils under 10-year continuous corn cropping. *Soil Biology & Biochemistry* 160 (2021).
8. Samuelson, M.B., E.V. Reid, R.A. **Drijber**, E. Jeske, H. Blanco-Canqui, M. Mamo, I. Kadoma, S.E. Wortman. 2021. Effects of compost, cover crops, and local conditions on degradation of two agricultural mulches in soil. *Renewable Agriculture and Food Systems*, 1-14.
9. Cooper, J.A. , R.A. **Drijber**, A. Malakar, V.L. Jin, D.N. Miller, M.L. Kaiser. Evaluating coal char as an economical alternative to biochar for mitigation of nutrient and carbon loss from manure amended soils. *Accepted by Journal of Environmental Quality Jan 3, 2022.*
10. Mooshammer, M., S. Grandy, F. Calderon, B. Deen, R. **Drijber**, K. Dunfield, V.L. Jin., M. Lehman, S. Osborn, M. Schmer, T. Bowles. 2022. Microbial feedbacks on soil organic matter dynamics underlying the legacy effect of diversified cropping systems*. Prepublication, 108584.*
11. Long, G., R. Xiang, D. Wang, S. He, P. Zhao, L. Tang, Y. Zhou, and **X. Yin**. 2021. Mitigation of intercropping-related potential nitrate leaching regulated by nitrogen level. *Agriculture, Ecosystems, and Environment.* 319:107540.
12. Zhou, G.S., **X. Yin,** and Y. Li. 2021. Long-term effects of tillage systems, cover crops, and nitrogen fertilization on growth, yield, and quality of cotton. *Journal of Yunnan Agricultural University* 36:173-178.
13. Nouri, A., D.C. Yoder, M. Raji, S. Ceylan, S. Jagadamma, J. Lee, F.R. Walker, **X. Yin,** J. Fitzpatrick, B. Trexler, P. Arelli, and A.M. Saxton. 2021. Conservation agriculture increases the soil resilience and cotton yield stability in climate extremes of the southeast US. *Communications Earth & Environment* 2:155.
14. Wang, D., W. Yi, Y. Zhou, S. He, L. Tang, **X. Yin,** P. Zhao, and G. Long. 2021. Intercropping and N application enhance soil dissolved organic carbon concentration with complicated chemical composition. *Soil and Tillage Research* 210:104979.
15. Wang, D., P. Zhao, R. Xiang, S. He, Y. Zhou, **X. Yin,** and G. Long. 2021. Nitrogen fertilization overweighs intercropping in promotion of dissolved organic carbon concentration and complexity in potato-cropped soil. *Plant and Soil* 462:273-284.
16. Leuthold, S., O. Wendroth, M. Salmeron, and **H. Poffenbarger**. 2022. Weather-dependent relationships between topographic variables and yield of maize and soybean. *Field Crops Research* 276: 108368.
17. Pecci Canisares, L., **H. Poffenbarger**, E.L. Brodie, P.O. Sorenson, U. Karaoz, D.M. Villegas, J. Arango, L. Momesso, C.A. Costa Crusciol, H. Cantarella. 2021. Legacy effects of intercropping and nitrogen fertilization on soil N cycling, nitrous oxide emissions and the soil microbial community in tropical maize production. *Frontiers in Soil Science* 1: 746433.
18. Leuthold, S., **D. Quinn**, F. Miguez, O. Wendroth, M. Salmeron, and **H. Poffenbarger**. 2021. Topographic effects on soil microclimate and surface cover crop residue decomposition in rolling cropland. *Agriculture, Ecosystems, and Environment* 320: 107609.
19. Messina, C., D. McDonald, **H. Poffenbarger**, R. Clark, A. Salinas, Y. Fang, C. Gho, T. Tang, and G. Graham, and M. Cooper. 2021. Reproductive resilience but not root architecture underpin yield improvement in maize. *Journal of Experimental Botany* 72: 5235-5245.
20. **Quinn, D.**, **H. Poffenbarger**, S. Leuthold, and C. Lee. 2021. Corn response to in-furrow fertilizer and fungicide across rye cover crop termination timings. *Agronomy Journal* 113: 3384-3398.
21. Pecci Canisares, L., J. Grove, F. Miguez, and **H. Poffenbarger**. 2021. Long-term no-till increases soil nitrogen mineralization but does not affect optimal nitrogen fertilization practices for corn. *Soil and Tillage Research* 213: 105080.
22. Leuthold, S., M. Salmeron, O. Wendroth, and **H. Poffenbarger**. 2021. Cover crops decrease maize yield variability in sloping landscapes through increased water during reproductive stages. *Field Crops Research 265*: 108111.
23. Crookston, B.S., M.A. Yost, M. Bowman, K. Veum, G. Cardon, **J. Norton.** 2021. Soil health spatial-temporal variation influence soil security on Midwestern, US farms. *Soil Security* 3: 100005.
24. KC, K., K. Zhao, M. Romanko, and S. **Khanal.** 2021. Assessment of the Spatial and Temporal Patterns of Cover Crops Using Remote Sensing. *Remote Sensing* 13(14): 2689.

**Conference presentations**

1. Singh, R., S.K. Sawatzky, S. Akin, M. Thomas, W.R. Raun, H. Zhang, **D.B. Arnall**. Interactive Effect of Nitrogen, Phosphorous, and Potassium Fertilizer on Grain Yield and Nutrient Uptake in Corn. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT. November 7-10, 2021.
2. **Li, X.,** T. Mieno, and D.S. Bullock. 2021. The Economic Performances of Different Trial Designs in On-Farm Precision Experimentation: A Monte Carlo Evaluation. In: First Conference on Farmer-Centric On-Farm Experimentation, Montpellier, France. October 13-15, 2021.
3. **Li, X**. 2021. The Economic Benefit of Applying Spatial Error Model to Agronomic Field Trial Data Analysis. In: The 2021 Agricultural & Applied Economics Association Annual Meeting, Austin, TX. August, 1 2021.
4. Adotey, N., M.A. McClure, and **X.** **Yin**. 2021. Performance of enhanced efficiency nitrogen fertilizers on ammonia loss and grain yield of unirrigated corn field under different sidedress nitrogen placement methods. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT. November 7-10, 2021.
5. **Drijber**, R., OLLI-Osher Lifelong Learning Institute, Lincoln NE, "Soil health - A microbial perspective", Local, June 22, 2021.
6. Panday, D., **Saha, D.**, Lee, J., **Jagadamma, S.** Cover crop influence on soil nitrous oxide emissions in response to drying and rewetting intensity. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT. November 7-10, 2021.
7. **Jagadamma, S.**, and Kramer, A. 2021. Cover crops: nitrogen availability and soil health. University of Tennessee Fertilizer Recommendations Update Meeting. December 10, 2021.
8. Kramer, A., and **Jagadamma, S.** 2022. Impact of cover crop species diversity on soil nutrient availability and crop productivity. ASA Southern Branch Meeting, February 12-14, 2021.
9. Davis, M.P., E. Waring, **M.D. McDaniel**, M.J. Helmers. Cover Cropping and No-Tillage Conservation Practices Enhance Soil Health Properties and Reduce Environmental Losses on Tile Drained Iowa Mollisols. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT. November 7-10, 2021.
10. Cano Camacho, V., **M.D. McDaniel**, M.A. Licht. Seed Treatment Effects on Biological Soil Health in Central, IA. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT. November 7-10, 2021.
11. Marcos, F.M., **M.D. McDaniel**, A.E. Robertson, M.A. Licht. Establishment and Termination of a Cover Crop Impact on Cereal Rye Biomass and Corn Yield Drag. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT. November 7-10, 2021.
12. KC, K. and **S. Khanal.** 2021. Crop yield and water quality effects of cover cropping in the Western Lake Erie Basin. American Society of Agricultural and Biological Engineers (ASABE) Annual International

Meeting 2021, July 12-16, Virtual. [Oral].

1. KC, K. and **S. Khanal.** 2021. Assessment of the spatial and temporal patterns of cover cropping practices in the Western Lake Erie Basin. American Society of Agricultural and Biological Engineers (ASABE) Annual International Meeting 2021, July 12-16, Virtual. [Oral].
2. Bhattaai, A. and **S. Khanal.** 2021. Modeling the effects of management practices and environmental variables on ecosystem services from corn-dominated agricultural systems. Northeast Agricultural and Biological Engineering Conference (NABEC) 2021, July 26-28, Virtual. [Poster].
3. **Khanal, S.**, M. Romanko, K. KC, J. Fisher, B. Moneymaker, C. Srasbaugh. 2021. Multiscale remote sensing technologies for monitoring cover crops and their impact on ecosystem services. EEGS/WG-PSS/SEG Symposium 2021, Application of Proximal and Remote Sensing Technologies for Soil Investigations. August 16-19, Virtual.
4. Khaleel, A., **M.D. McDaniel**, M.L. Thompson. 2021. Kinetics of Soil Enzyme Activities Under Long-Term Cropping Systems. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT. November 7-10, 2021.
5. Hendo, M., K. Cunningham, **J.M. Norton**. Investigation of the Effects of Land Use Histories and Fertilizer Treatments on Rhizobia *nifH* Diversity and *nifH* Soil Abundance in the*Vicia villosa* Cover Crop. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT, November 7-10, 2021.
6. **Norton,J. M.**, K. Cunningham, M. Hendon, P. Miller. Biological Nitrogen Fixation, Nodule Organisms and Nitrogen Dynamics in Silage Corn Following a Vetch Cover Crop. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT, November 7-10, 2021.
7. Cunningham, K., M. Hendon, **J.M. Norton**. Investigation of the Effects of Land Management Histories and Fertilizer Treatments on Rhizobia nifH Diversity and Soil Abundance in the Vicia villosa Cover Crop, SACNAS: The National Diversity in STEM Virtual Conference, SACNAS, virtual. October 25, 2021 - October 29, 2021. Awarded 2021 SACNAS Student Presentation Award
8. **Norton J. M.**, Y. Ouyang, M. Habteselassie, Nitrification communities in silage corn ecosystems, International Conference on Nitrification (ICoN7), Nitrification Network, Virtual host institution was Utah State University. July 20, 2021 - July 18, 2021.
9. Habteslassie, M. Y., L. Woodruff, **J.M. Norton**. Evaluating Microbial Function and Taxonomic Changes in Soil Treated with Different N Sources Using Metagenome-Assembled Genomes. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT, November 7-10, 2021.
10. Miller PK., **J.M. Norton.** Carbon and Nitrogen Mineralization in Soils from Corn Silage Production in a Semi-Arid Environment. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT, November 7-10, 2021.
11. **Castellano, M.**, M. Helmers, **H. Poffenbarger**, J. Six. Ecological Intensification of Agricultural Drainage: Balancing Productivity, Profitability and Environmental Performance. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT, November 7-10, 2021.
12. **Poffenbarger H.**, L. Pecci Canisares, J. Grove, F. Miguez. No-till Agriculture and Soil Fertility: Lessons from a 50-Year Tillage Comparison Study in Kentucky. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT, November 7-10, 2021.
13. Burton M., C.J. Matocha, H. Blanco, C. Creech, **H. Poffenbarger**, J.H. Grove, A. Woodley, and M.S. Coyne. Behavior of Ammonium in Soils. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT, November 7-10, 2021.
14. Flowers A., L. Pecci Canisares, and **H. Poffenbarger**. Decomposition Rates of Rye, Crimson Clover, and Mixed Rye-Clover Cover Crops in a Kentucky Corn Field. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT, November 7-10, 2021.
15. Pecci Cnisares L., D.H. McNear, T. Banet, B. Rinehart, and **H. Poffenbarger**. Interactive Effects of Living Roots and Litter Stoichiometry on Soil Carbon Stabilization and Nitrogen Cycling. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT, November 7-10, 2021.
16. Ison J., . Pecci Canisares, S. Leuthold, O. Wendroth, and **H.** **Poffenbarger.** Landscape Position and Cover Crop Effects on Soil Greenhouse Gas Fluxes. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT, November 7-10, 2021.
17. Antonio-Ordoñez R., C. White, J. Spargo, J. Kaye, Z. Sanders, R.R. Weil, W. Thomason, M. Ruark, J. Iqbal, N. Fiorellino, A.L. Schober, **M. Castellano**, S. Archontoulis, J.H. Grove, C. Lee, G. Danalatos, L.A. Puntel, **H. Poffenbarger,** and L.H. Wells. Yield Gap as a Key Metric to Determining N Fertilizer Rates in Maize Crop. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT, November 7-10, 2021.
18. Banet T., C. Messina, D.H. McNear, and **H. Poffenbarger**. In-Situ Root Imaging: Changes in Maize Root Traits over Decades of Crop Improvement. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT, November 7-10, 2021
19. Rinehart B., D. Lau, C. Messina, M. Salmeron, D.H. McNear, and **H. Poffenbarger**. Maize Root Composition Unaltered By Long-Term Selection. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT, November 7-10, 2021.
20. Pecci Canisares L., R. Thapa, S. Mirsky, R. Ye, P. Poudel, M.J. Mulvaney, Y. Upadhyaya, C. Pelzer, M.R. Ryan, A. Basche, T. Ferreira de Almeida, P.J. Tomlinson, D.R. Presley, K.L. Roozeboom, A. Sadeghpour, G. Sener, C. Kula, M.D. Ruark, J. Ross, J.M. Wallace, J. Adam, J. Miller, A. Woodley, L.M. Fultz, H.M. Darby, L. Ruhl, P. Carillo, S.D. Armstrong, A. Gautum, and **H. Poffenbarger.** Winter Cover Crop Biomass Production across a Fifteen-State Coordinated Study in the U.S. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT, November 7-10, 2021.
21. Reed, V., B. Arnall, J. Souza, B. Finch, M. Smith, R.L. Sharry, H. Lovewell. 2021 Relationship between Tissue Nutrient Concentration and Yield in Winter Wheat. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT, November 7-10, 2021.

**Grants awarded or ongoing in 2021**

1. Britt, D. W., A.J. Anderson, J. Zhan, **J.M. Norton**, R. Schaeffer, S. Young, A. Jacobson, J.E. McLean, REU Site: STEM for Plant Health, Sponsored by National Science Foundation, February 15, 2021 - January 31, 2024. $352,359.
2. Raman, R., C. Lu, and **M.D. McDaniel**. Regenerating America’s Working Landscapes to Enhance Natural Resources and Public Goods through Perennial Groundcovers. USDA Sustainable Agricultural Systems Grant, January 1, 2022 – December 31, 2026. $9,985,722.
3. Schulte-Moore, L.A., J. Arbuckle, N. Grudens-Schuck, M. Liebman, **M.D. McDaniel**, O. deKok-Mercado, T. Youngquist. Improving Midwestern Agriculture’s Environmental, Social, and Economic Footprint with Prairie Strips. Bia-Echo Foundation. January 1, 2021 – December 31, 2023. $1,104,788.
4. Saha, D., S.M. Schaeffer, **S. Jagadamma**, H. Gan, and A. Faija. Demystifying the oxygen enigma to enhance agricultural nitrous oxide mitigation by soil health practices. USDA-NIFA Foundational Program. 2021-2024. $498,923.
5. **Jagadamma, S.**, F. Walker, S. Singh, L. Duncan, M. McClure, S. Upendram. Demonstrating the impacts of cover crops for soil health and farm profitability in Tennessee. Tennessee Department of Agriculture. 2020-2025. $322,411.
6. **Drijber, R.** Soil Response to Agric Intensification, USDA-ARS, August 1, 2019 – July 31, 2024. $150,000.00.
7. Blanco, H., C. Creech, R. **Drijber**, A. Easterly, P. Jasa, S. Ruis, Soil Health with Biochar and Cover Crops, USDA-NIFA. May 1, 2020 - April 30, 2024. $499,999.00
8. Luck, J., S. Pitla, Y. Ge, Y. Shi, L. Puntel, L. Thompson, **R. Drijber**, J. Iqbal, R. Mahmood, T. Awada, C. Neale, H. Blanco, A. Little, M. Kaiser, A. Basche, K. Weber, D. Snow, A. Suyker, T. Mieno, Nitrogen Rsch for Ag Transform & Enhanc, Dept of Agriculture-ARS, July 28, 2021 – May 31, 2022. $442,800.00.
9. **Yin, X.** 2021. Comparison of humic acid to Agrotain in improving urea-N use efficiency. Live Earth Products Inc. 01/01/2021 - 12/31/2021. $39,000.
10. **Yin, X.,** N. Adotey, and M.A. McClure. 2021. Validation and modification of reference sufficiency ranges of nitrogen, phosphorus, and potassium for current corn cultivars. Tennessee Corn Promotion Board. 01/01/2021 - 12/31/2021. $22,680.
11. Adotey, N., L. Duncan, **X. Yin,** and **D. Saha.** 2021. Identifying suitable enhanced efficiency nitrogen fertilizers using a rapid and precise in-lab environment-controlled system. Tennessee Department of Agriculture. 04/01/2021 – 03/31/2023. $162,904.
12. Adotey, N., **X. Yin,** and R. Blair. 2021. Predicting corn N response using alkaline mineralizable nitrogen and Haney soil health test-nitrogen in TN. Southern Region SARE. 04/01/2021 – 03/31/2023. $20,000.
13. Dhillon, J. S. (PI), Fox, A., Singh, G., **Li, X.**, McCoy, J., Sensor-Based Nitrogen Management in Mississippi Maize (Zea mays L.) Production. Mississippi Agricultural and Forestry Experiment Station (MAFES) Special Research Initiative (SRI), Mississippi State University, $50,000, 12/1/2020–12/31/2021.
14. Lowry, G., J. Giraldo, G. Wang, O. Tsyusko, **H. Poffenbarger**, J. Unrine. ECO-CBET: Foliar Applied Plant-Activated Nitrogen Delivery Agents for Sustainable Crop Production, Carnegie Mellon University. National Science Foundation ECO-CBET. 2021-2025.$1,313,277.
15. **Poffenbarger H.**., D. McNear, E. Haramoto. Understanding the Roots of Soil Health, Foundation for Food and Agriculture Research New Innovator Award. 2021-2024. $449,563.
16. **Poffenbarger, H.**, M. Salmeron, and O. Wendroth. Evaluating cover crop mixtures as precision nitrogen management tools. United States Department of Agriculture Foundational and Applied Program Grant. 2020-2025. $499,522.
17. Reberg-Horton, S.B. Mirsky, S. Armstrong, M. Bagavathiannan, A. Basche, H. Smith Brubaker, M. Cabrera, M. Cavigelli, C. Chase, K. Clark, H. Darby, C. Ellis, D. Fleisher, J. Gaskin, L. Golden, E. Haramoto, R. Joergensen, E. Kladivko, A. Lamm, K. Lamm, M. Laursen, R.G. Leon, R. Massey, J. McMechan, A. Morrow, M. Mulvaney, M. Niles, D. Park, **H. Poffenbarger**, L. Prokopy, A. Robertson, M. Ryan, B. Salas, H. Schomberg, S. Skovesen, R. Smith, M. Swisher, J. Thompson, D. Timlin, J. Tooker, D. Treadwell, K. Tully, J. Wallace, A. Woodley, S. Wortman, R. Ye. A Cover Crop Network for Enhancing the Sustainability of U.S. Cropping Systems. United States Department of Agriculture Sustainable Agricultural Systems Grant. 2019-2024. $10,000,000 ($66,000).
18. **Poffenbarger, H**., and D. McNear. Getting to the root of the matter: Linking root traits to soil health. United States Department of Agriculture Foundational and Applied Program Grant. 2019-2023. $499,040.
19. **Poffenbarger H.**, M. Salmeron Cortasa, O. Wendroth. Investigating Winter Cover Crop Effects on Soil Health in Sloping Cropland. Kentucky Small Grain Growers Association. 9/1/2021-12/31/2022. $12,804.
20. Morgan, G., and D.B. Arnall. Evaluation of cotton nitrogen demand and fertilizer recommendation. Submitted to Cotton Incorporated. 2021. $5,000.
21. Arnall, D.B. Use of nitrogen enhancement products in grain sorghum production. Submitted to United Sorghum Checkoff. 2021. $15,000.
22. Arnall, D.B. and S. Phillips. Improved nutrient management of wheat grown in arid and semi-arid environments. Submitted to African Plant Nutrition Institute. 2021. $178,745.
23. Arnall, D.B. Impact of nozzle type, droplet size, and solution dilution on foliar nitrogen uptake in wheat. Submitted to John Deere Co. 2021. $14,000.
24. Arnall, D.B. Cotton Nutrient Management Extension. Submitted to Oklahoma Cotton Support Program and Cotton Incorporated. 2021 $12,500.
25. **Khanal, S.**, and S. Culman. Remote sensing for cover crop monitoring, Ohio Soybean Council, 2021-2022. $38,000.
26. **Khanal, S.**, S. Culman, C. Stewart, A. Bennett, M. Romanko, B. Fisher, B. Moneymaker, B. Hohman. Assessing the impacts of cover crops on the sustainability of agricultural production system using remote sensing and machine learning. OSU Sustainability Institute. 2021- 2022. Ohio State University. $34,970.
27. **Khanal, S.**, and S. Culman. Scalable, rapid, and cost-effective method for monitoring cover crops and their impacts on environment. New Researcher Incentive Program, Ohio State University. 2022 – 2024. $49,982.
28. **Khanal, S.,** M. Romanko, C. Strasbaugh, B. Hohmann, K. KC, M. Brigitte, B. Fisher, S. Culman, A. Bennett, F. Lipschitz, C. Stewart, and S. Lyon. Multiscale remote sensing technologies for monitoring cover crops and their impacts on ecosystem services. 2021 – 2022. INFACT Linages and Leverage Grant, Ohio State University. $35,000.