**Multistate Research Project Annual Report**

**Project Number:** NC1178

**Project Title:** Land use and management practice impacts on soil carbon and associated agroecosystems services

**Period Covered:** 6/01/2021-5/31/2022

**Date of This Report:** 7/18/2022

**Annual Meeting Dates:** 6/8/2022-6/9/2022

1. **Participants:**

*In person:* Asko Noormets (asko.noormets@ag.tamu.edu), Changyoon Jeong (CJeong@agcenter.lsu.edu), DeAnn Presley (deann@ksu.edu), Fugen Dou (Fugen.Dou@agnet.tamu.edu), Itamar Shabtai (Itamar.Shabtai@ct.gov), Rattan Lal (lal.1@osu.edu), Mohammad Golabi (mgolabi@triton.uog.edu), Rongzhong Ye (rongzho@clemson.edu), Xi Zhang (XiZhang@agcenter.lsu.edu)

*Virtually:* Humberto Blanco (hblanco2@unl.edu), Larry Cihacek (larry.cihacek@ndsu.edu), Sutie Xu (Sutie.Xu@sdstate.edu)

1. **Brief summary of minutes of annual meeting:**

The meeting was presided by Dr. Asko Noormets (Texas A&M). We clarified and defined the responsibilities of the project Chair and Chair-Elect. The majority agreed to meet in mid-June at the Pee Dee Research and Education Center, Clemson University for the 2023 annual meeting. Dr. Rongzhong Ye will organize and plan the meeting. Drs. Itamar Shabtai and Xi Zhang were elected to hold the 2024 and 2025 annual meeting in Connecticut and Louisiana, respectively.

We agreed to continue the discussions on generating review manuscripts and research proposals as a group, including a paper to introduce the history of the NC1178 to celebrate the 40-year mark. We discussed the renewal of the NC1178 in 2024, which will be prioritized in the 2023 annual meeting. After the business meeting, each participants made a 20-minute presentation. More details can be found in the attached “Meeting Minutes”.

1. **Accomplishments:**

*Research activities:* During the past reporting year, the NC1178 participants continued to carry out a range of research projects to evaluate the impacts of intensifying agroecosystems and management practices (e.g., reduced tillage and cover crop managements) on soil organic C (SOC), soil health, environmental footprint, and profitability (Table 1). Team members carried a shared vision to promote conservation production systems that improve soil health and sustainability through research and extension services. The team has met the 2022 milestone and will continue to implement the planned project.

Table 1. Major research activities conducted by NC1178 participants during 2021-2022

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| --- | --- | --- |
| State  | PI | Research Activities |
| CT | Shabtai | * Investigating the effects of long-term soil moisture on SOC composition, distribution in density fractions, and microbial processing on fallow plots
* Assessing the role of soil calcium in cycling of C added to soil as plant leaf litter
 |
| GU | Golabi | * Biochar amendment to increase soil pH and C sequestration
 |
| KS | Presley | * Crop residue removal on SOC stocks
 |
| LA | Zhang | * Quantifying the connections among SOC dynamics, soil aggregation, and pore morphology in response to conversion of native prairie to agricultural land.
 |
| MA | Hestrin | * Characterizing soil organic matter present in paired soil samples maintained under different crops and management systems
 |
| NE | Blanco | * Nitrogen fertilization and haying effects of winter rye cover crop on the quality and quantity of cover crop biomass inputs, soil health and crop yields
 |
| ND | Cihacek | * Residue C/N ratio effects on decomposition and soil N availability
* Impacts of low-rate liming on reducing soil pH in no-till system
 |
| OH | Lal | * Residue retention impacts on grain yield and soil properties
 |
| SC | Ye | * Tillage impacts on soil health and SOC dynamics
* Interactive impacts of cover cropping and reduced tillage on SOC dynamics
 |
| SD | Xu | * Tillage impacts on soil health
* Integration impacts of cover cropping and livestock on soil health and C distribution.
 |
| TN | Jagadamma | * Crop diversification influences on soil health indicators, soil microbial communities, agronomic responses, and soil resilience to moisture and temperature extremes
* Effect of long-term conservation crop management practices (no-till and cover cropping) in increasing subsoil SOC storage
 |
| TX | Noormets | * Management impacts on SOC balance and soil C stock in forest soils
 |
| TX | Dou | * Rice variety and N fertilization impacts on soil C and N and yield
* Biomass sorghum and N fertilization impacts on soil C and N and yield
 |
| WY | Zhu | * Characterizing an array of soil microbial and chemical properties pertinent to C and N in seasonal soils of alpine hay meadows under different managements (irrigation and/or fertilization).
* Collection of greenhouse gases every two weeks at each study site
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*Outputs:* This team has generated a wide range of research-based information and knowledge (Table 2), which has resulted in more than 45 publications in peer-reviewed journals and 29 presentations in academic conferences and meetings. In addition, the team has made at least 50 extension presentations in field days and workshops during the same period, some of which was reported by local media or news outlets. Most significantly, the team members worked collectively with external partners and submitted a $29,155,582 proposal “Implementing climate-smart agriculture and forest practices to achieve greenhouse gas reduction benefits in diverse U.S. commodities” to the USDA-NRCS in 2022.

Table 2. Major research findings generated by NC1178 participants during 2021-2022

|  |  |  |
| --- | --- | --- |
| State  | PI | Key Findings/Observations |
| CT | Shabtai | * Moistening soils promoted C mineralization by microbes and subsequent buildup of microbial-like C on silt and clay-sized particles, resulting in overall higher SOC content in moister soils.
* Calcium enriched the microbial community in taxa that favors attachment to particulate substrate (i.e., the litter) which resulted in more efficient conversion of litter into microbial biomass and to mineral-associated C. Overall, addition of calcium decreased CO2
 |
| GU | Golabi | * Application of ‘biochar’ increased soil C content and soil quality in both southern and northern Guam soils.
* Chemical properties of the soil may be the main factor in determining whether land application of ‘biochar’ could potentially improve C sequestration of the soil or not
 |
| KS | Presley | * On average, crop residue removal has had no statistically significant effects on continuous no-till corn yields in a 11-year, two site location study.
* For the upper 10 cm of the soil profile, SOC values do not differ among treatments (residue removal rates).
 |
| LA | Zhang | * Compared with cropland, native prairie has higher macroporosity and higher saturated hydraulic conductivity due to more organic carbon stored in the soil.
* A loss of SOC is linked to a reduction in aggregate size.
 |
| NE  | Blanco | * Nitrogen fertilization increased cover crop biomass production, but did not affect crop yield, soil Cand N concentrations, and other measured soil health indicators.
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| ND | Cihacek | * Heavy crop residue accumulation in cooler climates can cause a greater need for N fertilizers because of soil N immobilization during decomposition.
* Utilizing cover crop residues for their low C:N ratios can potentially mitigate soil N immobilization while reducing the need of additional fertilizer applications in no-till systems.
* Utilization of low-rate liming can be an economical means to manage soil acidity and maintaining or improving crop productivity as agricultural production practices intensify.
 |
| OH | Lal | * Residue management directly affected soil properties and processes such as hydro-thermal regimes, bulk density, porosity and pore size distribution, activity and species diversity of fauna and flora, and timings of farm operations during spring.
* Notable among indirect effects of crop residue retention include the rate and amount of SOC sequestration, vulnerability of soil to slaking and erosional processes (e.g., hydric and aeolian), storage of water in the root zone.
 |
| SC | Ye | * Long-term reduced tillage (~40 years) increased SOC in bulk soils and soil aggregates at the 0-5 cm depth but did not improve overall soil health at the 0-15 cm depth in sandy Coastal Plain soils.
* Integration of high biomass inputs with reduced tillage is seemingly the key to restore SOC in these sand soils.
 |
| SD | Xu | * No till improved soil health over time.
* Grassland showed greater soil health improvements than row crops after long-term use of no till.
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| TN | Jagadamma | * We have characterized a core set of soil properties that are considered early indicators of changes in soil health.
* Long-term conservation practices using deep-rooted grass-type cover crops resulted in significant subsoil SOC accumulation.
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| TX | Noormets | * Southern pine forests lost more soil C through heterotrophic respiration than they regain through above and belowground detritus inputs.
* Developed a non-destructive method for quantifying allocation of C within plants to belowground tissues (growth and respiration), non-structural storage carbohydrates and/or exudation.
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| TX | Dou | * Biomass sorghum production influenced soil C sequestration rates, which however varied across cultivars and N rates.
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| WY | Zhu | * Fertilization and irrigation of alpine hay meadows increased enzyme activities, and C and N contents in soil organic horizons but decreased them in mineral horizons, compared to the control.
* Irrigation created seasonal anoxic soil conditions which may decrease soil health.
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*Short-term outcomes:* Data generated by the team research have advanced our understanding of how management practices can be optimized to improve soil health and productivity (Table 2). Research-based information was delivered to targeted audiences through extension services and academic publications. Resulting benefits included, but not limited to, 1) adoption of no or reduced tillage management (e.g., SD), 2) integrations of cover cropping with other conservation management practices (e.g., SC), 3) improved cover crop management, such as residue return and fertilization (e.g., NE and KS), 4) optimized nutrient managements and crop selections for better management outcomes (e.g., TX), and 5) formulated and improved soil health assessment methodologies (e.g., TN). The resulting research data also demonstrated that the adoption of site-specific management recommendation and system-based conservation is necessary and critical to make agriculture a sound solution to climate change and other environmental issues. Moreover, data generated by the participants were also used to create course curriculums for undergraduate education (e.g., GU).

*Milestones:* The team has reached and will soon pass the 2022 milestone of “completion of sample and laboratory analyses”. The next milestone in 2023 is “Workshops and meetings; Begin posting of findings on project website and state agricultural experiment station and extension service web sites”.

1. **Impacts:**

During 2021-2022, the NC1178 project attracted at least five early career researchers to join in the group, while Dr. Rattan Lal has been appointed by the President a member of the Board for International Food and Agriculture Development. This project continued to assemble a wide range of expertise coupled with a long-term continuum of members and participants to provide a platform for new researchers to develop research that addresses evolving issues in food production and environmental quality. The research and extension activities conducted by this team across the U.S. not only demonstrate significant scientific merits, but also impose ecological, economic, and social impacts.

*Demonstrating the importance of soil health.* Building healthy and resilient soils is the central focus of most soil conservation programs being implemented worldwide. Team members demonstrated the importance of soil health in various agroecosystem functions and soils’ capacity to provide foods and services to human society. In addition, team members are developing a soil health assessment framework, emphasizing the significance of site-specific indicators, to be used by professionals and the general publics to guide sustainable agricultural management practices.

*Promoting sustainable soil management.* The outcome of this project reinforces the concept of using soil health principles in production agriculture. The research results support the development of management guidelines to improve the designed agronomic and environmental outcomes.

*Social benefits.* The results generated by the team research allow future researchers and farmers to improve N use-efficiency in row cropping systems by minimizing its losses as ammonia, nitrous oxide, and nitrate. The increased fertilizer use-efficiency will increase the economic competitiveness of production agriculture (i.e., less fertilizer inputs), mitigate its climate impacts (i.e., less greenhouse emissions), and reduce water degradation potentials (i.e., less nitrate leaching to aquatic systems), all of which improve human well-being through enhanced air and water quality. Meanwhile, the study on the responses of soil C dynamics will facilitate the development of management practices that mitigate climate change by promoting C sequestration.

*Grant and Resources obtained:* In addition to three pieces of equipment, the team members secured more than $2,522,273 from proposal as a result of the project’s activities.

*Equipment:*

1. Dou, F. SEAL AQ300 autoanalyzer
2. Dou, F. Shimadzu TOC autoanalyzer
3. Jagadamma, S. Picarro Isotopic Gas Analyzer (G2131-i) integrated with a Combustion Module (A0201)

*Funding:*

1. Dou, F. (PI). 2021. Rice varietal evaluation, ratoon, and nutrient management improvement for Texas production practices. Texas Rice Research Foundation. 2021-2023. $59,280.
2. Golabi, Mohammad H. (PI), (2021 – 2023). Application of biochar-based amendments in boosting soil fertility and crop disease resistance in the porous soils of northern Guam. Funded by NIFA ($110,000).
3. Jagadamma, S (PI). Demonstrating the impacts of cover crops for soil health and farm profitability in Tennessee. Co-PIs: Walker, F., Singh, S., Duncan, L., McClure, M., Upendram, S. Tennessee Department of Agriculture, 10-2019 to 09-2023 ($341,493).
4. Jagadamma, S (PI). Optimizing plant-soil-microbial interactions through crop diversification to enhance sustainability in southeastern croplands. Co-PIs: Lee, J., Duncan, L.A., McClure, A., Raper, T.B., Kivlin, S. USDA-NIFA Foundational Program, 09-2020 to 08-2024 ($500,000).
5. Jagadamma, S. (Co-PI). Row crop production under climate change – assessment of sustainable management practices and soil additives in sand deposited fields. PI: Lee, J; Co-PI: USDA-Agricultural Research Service, 09-2021 to 08-2022 ($103,704).
6. Presley, D. (PI). Assessing soil health on-farm in central Kansas. USDA-NRCS. 08/23/21 to 09/29/24. $197,084
7. Xu, S. (PI). Midwest Forage Association. Impacts of C3/C4 cover crop mixtures on productivity, forage quality, and soil health in livestock-cropping systems. 2021. ($5,000).
8. Xu, S. (PI). USDA-NRCS-CIG Classic program. Overcoming cover crop adoption barriers in dryland production systems by enhancing water use efficiency and soil health. 2022. ($705,727)
9. Zhang, X., C. Jeong, S. Dodla, and S. D. Conger. Spatial variability of soil properties in agricultural fields: what does this mean for soil water and nutrients management and crop production in Louisiana. Louisiana Soybean and Grain Research and Promotion Board. Apr. 2022-Mar. 2023 ($26,470).
10. Zhu, M. (Co-PI), Nitrogen Limitation in High-Elevation Hay Meadows: Understanding Processes for Improved Agroecosystem Health, Function, and Management, ARFI 2021-67020-33422, USDA NIFA Renewable Energy, Natural Resources, and Environment: Agroecosystem Management, $499,985, 2021 – 2024.
11. **Publications**
12. Aguilos M, Brown C, Minick K, Fischer M, Ile OJ, Hardesty D, Kerrigan M, Noormets A, King J. (2021) Millennial-Scale Carbon Storage in Natural Pine Forests of the North Carolina Lower Coastal Plain: Effects of Artificial Drainage in a Time of Rapid Sea Level Rise. Land 10 (12). <https://doi.org/10.3390/land10121294>
13. Aguilos M, Sun G, Noormets A, Domec J-C, McNulty SG, Gavazzi M, Prajapati P, Minick KJ, Mitra B, King JS (2021) Ecosystem Productivity and Evapotranspiration Are Tightly Coupled in Loblolly Pine (Pinus taeda L.) Plantations along the Coastal Plain of the Southeastern U.S. Forests 12. 1123. <https://doi.org/10.3390/f12081123>
14. Aguilos M, Sun G, Noormets A, Domec JC, McNulty SG, Gavazzi M, Minick K, Mitra B, Prajapati P, Yang Y, King JS (2021) Effects of land-use change and drought on decadal evapotranspiration and water balance of natural and managed forested wetlands along the southeastern US lower coastal plain. Agricultural and Forest Meteorology 303:108381.
15. Anderson, L. H. Blanco-Canqui, M. Drewnoski, and J. MacDonald. 2022. Cover crop grazing impacts on soil properties and crop yields under irrigated no-till corn-soybean. Soil Sci. Soc. Am. J. 86:118-133.
16. Blanco-Canqui, H. 2021. No-till technology has limited potential to store carbon: How can we enhance such potential? Agriculture, Ecosystems & Environment. 313, 107352.
17. Blanco-Canqui, H. 2022. Cover crops and carbon sequestration: Lessons from US studies. Soil Sci. Soc. Am. J. 86:501-519.
18. Blanco-Canqui, H., M. Drewnoski, and D. Rice. 2021. Does harvesting cover crops eliminate the benefits of cover crops? Insights after three years. Soil Sci. Soc. Am. J. 85:146-157.
19. Blanco-Canqui, H., S, Ruis, H. Holman, C. Creech, and A. Obour. 2022. Can cover crops improve soil ecosystem services in water-limited environments? A Review. Soil Sci. Soc. Am. J. 86:1-18.
20. Davis, C., D. Presley, C. Rivard, J. Griffin, and P. Tomlinson. 2022. Cover Crop Effects on Soil Properties in a Three-Year No-Till Pumpkin Experiment. Soil Science Society of America Journal. https://doi.org/10.1002/saj2.20365
21. Domec JC, King AW, Carmichael M, Treado Overby A, Wortemann R, Smith WK, Miao G, Noormets A, Johnson D (2021) Aquaporins, and not changes in root structure, provide new insights into physiological responses to drought, flooding, and salinity. Functional Plant Biology 72: 4489–4501. <https://academic.oup.com/jxb/advance-article/doi/10.1093/jxb/erab100/6156974>
22. Evans, D. L., Janes-Bassett, V., Borrelli, P., Chenu, C., Ferreira, C. S. S., Griffiths, R. I., Kalantari, Z., Keesstra, S., Lal, R., Panagos, P., Robinson, D. A., Seifollahi-Aghmiuni, S., Smith, P., Steenhuis, T. S., Thomas, A., & Visser, S. M. (2021). Sustainable futures over the next decade are rooted in soil science. European Journal of Soil Science, 1– 16. https://doi.org/10.1111/ejss.13145.
23. Gardner, G, G. Sampson, and D. Presley. 2021. Irrigator perceptions and the value of groundwater quality in the High Plains Aquifer. J. Soil and Water Conservation. 76:329-339. doi:10.2489/jswc.2021.00118
24. Gaudfrin, F., E. Santos, D. Presley, and M.J. Berg. 2020. Time-resolved imaging of settling mineral dust aerosols with digital holography. Optical Society of America Continuum. https://doi.org/10.1364/OSAC.404104
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52. Yoder, D., Jagadamma, S., Singh, S., Nouri, A., Xu, S., Saha, D., Schaeffer, S., Adotey, N., Walker, F., Lee, J., and Budipradigdo, M. 2022. Soil health: Meaning, measurement, and value through a critical zone lens. Journal of Soil and Water Conservation. 77: 88-99.
53. Alghamdi, R., and L. Cihacek. 2021. Do post-harvest crop residues in no-till systems provide for nitrogen needs of following crops? Agron. J. 2021:1-18. doi: 10.1002/agj2.20885.
54. Alghamdi, R., L. Cihacek, A. Daigh and S. Rahman. 2021. Post-harvest crop residue contribution to soil N availability or unavailability in North Dakota. Agrosys. Geosci. Environ.2021(4): e20221. doi: 10.1002/agg2.20221
55. Cihacek, L., and R. Alghamdi. 2021. Some thoughts on nutrient mineralization and cycling in no-till systems. pp 33-37. Proceedings of the 51st North Central Extension-Industry Soil fertility Conference, November 17-18,2021. Des Moines, IA.
56. Alghamdi, R., L. Cihacek and Q. Wen. 2022. Simulated cropping season effects on N mineralization from accumulated no-till crop residues. Nitrogen 3(2):149-160. <https://doi.org/10.3390/nitrogen3020011>.
57. **Conference Presentations**
58. Aguilos M, Sun G, Noormets A, Domec JC, McNulty SG, Gavazzi M, Prajapati P, Minick K, Mitra B, King JS (2021) Water and carbon cycles are tightly coupled in loblolly pine (Pinus taeda L.) plantations along the coastal plains of southeastern U.S. AGU Fall Meeting, December 13-17, 2021.
59. Bera, T., Y. Yang, F. Dou, L. T. Wilson, J. Jifon, N. Winans, W. Rooney, B. Baldwin, J. Morrison, J. E. Knoll, A. L. Wright, C. Odero, and H. S. Sandhu. 2021. Surface runoff and percolation water quality under biomass sorghum production in the Southern USA. Annual Meeting of ASA-CSSA-SSSA. Salt Lake City. UT. November 2021.
60. Bera, T., Y. Yang, L. T. Wilson, F. Dou, J. Jifon, N. Winans, W. Rooney, B. Baldwin, J. Morrison, J. E. Knoll, A. L. Wright, C. Odero, and H. S. Sandhu. 2021. Dynamics of biomass yield and composition under biomass sorghum production in the southern USA. Annual Meeting of ASA-CSSA-SSSA. Salt Lake City. UT. November 2021.
61. Canisares, L.P., many authors, including D.R. Presley. 2021. Winter Cover Crop Biomass Production across a Fifteen-State Coordinated Study in the U.S.
62. Hirmas, D., X. Zhang, P. Sullivan, S. Billings, L. Souza, L. Li, H. Ajami, M. Sena, and A. Flores. 2021. A novel method for predicting rapid changes in soil structure and hydraulic conductivity. AGU Fall Meeting, New Orleans, LA.
63. Jagadamma, S. 2021. Conservation agricultural strategies for soil organic carbon accumulation in Tennessee. ASA-CSSA-SSSA Annual Meeting (Oral), November 7-10. Salt Lake City, UT (Invited Oral).
64. Kortokrax, A., Nelson, N.O., Roozeboom, K.L., Tomlinson, P.J., Presley, D.R., Sweeney, D.W., Pierzynski, G.M., Sheshukov, A., Bhandari, A. (2021) Kansas Phosphorus (P) Index: Identifying a Runoff Estimation Method That Works Best within a Component P Index. [Abstract]. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT. https://scisoc.confex.com/scisoc/2021am/meetingapp.cgi/Paper/136025
65. Lal, R. 2021. Managing Organic Matter: The Heart of Soil Health. Virtual World Agri-Tech Innovation Summit 2021: Harnessing Agriculture as a Source of Nature-Based Solutions for Climate. 9 March 2021. World Agri-Tech USA. Rethink Events. Brighton, United Kingdom. Online. Recorded.
66. Lamichhane, S., L. Tarpley, and F. Dou. 2021. The effect of excess magnesium supply on the growth, physiology, yield, and mineral content in rice. 2021 ASA, CSSA, SSSA International Annual Meeting. November 7-10, 2021. Salt Lake City, Utah, U. S. A.
67. Nelson, N. O., Tomlinson, P. J., Kluitenberg, G. J., Schnarr, C., & Presley, D. R. (2021) Cover Crop Effects on Edge-of-Field Water Quality: An on-Farm Demonstration Study [Abstract]. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT. https://scisoc.confex.com/scisoc/2021am/meetingapp.cgi/Paper/136962
68. Parajuli, B., Szogi, A., Ye, R. 2021 Nitrogen addition reduced the decomposition of organic carbon derived from long-term conservation management. ASA-CSSA-SSSA International Annual Meeting, Salt Lake City, UT
69. Patra, R., Saha, D., and Jagadamma, S. 2021. Long-term conservation management practices on depth distribution of soil organic carbon in croplands. ASA-CSSA-SSSA Annual Meeting, November 7-10. Salt Lake City, UT (Oral).
70. Patra, R., Saha, D., and Jagadamma, S. 2021. Microbial biomass and enzymatic efficiencies as moderators of soil carbon accumulation in croplands. ASA-CSSA-SSSA Annual Meeting, November 7-10. Salt Lake City, UT (Poster).
71. Poudel, P., Parajuli, B., Park, D., Ye, R. 2021. Cover crop residue decomposition and nutrient releases: a test of termination timing impacts. ASA-CSSA-SSSA International Annual Meeting. Salt Lake City, UT.
72. Thotakuri G., Sangotayo, A., Chellappa, J., Bansal, S., Iqbal, J., Xu, S., and Kumar, S., 2021. Estimation of soil health parameters influenced by long-term tillage and crop rotation systems. ASA-CSSA-SSSA Annual Meeting (Oral). November 7-10. Salt Lake City, Utah.
73. Thotakuri, G. Chakraborty, P., Iqbal, J., Xu, S., Kumar, S. 2021. Assessing the impacts of long-term tillage and crop rotation on root zone soil hydraulic properties and X-Ray computed tomography derived soil pore structures. ASA-CSSA-SSSA Annual Meeting (Poster). November 7-10, Salt Lake City, Utah.
74. Varikuti, V., Chakraborty, P., Navreet, M., Xu, S., and Kumar, S. 2021. Intercropping kura clover in prairie cordgrass to maintain soil hydrological properties while mitigating greenhouse gas emissions. ASA-CSSA-SSSA Annual Meeting (Poster). November 7-10. Salt Lake City, Utah.
75. Varikuti, V., Navreet, M., Bansal, S., Xu, S., and Kumar, S. 2021. Does intercropping of kura clover with prairie cordgrass improve soil biochemical properties on marginal lands? ASA-CSSA-SSSA Annual Meeting (Oral). November 7-10. Salt Lake City, Utah.
76. Wells J, Aguilos M, Huang X, Gao Y, Hou E, Huang W, Liao C, Lin L, Zhao R, Qiu H, Allen K, King JS, Noormets A, Jiang L, Luo Y (2021) Separating the Effects of Stand Age and Interannual Variability on Net Ecosystem Carbon Exchange: Data-Model Fusion in Loblolly Pine. AGU Fall Meeting, December 13-17, 2021.
77. Wooliver, R., Kivlin, S., Jagadamma, S. 2021. Outcomes of crop diversification for soil microbial communities, soil health, and crop yields in west Tennessee. ASA, CSSA, SSSA International Annual Meeting, November 7-10, Salt Lake City, UT (Oral).
78. Xu, S. 2021. Invited talk: Sustainable Soil Management: Strategies for Improving Agricultural Ecosystem Functions. ASA-CSSA-SSSA Annual Meeting (Oral). November 7-10, Salt Lake City, Utah.
79. Yang L, Noormets A (2021) Evaluation of temporal resolution effects on phenology extraction using MODIS derived vegetation indices. AGU Fall Meeting, December 13-17, 2021.
80. Zhang, X., and V.L. Bailey. 2021. Symposium-Soil Organic Matter Dynamics and Soil Health: Honoring the Contributions of Dr. Cynthia Cambardella. ASA-CSSA-SSSA Annual Meeting, Salt Lake City, UT.
81. Zhang, X., P. Sullivan, S. Billings, D. Hirmas, L. Souza, and M. Unruh. 2021. How does land use mediate changes in soil structure dynamics and subsurface hydrologic processes with carbon decomposition? ASA-CSSA-SSSA Annual Meeting, Salt Lake City, UT.
82. Zheng, W., and X. Zhang. 2021. Symposium-Biochar for Sustainable Soil Health: Perspectives and Opportunities. ASA-CSSA-SSSA Annual Meeting, Salt Lake City, UT.
83. Alghamdi, R., L. Cihacek, C. Augustin, R. Buetow, D. Landblom, and S. Senturklu. 2021. Soil acidity and aluminum toxicity in calcareous soils in semi-arid western North Dakota. 2021 ASA-CSSA-SSSA Annual International Meetings, November 9, 2021. Salt Lake City, UT. Oral presentation.
84. Cihacek L., and R. Alghamdi. 2021. Nitrogen dynamics of soybeans and soybean residues in long-term no-till production systems. 2021 ASA-CSSA-SSSA Annual International Meetings, November 10, 2021. Salt Lake City, UT. Poster presentation.
85. Cihacek, L., and R. Alghamdi. 2021. Some thoughts on nutrient mineralization and cycling in no-till systems. 51st North Central Extension-Industry Soil fertility Conference, November 18, 2021. Des Moines, IA. Oral presentation.
86. Adamson, D., Norton, J. B., Norton, U., Brummer, J. E., Van Diepen, L., Zhu, M., Otuya, R., Albeke, S., & Sebade, B. 2021 Carbon and nitrogen cycling in high-elevation hay meadows: Understanding processes for improved agroecosystem productivity, management, and health. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT.
87. **Extension Services and Reports**
88. Billings, S., P. Sullivan, D. Hirmas, X. Zhang, L. Souza, A. Guthrie, M. Unruh, K. Lang, T. Swantek, L. Li, D. Richter, I. Baneschi, and C. Rice. 2021. Towards a predictive understanding of the biotic drivers of soil structure. ASA-CSSA-SSSA Annual Meeting, Salt Lake City, UT.
89. Cihacek, L. 2021. Crop rotation effect on microbial soil nitrogen mineralization and nitrogen fertilizer reduction potential. NDSU DREC Soil Health Workshop. September 14, 2021. Dickinson and Manning, ND. Invited presentation.
90. Cihacek, L. 2021. Acid soils in North Dakota. 2021 Fall Extension/Research Center Conference, October 13, 2021. Bismarck, ND. Invited presentation.
91. Deann Presley:
92. July 7, 2021. Soil Carbon. KARA Summer Field School. 64 participants.
93. July 8, 2021. Soil Carbon. KARA Summer Field School. 64 participants.
94. July 8, 2021. Remediating compacted rangeland after windfarm maintenance. Extension agent. 1 contact.
95. July 10, 2021. Soil health and soil carbon. 2021 16th Annual Dialog on Sustainability, Consortium for Environmental Stewardship and Sustainability. Manhattan, KS. 28 participants.
96. July 15, 2021. Question from extension agent about agricultural drainage. 1 contact.
97. July 27, 2021. Soil judging tips and tricks. Kansas Association for Agricultural Educators. Manhattan, KS. 50 attended.
98. August 5, 2021. Carbon farming. Iowa Women in Agriculture conference. Ankeny, Iowa. 100 attended.
99. August 10, 2021. Soil health and tillage practices. Kansas River Valley Field Day. 40 attended.
100. August 18, 2021. Soil health and carbon markets. East Central Kansas Field Day. 65 attended.
101. August 30, 2021. Soil health and cover crops. Riley County Field Day. 50 attended.
102. August 31, 2021. Soil health from a soil pit. Flickner Innovation Farm field day. Moundridge, KS. 120 attended.
103. September 14, 2021. Onsite wastewater basics. Kansas Environmental Health Association meeting. Manhattan, KS. 80 attended.
104. September 15, 2021. AgPhD Sirius radio interview on water management. 1 contact.
105. October 18, 2021. Question from city planner about soil health testing for a solar farm. 1 contact.
106. November 1, 2021. Radio interview on cover crops in soybean production systems. WIBW. Kansas Soybean Commission.
107. November 1, 2021. Answered question on FGD gypsum for Nebraska extension person. 1 contact.
108. November 1, 2021. Extension specialists, what do they do? Agronomy Graduate Student Association. 24 attended.
109. November 2, 2021. Composting organic materials. Agronomy 305 class. 72 students.
110. November 4, 2021. Agronomy 305 class. 20 students.
111. November 8. 2021. Accelerator roundtable on consulting for SASES meeting. 30 attended.
112. November 18, 2021. Soils for onsite wastewater management. Kansas Small Flows Association. Wichita, KS. 40 attended.
113. November 30, 2021. Answered question on soil texture for Riley County environmental health dept employee. 1 contact.
114. December 7, 2021. Managing soil carbon. Western Area Ag agent update. Ness City. 24 attended.
115. December 9, 2021. Managing soil carbon. Northeast Ag Agent update. 20 attended, 15 male, 5 female, all Caucasian.
116. December 10, 2021. Flickner Farm update. Manhattan. 16 attended.
117. December 15, 2021. Managing soil carbon. Ag Econ Extension Agent in-service training. Salina, KS. 25 attended.
118. December 16, 2021. Crop residue removal in irrigated and dryland environments. Oklahoma State Winter Crops School. 200 attended.
119. Dou, F., and S. Lamichhane. 2021. 2020 Varietal evaluation and N application for rice main and ratoon crop yield potential. Texas Rice Field Day at Beaumont Research Center. July 2021
120. Dou, F., J. Samford, and S. Lamichhane. 2021. 2020 Varietal evaluation and N application for rice main and ratoon crop yield potential. Texas Rice Field Day at Eagle Lake Research Station. June 2021.
121. Jagadamma, S. 2022. Crop diversity for nutrient release and soil health. University of Tennessee Fertilizer Update Meeting, Nashville, TN (Oral).
122. Lal, R. 2021. Carbon… the Heart of Soil Health. 2021 Soil Health Conference. 6-7 January 2021. South Dakota Soil Health Coalition. Pierre, South Dakota, USA. Online.
123. Lal, R. 2021. Crop Residue Management and Properties of Some Soils in Ohio. 15 June 2021. Ohio NC-1178 Virtual Annual Meeting Committee. The Ohio State University, Columbus, Ohio, USA.
124. Lal, R. 2021. Soil Quality Management. Northeast Nebraska Bazile Groundwater Management Area Annual Public Winter Meeting. 19. February 2021. Lower Elkhorn Natural Resources District. Bazile, Nebraska, USA. Online.
125. Moreno, V., P. Sullivan, X. Zhang, R. Keen, J. Nippert, A. Duro, D. Hirmas, K. Sadayappan, and L. Li. 2021. Contrasting soil structure and biogeochemistry under grassy and woody encroached land. ASA-CSSA-SSSA Annual Meeting, Salt Lake City, UT.
126. Ni, J., Z. Zhu, X. Zhou, F. Dou, Y. Yang, L. T. Wilson, S. O. Samonte, J. Wang, and J. Zhang. 2021. Ridge detection and perceptual grouping based automatic counting of rice seedlings using UAV images. 6th International Conference on Image, Vision, and Computing (ICIVC), Jul. 23-25, 2021, Ocean University of China, Qingdao, China
127. Sullivan, P., H. Wen, X. Zhang, A. Koop, V. Moreno, R. Keen, K. Sadayappan, J. Nippert, D. Hirmas, S. Billings, and L. Li. 2021. How sensitive is the rate of bedrock weathering to near-surface changes in critical zone architecture? GSA Annual Meeting, Portland, OR.
128. Tarpley, L., F. Dou, and X. Zhou. 2021. Repair of research plot combine. Texas Rice Research Foundation. February 25, 2021. East Bernard, Texas, U. S. A.
129. Wilson, L. T., S. Talukder, O. Samonte, Z. Yan, D. Sanchez, L. Tarpley, F. Dou, L. Barneola, X. G. Zhou, M. Bagavathiannan, and Y. Yang. 2021. Texas rice research update. 2021 USA Rice Outlook Conference. Dec. 6-7, 2021. New Orleans, Louisiana, USA.
130. Wilson, L. T., Y. Yang, F. Dou, T. Bera, H. Araji, J. Jifon, W. Rooney, N. Winans, A. Hale, B. Baldwin, J. Morrison, P. Illukpitiya, J. Knoll, A. Wright, C. Odero, and S. Hardev. 2021. Sustainable herbaceous energy crop production in the Southeast United States. DOE monthly report of October 2021.
131. Wilson, L. T., Y. Yang, F. Dou, T. Bera, H. Araji, J. Jifon, W. Rooney, N. Winans, A. Hale, B. Baldwin, J. Morrison, P. Illukpitiya, J. Knoll, A. Wright, C. Odero, and S. Hardev. 2021. Sustainable herbaceous energy crop production in the Southeast United States. DOE monthly report of December 2021.
132. Wilson, L. T., Y. Yang, F. Dou, T. Bera, H. Araji, J. Jifon, W. Rooney, N. Winans, A. Hale, B. Baldwin, J. Morrison, P. Illukpitiya, J. Knoll, A. Wright, C. Odero, and S. Hardev. 2021. Sustainable herbaceous energy crop production in the Southeast United States. DOE monthly report of November 2021.
133. Wilson, L. T., Y. Yang, F. Dou, T. Bera, J. Jifon, W. Rooney, N. Winans, A. Hale, B. Baldwin, J. Morrison, P. Illukpitiya, J. Knoll, A. Wright, C. Odero, and S. Hardev. 2021. Sustainable herbaceous energy crop production in the Southeast United States. DOE monthly report of January 2021.
134. Wilson, L. T., Y. Yang, F. Dou, T. Bera, J. Jifon, W. Rooney, N. Winans, A. Hale, B. Baldwin, J. Morrison, P. Illukpitiya, J. Knoll, A. Wright, C. Odero, and S. Hardev. 2021. Sustainable herbaceous energy crop production in the Southeast United States. DOE monthly report of February 2021.
135. Wilson, L. T., Y. Yang, F. Dou, T. Bera, J. Jifon, W. Rooney, N. Winans, A. Hale, B. Baldwin, J. Morrison, P. Illukpitiya, J. Knoll, A. Wright, C. Odero, and S. Hardev. 2021. Sustainable herbaceous energy crop production in the Southeast United States. DOE biannual review March,2021.
136. Wilson, L. T., Y. Yang, F. Dou, T. Bera, J. Jifon, W. Rooney, N. Winans, A. Hale, B. Baldwin, J. Morrison, P. Illukpitiya, J. Knoll, A. Wright, C. Odero, and S. Hardev. 2021. Sustainable herbaceous energy crop production in the Southeast United States. DOE monthly report of April 2021.
137. Wilson, L. T., Y. Yang, F. Dou, T. Bera, J. Jifon, W. Rooney, N. Winans, A. Hale, B. Baldwin, J. Morrison, P. Illukpitiya, J. Knoll, A. Wright, C. Odero, and S. Hardev. 2021. Project progress review: Sustainable herbaceous energy crop production in the Southeast United States. DOE BP2 Go/NoGo review meeting.
138. Wilson, L. T., Y. Yang, F. Dou, T. Bera, J. Jifon, W. Rooney, N. Winans, A. Hale, B. Baldwin, J. Morrison, P. Illukpitiya, J. Knoll, A. Wright, C. Odero, and S. Hardev. 2021. Sustainable herbaceous energy crop production in the Southeast United States. DOE monthly report of May 2021.
139. Wilson, L. T., Y. Yang, F. Dou, T. Bera, J. Jifon, W. Rooney, N. Winans, A. Hale, B. Baldwin, J. Morrison, P. Illukpitiya, J. Knoll, A. Wright, C. Odero, and S. Hardev. 2021. Sustainable herbaceous energy crop production in the Southeast United States. DOE monthly report of June 2021.
140. Wilson, L. T., Y. Yang, F. Dou, T. Bera, J. Jifon, W. Rooney, N. Winans, A. Hale, B. Baldwin, J. Morrison, P. Illukpitiya, J. Knoll, A. Wright, C. Odero, and S. Hardev. 2021. Sustainable herbaceous energy crop production in the Southeast United States. DOE monthly report of July 2021.
141. Wilson, L. T., Y. Yang, F. Dou, T. Bera, J. Jifon, W. Rooney, N. Winans, A. Hale, B. Baldwin, J. Morrison, P. Illukpitiya, J. Knoll, A. Wright, C. Odero, and S. Hardev. 2021. Sustainable herbaceous energy crop production in the Southeast United States. DOE monthly report of August 2021.
142. Wilson, L. T., Y. Yang, F. Dou, T. Bera, J. Jifon, W. Rooney, N. Winans, A. Hale, B. Baldwin, J. Morrison, P. Illukpitiya, J. Knoll, A. Wright, C. Odero, and S. Hardev. 2021. Sustainable herbaceous energy crop production in the Southeast United States. DOE monthly report of September 2021.
143. Xu**,** S**.,** Zilverberg, C., Dwayne, B., Vital, S., Beck R., 2022. Assessing Soil Health Under Long-Term Tillage Management in Central South Dakota. Dakota Lakes Research Farm Field Day. May 22, Pierre, South Dakota.
144. Xu., S. Dakota Lakes Research Farm Field Day. 2021. Talk: Soil Health Management for Sustainable Agriculture in South Dakota. Virtual meeting. Feb 9.
145. Xu., S., South Dakota Soil Health Coalition Meeting. 2021. Invited talk: Soil Health Management for Sustainable Agriculture in South Dakota. Pierre, SD. June 10.
146. Yadav, G.S., A. Das, S. Babu, K.P. Mohapatra, R. Lal, and D. Rajkhowa. 2021. Potential of Conservation Tillage and Altered Land Configuration to Improve Soil Properties, Carbon Sequestration and Productivity of Maize Based Cropping System in Eastern Himalayas, India. International Soil and Water Conservation Research. http://www.sciencedirect.com/science/article/pii/S2095633921000010

NC1178 Annual Meeting

6/8/2022-6/9/2022

Texas A&M, College Station, TX

**6/8/2022 9:00am-6:10pm Project meeting**

**Participants:**

In person: Asko Noormets, Changyoon Jeong, DeAnn Presley, Fugen Dou, Itamar Shabtai, Rattan Lal, Mohammad Golabi, Rongzhong Ye, and Xi Zhang

Virtually*:* Humberto Blanco, Larry Cihacek, and Sutie Xu

**What Happened/Discussed:**

Vice Chair duties and responsibilities:

1. Vice-Chair will be the Chair for the following year
2. Take notes for the annual meeting
3. Summarize meeting minutes
4. Compile project report to Dr. Gary Pierzynski in a timely manner
5. Plan and host the next annual meeting as the Chair

Group agreement:

1. The 2023 annual meeting will be hosted by Dr. Rongzhong Ye at Pee Dee Research and Education Center, Clemson University, Florence, SC
2. Dr. Itamar Shabtai was voted unanimously as the Vice-Chair for 2022-2023 (Chair 2023-2024); annual meeting will be held at Connecticut Agriculture Station in 2024
3. Dr. Xi Zhang will be the Vice-Chair for 2023-2024; annual meeting will be held at Red River Research Station, Louisiana State University-Agricultural Center in 2025

Thoughts and discussion:

1. The priority to make sure the team work together to produce measurable outcomes
2. Renewing proposal: the current granted period ends in 2024. The group needs to start thinking about the renewal processes. We need to think about keywords, objectives, and area of interests

*General timeline:* 2023 start writing according to the guideline; complete in December 2023; revise by January-July 2024, if necessary; project start in October 2024

*Dr. Golabi suggested:* the new proposal can align with the grant we submitted to NRCS (i.e., Partnership for Climate-Smart Commodities)

*Dr. Lal suggested:* need to continue the SOC subject to address the assessment and prediction of C credits at farm scale with easy and simple way to measure, verify, and report C credits; adding societal values to the new proposal

*Dr. Pierzynski confirmed* that these topics remain of utmost interest to USDA, and that the number of groups working in this area is increasing, raising the need to consider collaboration and avoid overlap.

1. Writing a review of the NC1178 history to peer-reviewed journal to celebrate the 40-year anniversary of the Multistate Project. Dr. Larry Cihacek will take the lead

 Project update presentation (20 min each):

1. Sutie Xu, South Dakota State University
2. Larry Cihacek, North Dakota State University
3. Humberto Blanco, University of Nebraska-Lincoln
4. Rattan Lal, Ohio State University
5. DeAnn Presley, Kansas State University
6. Itamar Shabtai, Connecticut Agricultural Experimental Station
7. Rongzhong Ye, Clemson University
8. Mohammad Golabi, University of Guam
9. Xi Zhang, Louisiana State University
10. Fugen Dou, Texas A&M University
11. Changyoon Jeong, Louisiana State University
12. Asko Noormets, Texas A&M University

Updates from Dr. Gary Pierzynski, NC1178 project advisor:

1. NC1178 passed the mid-term review
2. The project needs to be renewed by 9/30/2024

9/15/2023 is the deadline to request to write a proposal

10/15/2023 is the deadline to submit proposal objectives

12/1/2023 is the date for full proposal submission

1. Avoid proposing something that overlaps with other on-going projects
2. The annual report should indicate the collaborative efforts across the states

**6/9/2022 8:00am-6:10pm:** Field tourto Cook’s Branch Conservancy (Mitchell Foundation) and Davy Crockett National Forest (USDA Forest Service)