**NC-1178: 2018 Annual Meeting Minutes**

Meeting Dates: July 24-25, 2018

Meeting Location: McCrory Gardens, South Dakota State University, Brookings, SD

*Chair:* Sandeep Kumar, South Dakota State University

*Secretary:* Larry Cihacek, North Dakota State University

*Chair Elect:* Larry Cihacek, North Dakota State University

*Secretary Elect:* Deann Presley, Kansas State University

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| *Members Present*Mahdi Al-Kaisi (IA)Francisco Arriaga (WI)Larry Cihacek (ND)Mohammad Golabi (Guam)Jose Guzman, SDDavid Lobb (U. Manitoba)Klaus Lorenz (OH)Deann Presley (KS)Tom Schumacher (SD) (retired)Sandeep Kumar (SD) | *Members Absent*Ken Olson (IL) (retired)Vijay Gopal Kakani (OK)Gary Steinhardt (IN)Humberto Blanco (NE) (Report Submitted)Rattan Lal (OH) (Report Submitted)Lisa Tiemann (MI)Michael Cox (KY) |
| *Guests*Don Reicosky (USDA-ARS) (retired)Jasdeep Singh (SDSU)Navdeep Singh (SDSU) |  |

Summary of Minutes of Annual Meeting:

Recorded by Larry Cihacek

*Tuesday, July 24, 2018*

Sandeep Kumar (SD) opened the meeting at 8:00 AM in the conference room at McCrory Gardens on the South Dakota State University campus. Tom Schumacher gave the welcome and discussed the linkages that SDSU has historically had with other soil science departments and historical figures in the study of soil science around the country. This was followed by introductions of the attendees of the meeting.

Presentation of research reports followed. The reports were started off by researchers at South Dakota State University describing their research (S. Kumar, N. Singh, J. Singh, J. Guzman) and providing background for the field tours later in the day and on Wednesday.

Don Reicosky presented concepts on conservation agriculture that integrates conservation tillage with soil health practices and building up soil carbon to improve productivity.

David Lobb discussed the state of erosion and nutrient management in Manitoba. A major issue is tillage erosion which has degraded many soils of the glacial till plains in Canada. A major problem is that once a soil is degraded, no-till and cover crops cannot increase carbon inputs to improve soil productivity.

Following these presentations, the group toured the USDA-ARS NCARL Laboratory hosted by Sharon Papernik followed by visiting the regional USDA-CAP grazing research site hosted by Navdeep Singh and the on campus laboratories that are directed by Sandeep Kumar.

The group broke for lunch at noon back at McCrory Gardens.

Following the lunch break, the presentation of state research reports continued with Arriaga (WI), Presley (KS), Cihacek (ND), Lorenz (OH), Al-Kaisi (IA), and Golabi (Guam) presenting their reports.

After the reports were finished, Sandeep Kumar called the business meeting to order at 3:40 PM. The first order was the approval of the 2017 meeting minutes. Al-Kaisi moved to approve the minutes, Golabi seconded the motion and the minutes were approved.

The move of the administrative advisor from Kansas State to Ohio State as Associate Dean was discussed. He has expressed willingness to continue as the administrative advisor but several committee members were concerned whether this would affect time commitments to this committee. After a discussion, the committee recommended that Cihacek (ND) contact him and discuss his continuing as the administrative advisor.

Dates and place of the 2019 annual meeting were discussed. Proposed dates were the week of July 15, 2019 or the week of July 22, 2019 with the preferred date being during the week of July 22. Arriaga moved that the dates be July 23 and 24, 2019. Mohammad seconded the motion. The motion passed. North Dakota State University will host the 2019 meeting.

After discussion about the 2019 Secretary Elect position, Deann Presley was elected by acclamation. She will then be Chair in 2020.

Dr. David Wright, Chair of the Agronomy, Plant Sciences and Horticulture Department welcomed the group to campus and discussed research and building activities of the department. They will be constructing a new 129,000 ft2 facility costing approximately $45 million out of a $55 million campus package.

The final item of business for the day was writing the new revision of the project to begin in 2019 which will be due by the end of the year for review by the North Central Administrators group. An outline of the new project needs to be submitted to CSREES by September 15th.

Discussion revolved around the comments made by Al-Kaisi that the newer researchers should take the lead in the revision in order to coordinate it with their research objectives. This lead to developing the wording for the new objectives which are as follows:

*1. Evaluate the impact of intensifying agroecosystems (e.g. increased crop rotations/double cropping, and management integration) on soil organic C, soil health, productivity, the environment, and profitability.*

*2. Assess management effects (e.g. crop residue, tillage, cover crops,) on soil organic C, environmental footprints (e.g. GHG emissions, water quality, water quantity, soil erosion, input use efficiency), and productivity.*

Things to keep in mind for write-up - spatial and temporal variability/changes; risk management and economic potential; tradeoffs of intensification (+ and - impacts); diversification vs intensification; crop residue utilization; soil degradation (salinity and sodicity) management and risk assessment

Al-Kaisi moved and Arriaga seconded that Kumar and Guzman prepare a draft of the proposed methods for the committee by the last week of September. The motion passed.

The meeting was adjourned until Wednesday morning at 5:30PM. Following adjournment the committee members went to dinner as a group.

*Wednesday, July 25, 2018*

The committee participants drove to Garretson, SD to view long-term no-till crop production and eroded soils. From there they traveled to the SDSU Southeast Research Farm to view ongoing grazing plots, long-term rotations and cover crops, manure and compost, and drainage studies with Dr. Peter Sexton providing a discussion of the history and operation of the research farm. After a catered lunch, the meeting adjourned at 12:30 PM.

**Multi-State (NC-1178) Project 2018 Station Report for Guam**

**Mohammad H Golabi**

1. **Impact Nugget**

Our continued findings show that soil disturbances including residue removal increases the potential for soil carbon loss hence overall reduction of carbon storage in the soils under study. Increased carbon loss from the soil translates to increased net carbon dioxide emission to the atmosphere due to continued disturbances of the soil surface.

1. **New Facilities and Equipment.**

The study is being conducted at the University of Guam’s experiment station located in the district of Inarajan village in Southern region of Guam known as ‘Ija’. The station is equipped with full set of farming machinery that are operated and maintained by the university personnel working at the station. However, the equipment at the station does not include No-till planters and similar machinery for conservation farming systems. Therefore, no till planting is conducted manually using hand held planter. In addition to farm machineries the facilities in Ija station also include resident building and water supply. Due to unpredictable weather patterns in the area, irrigation lines are installed for regular watering as well as for fertigation procedures.

1. **Unique Project Related Findings**

Continued data collection and analysis from the study has shown that the higher percent carbon content (Figure 1) of the soil under the no-tillage (NT) was due to no disturbances on the soil surface during the study period. On the reduced till (RT), the percent carbon content also remained high next to the NT mainly due to the reduced disturbances as compared to conventional tillage (CT). As it is shown (Fig. 1), the percent carbon content in the conventional tilled (CT) where the crop residue was removed, were the lowest for all sampling events. On the other hand, when the ‘biochar’ was applied on conventionally tilled plots (CT/BC) it showed improvement with the soil carbon content as compared to CT treatment plots. This improvement of the soil carbon level was mainly due to the carbon effect of the ‘biochar’ that was added to the soil before planting.

As it is reported (Julian Yua et.al., 2018);

“enhancement of soil fertility and mitigation of atmospheric greenhouse gases are potential benefits of biochar amendments with proximate links to microbiological processes”.

Additionally, and as it is reported (Julian Yua et.al., 2018), soil bacterial community composition is increased following biochar amended soils.

Although not conclusive, the data collected from this study so far has shown that any disturbance to the soil surface due to tillage negatively affect the amount of soil carbon storage/sequestration capacity, thus increasing the chance of carbon dioxide emission into the atmosphere (Fig. 2).

1. **Accomplishment Summaries.**

Soil quality and soil and water conservation strategies are the building blocks of agricultural sustainability in Guam and the other islands of the American Pacific’s. In order to improve the soil quality for agricultural sustainability, among the methods and management practices proposed on these demonstrations are; reduced tillage (RT), crop rotation, crop residue management, use of green manure (legume) and the application of biochar as soil amendment which increases soil carbon storage capacity.Our parallel research works have shown (Golabi, et. al., 2014) that relatively long growing season and adequate rainfall in Guam enables growth of legumes which can be used to supply nitrogen to subsequent crops. Other researchers (Hargrove and Frye, 1987, Hargrove, 1985, Hargrove et. al., 1982) also have reported that a well-adopted legume can replace from 60 to 120 kg N ha-1 for subsequent crops of corn or grain sorghum. Additionally, El-Swaify et.al (1988) have reported that drastic reduction in runoff and soil loss resulted from rotating with legumes.

Soil organic matter is probably the most important indicator for soil quality improvement (Golabi, et. al., 2014). Surface residue management practices can have a significant impact on increasing soil organic matter. On the other hand, loss of organic matter due to crop residue removal affects several soil properties including deterioration in soil structure, lower water and nutrient retention, lower infiltration rate, and accelerated runoff and erosion.

Moreover, excessive tillage and frequent soil disturbances especially crop residue removal significantly reduces the chances for increasing soil organic matter resulting in poor soil quality. Excessive tillage also attributes to soil erosion by water hence, deteriorating the environmental quality in Guam and other island of Micronesia where water quality and coral health are affected by sedimentation and runoff from unprotected farms and ranches.

 On the other hand, conservation practices such as reduced till (RT) or crop rotation not only reduce or eliminate soil erosion, it also provides crop residue as energy source available for top-feeding organisms (earthworms) thus helping to maintain the sustainability and the efficiency of cropland over long periods of time. As these macro-and-microorganisms use the surface residue as source of food and energy, they return humus to the soil, resulting in an increased soil organic matter hence improving soil quality.

Conservation crop rotation is also a systematic sequence of crops grown in combination with other crops and/or legumes. When legumes as green manure is part of the rotation, nitrogen is supplied to the succeeding crop. In addition to nutritional benefit to the subsequent crop, legumes have shown to suppress reniform nematodes.

Crop rotation can be simple; corn followed by a legume (Sunnhemp for Guam), followed by other crops using conservation tillage. Crop yields in rotation are often higher than those grown in monoculture. Research has shown that under reduced and no-till systems water infiltration into the soil is considerably higher. The greater water infiltration, coupled with reduced evaporation afforded by mulch resulted in more water available for crop use hence, making crop more resistant to occasional droughts.

1. **Impact Statements**

The result of this on-going project has shown that the tillage systems as well as residue removal affect the soil quality hence, the crop productivity and agricultural sustainability in Guam and other islands in the western pacific. The continued results also showing that the residue removal negatively affects the amount of soil carbon content level specially near the soil surface, hence affecting the carbon sequestration potential of these degraded soils of southern Guam (Figure 1).

It is expected that, findings from this on-going experiment will contribute to the overall scientific efforts in understanding the role of different agriculture practices in carbon dynamics of the soils, and the ways in which this may reduce atmospheric carbon dioxide. It also provides information pertaining to the local conditions of the island’s tropical climate as it relates to carbon sequestration and/or carbon loss in the form of carbon dioxide emission into the atmosphere following the removal of crop residue as well as disturbances that occur during the tilling process.

In order to disseminate the findings of this project occasional field days, and other educational events have been organized during the project life for agricultural professionals and soil scientists as well as farmers and ranchers and the general public at the University of Guam research station located in Ija (southern Guam).

1. **Published Written Works.**

**Book Chapter:**

Jose Guzman, and **Mohammad H. Golabi**. (2017). Agroecosystem Net Primary Productivity and carbon Footing. **In:** Soil Health and Intensification of Agroecosystems. Edited by; Mahdi Al-Kaisi (Iowa State University), and Birl Lowery (University of Wisconsin-Madison). Academic Press (AP), An imprint of Elsevier. London, San Diego, Cambridge, MA, Oxford, England. ***Published***

 **Journal Article in progress:**

 None

1. **Scientific and Outreach Oral Presentations.**

CONFERENCE/MEETING PRESENTATIONS

1. **Golabi, Mohammad H.**, (2018). “Evaluating the effect of ‘Biochar’ on soil quality and on ‘Soil Carbon Sequestration’ for reducing the carbon print of CO2 emission into the atmosphere”. *Presented at the*: Multi-State (NC 1178) 2018 annual meetings that were held in Brookings, south Dakota during July 24-25.
2. **Mohammad H. Golabi**, Ferdinand Galsim, Clancy Iyekar, and Chieriel S. Desamito. (2018). ‘Mitigating soil acidity for agricultural sustainability in the humid tropics of Micronesia’. The 10th International Symposium on Plant-Soil Interaction at Low pH soils that was held in Putrajaya, Malaysia, during June 25-29, 2018.
3. Golabi, Mohammad H., and Clancy Iyekar. (2017). Evaluating the role of Soil and Water Conservation on ‘Carbon Sequestration’ for reducing the carbon dioxide (CO2) emission into the Atmosphere – a Case study from southern Guam. Submitted to the: 1st World Conference on Soil and Water Conservation under Global Change (CONSOWA-2017) for: Sustainable Life on Erath through Soil and Water Conservation. Lleida, Spain June 12 - 16, 2017. Invited Paper
4. Golabi, Mohammad H., and Clancy Iyekar. (2017). Would the land application of ‘Biochar’ help ‘Sequester’ soil carbon hence, reduce the CO2 emission into the Atmosphere? – an environmental case study in southern Guam. Submitted to: Presented at: The 8th Regional Conference on Island Sustainability. April 17-21, 2017 at the Hyatt Regency hotel in the island of Guam.
5. **Golabi, Mohammad H.**, and Clancy Iyekar. Evaluating the benefits of ‘Biochar’ on soil quality while determining its effect on ‘Soil Carbon Sequestration – A pathway to Sustainability. *Abstract Submitted to the:* 72nd International Annual Conference of the Soil and Water Conservation Society. Madison, Wisconsin, July 30th to August 2nd, 2017.
6. **Fund leveraging, specifically, collaborative grants between stations and members**.

COLLABORATIVE EFFORTS

**Potential collaborative research project(s) in the pipe:**

1. Pursuing a collaborative effort with researcher Dr. Nguyen Hue at the University of Hawaii. Dr. Hue is a well know soil scientist who does a lot of work with ‘biochar’ and has expressed interest in our Multi-State project here in Guam. Dr. Hue, is interested in learning about the effect of ‘biochar’ specifically on highly weathered, very acidic soils of southern Guam and compare the effect with very alkaline soils of northern Guam. We are jointly seeking grant opportunity from the NRCS at the Honolulu station for this possible collaboration. With the possibility of a grant from NRCS, a joined research project with Dr. Hue’s lab, we could possibly create an opportunity for obtaining new information about ‘biochar’ application on these unique soils of Guam.

1. **Other relevant accomplishments and activities.**
2. In addition to the dissemination of the results from this research, indicated above this project has also been used as a teaching tool/opportunity throughout each academic year for educational purposes. Graduate as well as undergraduate students from the Soil as well as Geography classes had been taken to the project sites where the purpose and the objectives of the project were described to them as part of outside classroom learning opportunities. The effect of each tillage treatment, crop residue removal, as well as ‘biochar’ application on unique soils of Guam (both north as well as in southern regions) have been demonstrated to students at the project site, where they were able to write report and/or answer to the related exam questions.

**References:**

Julian Yua, Lauren M. Deem, Susan E. Crow, Jonathan L. Deenik, C. Ryan Penton. (2018). Biochar application influences microbial assemblage complexity and

composition due to soil and bioenergy crop type interactions. Soil Biology and Biochemistry, 117, 97-107.

URL: journal homepage: [www.elsevier.com/locate/soilbio](http://www.elsevier.com/locate/soilbio)

El-Swaify S.A., A. Lo, R. Joy, L. Shinshiro, R.S. Yost. 1988. Achieving conservation-effectiveness in the tropics using legume intercrops. Soil Technology vol.1, pp1-12

**Golabi, M. H**., S.A. El-Swaify, and Clancy Iyekar (2014). Experiment of “no-tillage” farming system on the volcanic soils of Tropical Island of Micronesia. ***International Soil and Water Conservation Research Journa***l. Vol. 2, No. 2, June 2014.

Golabi, M.H., S.E. Radcliffe, W.L. Hargrove, and E.W. Tollner. 1995. Macropore effects in conventional tillage and no-tillage soils. Jour. Soil and Water Cons. 50(2) 205-210

Hargrove, W.L., and W.W. Frye. 1987. The need for legume cover crops in conservation tillage production. *In*: J.F. Power (ed.), The role of legumes in conservation tillage systems. Soil Conserv. Soc. Am., Ankeny, Iowa. Pp1-5

Hargrove, W.L., J.T. Reis, J.T. Touchton, and R.N. Gallaher. 1982. Influence of tillage practices on the fertility status of an acid soil double-cropped to wheat and soybean. Agron. J. 74:684-687

Hargrove, W.L. 1985. Influence of tillage on nutrient uptake and yield of corn. Agron. Jour. 77: 763-768.



Figure 1. Showing percent carbon content of the soil at different depth under different treatments: Reduced till, No-Till, Conventional till, and Conventional till with ‘Biochar application’.



Figure 2. Showing carbon dioxide (CO2) emission from the soils under different treatments: Till, No-Till (NT), Reduced till (RT), Conventional till (CT), and Conventional till ‘Biochar application’ (CT/BC).

**NC-1178 Annual State Report**

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| **Year: July 24-25, 2018, Brookings, SD** |
| **Institution: Iowa State University**  |
| **Committee Representative: Mahdi Al-Kaisi, Professor, Agronomy Department**  |

1. **Impact Nugget:**

Iowa State University research demonstrated a reduction in input cost of producing corn and soybean with No-till and Strip-till by $15-25/ha compared to conventional tillage and improvement in SOC with NT and ST by 0.3 to 0.5 Mg/ha/yr while conventional tillage systems lost 0.4-0.5 Mg/ha/yr in a 14-yr study.

1. **New Facilities and Equipment:**

None

1. **Unique Project Related Findings:**
* NT and ST show an increase in SOC in the range of 0.30-0.50 Mg/ha/yr and decline in SOC with convectional tillage systems after 14 years of implementing 5 tillage and 3 crop rotations in Iowa.
* Reduction in input cost of $15-25/ha with NT and ST compared to conventional tillage systems.
* Decline in corn yield across all tillage systems with continuous corn by 11-28% compared to corn after soybean or corn-corn-soybean rotations. No change in soybean yield across all tillage systems.
1. **Accomplishment Summaries:**

Iowa State University conducted long-term tillage and crop rotation study that include five tillage systems include: no-till (NT), strip-till (ST), chisel plow (CP), deep rip (DR), and moldboard plow (MP) and the three crop rotations include two with soybean: Corn-soybean (C-S), Corn-corn-soybean (C-C-S) and a continuous corn (C-C) system. Corn and soybean yields were determined from the center 4 and 6 rows of each plot, respectively. These experiments implemented at seven Iowa State University Research and Demonstration Farms representing different soil types and climate conditions. Analysis of 14 years of data showed greater yield response with C-S rotation compared to C-C by 11-28% across all tillage systems and greater input cost with Conventional tillage systems compared to NT and ST by 7.5% and %.7%, respectively. Preliminary analysis of soil carbon over the past 14 years showed an improvement in soil carbon with NT and ST by 0.50 and 0.30 Mg/ha/yr, respectively as compared to conventional tillage systems with soil carbon loss of approximately 0.60 Mg/ha/yr.

1. **Impact Statements:**
* Preliminary analysis of soil carbon over the past 14 years showed an improvement in soil carbon with NT and ST by 0.50 and 0.40 Mg/ha/yr, respectively as compared to conventional tillage systems with soil carbon loss of approximately 0.60 Mg/ha/yr.
* The analysis of 14 years of data on the effect of long-term tillage and crop rotation on corn and soybean yield and economic returns showed an interesting trend across the state of Iowa. Corn yield and economic return showed significant variability across the state as affected by soil type and climate conditions.
* Economic return showed a significant advantage for NT and ST over conventional tillage systems where input cost was $15-25/ha less with NT and ST compared to conventional tillage systems. Also the results reveal a significant decline in corn yield with continuous corn compared to corn following soybean rotation.
* The soybean yield in the same study shows no significant differences in yield regardless of tillage or crop rotation. However, economic return for soybean across all tillage systems and locations was 5% greater with C-C-S compared to C-S rotation.
1. **Published Written Works:**

Al-Kaisi, M. and B. Lowery. 2017. Soil Health and Intensification of Agroecosystems. Academic Press. (Book).

Al-Kaisi, M., R. Lal, K. Olson, and B. Lowery. 2017. Fundamentals of Soil Environment and Functions. In: Al-Kaisi, M. and B. Lowery (Eds), Soil Health and Intensification of Agroecosystems. Academic Press.

Al-Kaisi, M. and R. Lal. 2017. Conservation Agriculture Systems to Mitigate Climate Variability Effects on Soil Health. In: Al-Kaisi, M. and B. Lowery (Eds.), Soil Health and Intensification of Agroecosystems. Academic Press.

1. **Scientific and Outreach Oral Presentations.**
* During the growing season of 2017, several presentations of the preliminary findings of these studies were presented to local farmers and agronomists in the state. These workshops were organized by Extension as part of the annual Extension and education program.
* Yield data collected from these studies analyzed for yield response and economic returns to different tillage and crop rotations.
* Training sessions, PowerPoint presentations, and educational materials were presented during different events in the state. In addition to field days, initial findings of this research were shared with other colleagues and agricultural professionals through newsletter articles, and annual meetings.
* Presentation at the regional committee meeting and presentation to extension educators and other agricultural professionals during various events such as the Integrated Crop Management (ICM) conference in Iowa in 2017. The ICM conference is organized annually and approximately 1,000 agricultural professionals attended the conference.
1. **Funding Leveraging: None**
2. **Other Relevant Accomplishments and Activities:**

Soil Health conference is organized since 2016 at Iowa State University. In 2017, two days conference was organized by inviting scientists from land grant universities and ARS-USDA to share their research and present posters. Over 400 farmers, agronomists and students attend the conference in Ames Iowa.

**NC1178 2018 Report**

DeAnn Presley

Department of Agronomy

Kansas State University

Manhattan, KS 66506

1. **Impact Nugget**:

Over a 9-year average, crop residue removal had no significant effect on corn yield at two locations in Kansas; for the most recent 2 harvests, there were no yield differences at either site. At both sites all treatments appear to have declined in soil organic C content (0-10 cm depth, in Mg ha-1) since initiation in 2009, with no differences among treatments at either site.

1. **New Facilities**: None
2. **Unique Project Related Findings**:

The tradeoff between increasing crop yields and increasing soil organic C sequestration is an illustration of the need for balancing two ecosystem services provided by cropland soils, i.e., provisioning and regulating.

1. **Accomplishment Summary**:

A corn residue removal research project began in 2009 at three sites. One site was discontinued after 2011, but the other two locations are still active research sites. Residue removal studies continue on two sets of plots with 0, 25, 50, 75, and 100% stover removal levels. One plot is in eastern Kansas, and the other is an irrigated site in western Kansas. Crop grain yield is measured annually and soil organic C and bulk density are measured every other year in odd years. Thus far, there have been few instances where crop residue removal has been detrimental to corn yields. In fact, removal has led to increased crop yields at the irrigated Colby site, where an average of 330 mm irrigation is applied during the corn growing season. Corn yields are high; therefore residue production has been high, and removal led to increased crop yields at Colby in this high-yielding environment. At the rainfed Ottawa site, differences in crop yields were observed in 2009, 2010, and 2015, when crop yields increased with increasing residue removal. Soil organic C has been measured multiple times during the experiment. Relative to the 2009 baseline levels of soil organic C in the upper 10 cm of the soil profile is slightly lower, however, the values are not significantly different between treatments.

**Table 1. Corn yields 15.5% moisture, Mg ha-1, 2009-2017. Letters denote statistical differences among treatments within each site year (p<0.05).**

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| --- | --- | --- | --- |
| Time | Removal Level | **Colby** | **Ottawa** |
| 2009 | 0% | 13.11 | b | 7.49 | bc |
| 25% | 16.48 | ab | 6.32 | c |
| 50% | 17.86 | a | 7.96 | ab |
| 75% | 18.14 | a | 8.08 | ab |
| 100% | 17.32 | a | 9.43 | a |
| 2010 | 0% | 13.48 | ab | 4.41 | c |
| 25% | 12.59 | b | 4.40 | c |
| 50% | 14.41 | ab | 4.59 | bc |
| 75% | 15.89 | a | 5.56 | a |
| 100% | 15.72 | a | 5.33 | ab |
| 2011 | 0% | 6.73 | a | 0.88 | a |
| 25% | 8.81 | a | 1.05 | a |
| 50% | 9.42 | a | 1.23 | a |
| 75% | 8.91 | a | 1.58 | a |
| 100% | 9.99 | a | 1.40 | a |
| 2012 | 0% | 9.61 | b | 1.27 | a |
| 25% | 10.06 | ab | 1.59 | a |
| 50% | 11.01 | ab | 1.52 | a |
| 75% | 12.45 | a | 1.22 | a |
| 100% | 12.31 | ab | 1.72 | a |
| 2013 | 0% | 12.33 | b | 9.22 | a |
| 25% | 13.98 | ab | 9.02 | a |
| 50% | 12.68 | b | 9.35 | a |
| 75% | 14.88 | a | 9.89 | a |
| 100% | 14.67 | a | 9.45 | a |
| 2014 | 0% | 11.32 | b | 7.96 | a |
| 25% | 12.86 | ab | 7.84 | a |
| 50% | 11.79 | b | 8.85 | a |
| 75% | 14.14 | a | 8.46 | a |
| 100% | 14.01 | a | 9.86 | a |
| 2015 | 0% | 14.7 | a | 6.77 | b |
| 25% | 13.1 | a | 8.14 | a |
| 50% | 13.3 | a | 8.71 | a |
| 75% | 13.0 | a | 8.53 | a |
| 100% | 13.3 | a | 8.32 | a |
| 2016 | 0% | 11.8 | a | 8.6 | a |
| 25% | 12.7 | a | 9.0 | a |
| 50% | 13.1 | a | 8.2 | a |
| 75% | 12.7 | a | 8.6 | a |
| 100% | 13.6 | a | 8.0 | a |
| 2017 | 0% | 13.5 | a | 7.2 | a |
| 25% | 14.7 | a | 6.5 | a |
| 50% | 15.0 | a | 6.3 | a |
| 75% | 15.8 | a | 6.6 | a |
| 100% | 15.9 | a | 6.6 | a |

Figure 1. Corn yields at 15.5% moisture, averaged by treatment 2009-2017. There are no statistical differences between yields when averaged across years.

Figure 2. All treatments have less SOC (Mg ha-1) relative to 2009 values, at both sites, with no statistical differences between treatments.

1. **Impact Statements**:
* On average, crop residue removal has had no statistically significant effects on continuous no-till corn yields in this eight years, two site location study.
* For the upper 10 cm of the soil profile, soil organic C values do not differ among treatments, but the 2017 values are less than the 2009 values.
1. **Published Written Works**

Presley, DeAnn, Yuxin He, and Peter Tomlinson. 2018. Soil Health and Yields on Non-Sodic Soils Amended With Flue Gas Desulfurization Gypsum. Crops Forage Turfgrass Management. doi: 10.2134/cftm2018.01.0001.

Farney, Jaymelynn, Gretchen F. Sassenrath, Cathryn Davis, and DeAnn Presley. 2018. Production, Forage Quality and Economics of Three-Way Cover Crop Mixes. Crops Forage Turfgrass Management. doi: 10.2134/cftm2017.11.0081;

Alghamdi, A., M.B. Kirkham, D.R. Presley, Ganga Hettiarachchi, and L. Murray. 2017. Rehabilitation of an Abandoned Mine Site with Biosolids. In: Spoil to Soil: Mine Site Rehabilitation and Revegetation. Eds. N.S. Bolan, M.B. Kirkham, and Y.S. Ok. CRC Press. Portland, United States.

He, Y., D.R. Presley, J. Tatarko, and H. Blanco-Canqui. 2017. Crop residue harvest impacts wind erodibility and simulated soil loss in the Central Great Plains. Global Change Biol. Bioenergy. doi: 10.1111/gcbb.12483

1. **Scientific and Outreach Oral Presentations:**
2. July 11-14, 2017. Measuring soil physical properties. KARA summer field school. 150 attendees.
3. August 8, 2017. Agronomy: What’s it all about? Pottawatomie County 4-H club. 18 attendees.
4. August 8, 2017. Cover crops and water quality. Australian Grain Farmers visit. 40 attendees.
5. September 22, 2017. Composting food waste. Tour for Fort Hays State University class. 4 attended.
6. September 27, 2017. Soil health boot camp. Southeast Kansas extension agents. Fort Scott. 20 attended.
7. October 5, 2017. Composting food waste. Kansas Chapter of the Solid Waste Association of North America. North Farm. 80 adults.
8. October 11, 2017. Soil, geomorphology, geology training for Johnson County Master Naturalists. Olathe, KS. 30 attendees.
9. October 18, 2017. Cover crops and soil health. Riley County Conservation district plot tour. Leonardville, KS. 50 attendees.
10. October 28, 2017. Getting started with composting. Willow Lake Student Farm club. 2 attendees.
11. November 3, 2017. Cover crop selection. Cover crops Agronomy Department field day. Ashland Bottoms. 150 attendees.
12. November 14, 2017. Soil health research report. Wolf Creek cover crops field day, host Coffey County Extension. 40 attendees.
13. November 29, 2017. Soil health with cover crops. Henry Hill field day hosted by Meadowlark extension district. Holton, 50 attendees.
14. **Fund leveraging:**
	1. National Science Foundation Grant: “REU Site: Summer Academy in Sustainable Bioenergy; NSF Award No.: SMA-1359082, awarded to Kansas State University. $10,000.
	2. Grant: United States Department of Energy: Enabling Sustainable Landscape Design for Continual Improvement of Operating Bioenergy Supply Systems. Total award $9 million, sub-award to Kansas State University $125,000.
15. **Other Activities:**

Graduate Students:

1. Savanna Crossman. M.S. May 2018-present.

**NC1178 2017 Report**

Humberto Blanco, Associate Professor

Department of Agronomy and Horticulture, University of Nebraska-Lincoln

**Cattle grazing of corn residues: Implications on soil services**

1. **Impact Nugget**:

Cattle grazing of corn residues at recommended stocking rates has small or no effects on soil ecosystem services in the short term, but high rates (>50%) of corn residue baling may have some rapid impacts. For example, residue baling could decrease soil water content, increase soil temperature, and make soil more susceptible to wind erosion. Corn residue grazing and baling impact on soil compaction does not persist throughout the crop growing season.

1. **New Facilities**:
2. **Unique Project Related Findings**:

Any increase in soil compaction due to corn residue grazing at recommended stocking rate and baling disappears during the crop growing season. Residue baling at high rates may increase risks of wind erosion and decrease soil water content.

1. **Accomplishment Summary**:

In 2017, field measurements and soil sampling was done at a farm-scale corn residue grazing and baling experiment in no-till corn-soybean system established in fall 2014 near Clay Center, NE. Soil compaction, water content, and temperature were measured on a monthly basis. In addition, data were collected for wind erosion potential in spring, summer, and fall.

**Fig.1. Impact of residue treatments on soil compaction (cone index, MPa) at 0-5 cm soil depth in an irrigated corn-soybean system in south central Nebraska for two years. Bars with different letters represents significant difference at p ≤ 0.05.**

Residue treatments influenced cone index during four out of the six sampling months at 0- to 5-cm soil depth (Fig. 1). Residue grazing increased cone index up to 50% during March and May compared with the control. The impact of residue grazing treatment disappeared after May, however, the impact of grazing-1.5x treatment on cone index persisted until September. Residue baling increased cone index by 30% in March and by 55% in May but the impact on soil compaction disappeared after May. It is important to mention that the impact of residue grazing at recommended stocking rates on cone index was below the threshold limit of 2 MPa to restrict root growth and disappeared after spring. Results indicate that the impact of residue baling on soil compaction is short lived and is generally below the threshold limit to cause yield declines. However, grazing at high stocking rates (grazed-1.5x) may increase risks of soil compaction in corn-soybean system.

**Fig. 2. Impact of residue treatments on soil water content at 0-5 cm soil depth in an irrigated corn-soybean system in south central Nebraska for two years. Bars with different letters represents significant difference at p ≤ 0.05.**

Residue treatments affected volumetric water content during three of the six sampling months at 0- to 5-cm soil depth (Fig. 2). Grazing treatment did not decrease water content compared with the control. Grazed-1.5x treatment decreased water content by 2 to 22% during March, June, and July compared with the control. Residue baling decreased soil water content up to 45% compared with the control. The volumetric water content results indicate that residue baling decreases water content more than residue grazing. The decrease in water content due to grazing was mainly when grazing occurred at higher stocking rates than recommended (Grazed-1.5x).

**Fig. 3. Impact of residue treatments on soil temperature at 0-5 cm soil depth in an irrigated corn-soybean system in south central Nebraska for two years. Bars with different letters represents significant difference at p ≤ 0.05.**

Residue treatments influenced soil daytime temperature during three of the six sampling months at 0- to 5-cm soil depth (Fig. 3). An increase of 1 to 5 oC was observed in baled plots whereas grazing had similar temperature compared with the control. The increased temperatures could be due to decreased in residue cover due to baling. Residue treatments also influenced the wind erodible fraction in all sampling seasons (spring, summer, and fall). On average, residue baling increased wind erodible fraction by 52% whereas grazing showed no impact (Fig. 4.).

**Fig. 4. Impact of residue treatments on soil wind erodible fraction in an irrigated corn-soybean system in south central Nebraska for two years. Bars with different letters represents significant difference at p ≤ 0.05.**

1. **Impact Statements**:
* Any compaction caused by residue grazing and baling does not persist throughout the crop growing season.
* Residue baling may increase risks of wind erosion and decrease soil water content.
* Residue grazing at appropriate stocking rates can be an important strategy to obtain additional ecosystem services from cropping systems, however, the practice of baling might not be a sustainable crop residue management strategy.
1. **Published Written Works**

Rakkar, M.K. and H. Blanco-Canqui. 2018. Grazing of crop residues: Impacts on soils and crop production. Agriculture, Ecosystem and Environment. 254:71-90.

Rakkar, M.K., H. Blanco-Canqui, R. Rasby, K. Ulmer, J. Cox, M.E. Drewnoski, R. Drijber, K. Jenkins, and J. MacDonald. 2018. Grazing crop residues has less short-term impact on soil properties than baling in the central Great Plains. Agron. J. doi: 10.2134/agronj2018.03.0224.

Ruis, S., H. Blanco-Canqui, C. Burr, B. Olson, M. Reiman, D. Rudnick, R. Drijber, and T. Shaver. 2018. Corn residue baling and grazing impacts on soil carbon stocks and other properties on a Haplustoll. Soil Sci. Soc. Am. J. 82:202–213.

Cox-O'Neill, J.L., K.M. Ulmer, M. Rakkar, L. Franzen-Castle, H. Blanco-Canqui, M.E. Drewnoski, J.C. MacDonald, and R.J. Rasby. 2017. Perceptions of crop consultants and crop producers on grazing corn residue in Nebraska. Journal of Extension. 55:1-11.

Blanco-Canqui, H., C.W. Wortmann. 2017. Crop residue removal and soil erosion by wind. J. Soil and Water Conservation. 72:97A-104A.

Rakkar, M.K., H. Blanco-Canqui, M.E. Drewnoski, J.C. MacDonald, T. Klopfenstein, and R.A. Drijber. 2017. Impacts of cattle grazing of corn residues on soil properties after 16 years. Soil Sci. Soc. Am. J. 81:414-424.

1. **Scientific and Outreach Oral Presentations:**

Rakkar, M.K., H. Blanco-Canqui. 2017. Temporal changes in soil physical properties due to corn residue grazing and baling. SSSA Division: Soil and Water Conservation. ASA-SSSA-CSA International Annual meeting-2017, Tampa, FL.

Rakkar, M.K., H. Blanco-Canqui, and R. Drijber. 2017. Impact of residue grazing and baling on greenhouse gas fluxes under irrigated system. ASA: Environmental Quality. ASA-SSSA-CSA International Annual meeting-2017, Tampa, FL.

Rakkar, M.K., and H. Blanco-Canqui. 2017. Prediction of soil wind erosion potential and soil compaction under different residue management scenarios. SSSA Division: Soil and Water Conservation. ASA-SSSA-CSA International Annual meeting-2017, Tampa, FL.

1. **Fund leveraging: None**
2. **Other Activities: None**

**NC-1178 Annual State Report**

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| --- |
| **Year: 2018** |
| **Institution:** North Dakota State University |
| **Committee Representative:** Larry Cihacek |

1. Impact Nugget:
* Studies of N mineralization from crop residues originating in a long-term no-till cropping systems studies show net N immobilization by corn, soybean, spring wheat, winter wheat and flax residues.
* Winter pea and forage radish residues, though minor components in the long-term systems, showed net N mineralization.
* Studies relating short term soil incubations with soil organic matter currently indicate a net N mineralization of 6-13 kg N/% SOM.
1. New Facilities and Equipment:

None.

1. Unique Project Related Findings:
2. Long-term (20 week) incubation studies (Stanford and Smith method) using three soils and seven individual crop residues from a long-term no-till cropping systems study were conducted to evaluate N mineralization rates under controlled conditions. N mineralization by soils alone reflected their textural (fine sandy loam, clay loam, silty clay) and SOM differences (4, 5, 6%). With the exception of winter pea and forage radish, all other residues (corn, soybean, spring and winter wheat and flax) showed very little N mineralization across the incubation period resulting in net immobilization. Only winter pea and forage radish showed neutral or net mineralization. The driving factor in this mineralization study appears to be the C:N ratios of the residue materials. (See attached figures).
3. Short-term incubations (7-day anaerobic incubations) from an integrated crop-grazing system across three growing seasons show net N mineralization of 6 to 13 kg N/% SOM across all treatments. Treatments included continuous spring wheat as a control treatment and a 5 year rotation of spring wheat, winter triticale/hairy vetch/cover crop, corn (grazed), field pea/barley, and sunflower. Soils were sampled to a depth of 15 cm from 3 to seven times across the growing season each year. Mineralization tends to be higher for early season sampling dates than for later season sampling dates. As the crop-grazing system matures, a reduced need for additional fertilizer N based on soil tests and yield goals has declined likely due to the occurrence of legumes at three points in the rotation.
4. Accomplishment Summaries:
5. The residue N mineralization study is in the first year and is expected to continue for 1 to 2 additional years. Mineralization studies have been conducted on individual crop residues for 20 weeks and are currently being conducted on the same residues in a “no-till” mode in 12 week cycle increments followed by 3 weeks of freezing the soils followed by subsequent residue addition and 12 weeks more of incubation. This process will be repeated a total of three times to evaluate the effects of residue additions on N mineralization. A third study utilizing mixed residues consisting of corn/soybean residues and corn/soybean/winter wheat/cover crop are currently underway for 20 weeks.
6. The crop-grazing study is in its 7th season and data is continuing to be collected. This study is scheduled to continue for two more seasons. Changes in soil nutrient content, N mineralization, SOC, soil physical and soil health properties are being observed.
7. Impact Statements:
8. In long-term no-till production systems of the northern Great Plains, high accumulations of residues may be contributing to N immobilization in cropping systems, thus resulting in higher fertilizer applications to maintain yields.
9. In integrated crop-grazing systems, crop rotations with use of several legumes and livestock manure spreading appear to be enhancing the sustainability of the production system and soils.
10. Published Written Works:

Kaur, J., **L. J. Cihacek**, and A. Chatterjee. 2018. Estimation of nitrogen and sulfur mineralization in soils amended with crop residues contributing to nitrogen and sulfur nutrition of crops in the North Central U. S. Comm. Soil Sci. Plant Anal. (https://doi.org/10.1080/00103624.1499761)

1. Scientific and Outreach Oral Presentations.

**Cihacek, L. J.,** E. Lovering, C. Race, and J. Ransom. 2017. Mineral nitrogen availability from ethanol distiller’s by-products. 2017 ASA-CSSA-SSSA International Meetings. Tampa, FL.

**Cihacek, L. J.,** J. M. Teboh, J. Ransom, P. J. Flores, and S Zilhai-Sebess. 2017. Plant available phosphorus from distiller’s by-products. 2017 ASA-CSSA-SSSA International Meetings. Tampa, FL.

De, M., M. Lawerinko, R. Baldwin-Kordick, S. Hall, **L. J. Cihacek**, and M. D. McDaniel. 2017. Impacts of Conservation Reserve Program on soil health. 2017 ASA-CSSA-SSSA International Meetings. Tampa, FL.

Kaur, J., **L. Cihacek**, and A. Chatterjee. 2017. Estimation of nitrogen (N) and sulfur (S) mineralization in soils amended with crop residues. 2017 ASA-CSSA-SSSA International Meetings. Tampa, FL.

**Cihacek, L. J.** 2017. Benefits of integrated crop-livestock systems on soil health. 2017 ND Chapter Soil and Water Conservation Society Annual Workshop. Bismarck, ND.

**Cihacek, L.** 2018. N mineralization in differing cropping and grazing systems. ND Ag Experiment Station Spring Workshop. Fargo, ND.

**Cihacek, L.** 2018. Soil erosion, soil productivity and soil health. Cover Crops for Soil Health Workshop. Langdon, ND.

**Cihacek, L. J.,** D. L. Landblom, and S. Senturklu. 2018. A place for cover crops in and integrated crop-grazing system. 2018 Midwest Cover Crops Council Workshop. Fargo, ND.

**Cihacek, L.,** S. Senturklu, and D. Landblom. 2018. Enhancing soil sustainability and soil health in and integrated crop-grazing system. 73rd SWCS International Annual Conference. Albuquerque, NM.

Alghamdi, R. and **L. Cihacek**. 2018. Nitrogen mineralization from selected no-till crop residues. . 73rd SWCS International Annual Conference. Albuquerque, NM.

1. Funding Leveraging:

**Cihacek, L.** 2016. Plant Available Nitrogen Mineralization from Mixed-species Crop Residues in Long-term No-till Corn Production Systems. North Dakota State Board of Agricultural Research and Education (SBARE). $7300. 1 year.

**Cihacek, L.** 2016. Plant Available Nitrogen Mineralization from Mixed-species Crop Residues in Long-term No-till Corn Production Systems. North Dakota Corn Council. $2433. 1 year.

1. Other Relevant Accomplishments and Activities:

None.

Figures for 3a above:



Figure 1. Total N mineralization by crop residue over time for a Heimdahl fine sandy loam soil (4 % SOM) over a 20-week incubation period. The control treatment is the soil alone without residue added.



Figure 2. Total N mineralization by crop residue over time for a Fargo silty clay soil (6 % SOM) over a 20-week incubation period. The control treatment is the soil alone without residue added.



Figure 3. Total N mineralization by crop residue over time for a Forman clay loam soil (5 % SOM) over a 20-week incubation period. The control treatment is the soil alone without residue added.

**NC1178 Report 2018**

Rattan Lal

The Ohio State University

Columbus, OH 43210

Report distributed at the annual NC1178 meeting in Brookings,

South Dakota State University from 24-25 July, 2018.

* 1. **Impact Nugget**

The Ohio State University has assessed the rates of soil organic carbon (SOC) sequestration of different soils and cropping systems, and related agronomic productivity to SOC concentration in the root zone.

* 1. **New Facilities and Equipment**

The Carbon Management and Sequestration Center has acquired a new PAS device for the in-field measurements of gaseous emissions from soils.

**3. Unique Project Related Findings.  List anything noteworthy and unique learned this year.**

* Poor drainage and sub-optimal soil temperatures during the early spring in 2017, adversely affected corn growth for a clayey soil at Hoytville and reduced grain yield by 50% compared with that on a well-drained soil.
* There were strong differences in crop growth and yield among two sites of the long-term residues management experiment because of differences in soil texture, climate and physiography. Because of the wet and sub-optimal soil temperatures during the early spring at the poorly-drained Hoytville soil, the average grain yield at Hoytville was about 5 Mg/ha compared with 9.6 Mg/ha for the well-drained soil at South Charleston.
* The highest grain yield of 12.6 Mg/ha at South Charleston was obtained for the 200% residue retention treatment and the lowest of 78 Mg/ha for the 0% residue treatment.

Residue Retention and Grain Yield at South Charleston

While there were no significant differences in grain yield at the South Charleston site among residues management treatments, the highest grain yield obtained for the 200% treatment was 62% more than that for the 0% residue retention treatment (Table 1). The drastic grain yield reduction for the complete residue removal treatment may be attributed to sub-optimal soil moisture (drought) and supra-optimal (high) soil temperatures in a bare and un-mulched soil during the critical stage of corn growth.

Stover yield at South Charleston followed trends similar to that of the grain yield with regards to the residue management (Table 1). The highest corn stover yield of 12.0 Mg/ha was also obtained for the 200% and the lowest stover yield of 6.5 Mg/ha for the zero residue retention (complete removal) treatment. The stover yield for 0% residue retention was merely 54% of that for the 200% residue retention treatment. The drastic stover yield reduction for the complete residue removal treatment, similar to that of the grain yield, may also be due to sub-optimal soil moisture and supra-optimal soil temperature regimes at the critical stages of corn growth.

|  |
| --- |
| Table 1. Effects of residues retention on corn grain and stover yields for a well-drained silt loam soil at South Charleston during 2017. |
| **Residue Retention (%)** | **Yield (Mg/ha)** | **Harvest Index (%)** |
| **Grain** | **Stover** |
| 200 |  12.62a | 12.0a | 51.3a |
| 100 | 9.67a |  9.5abc | 50.2a |
| 75 | 9.87a |  11.1ab | 47.1a |
| 50 | 7.75a |  7.5bc | 50.8a |
| 25 | 9.79a |  9.6abc | 50.5a |
| 0 | 7.80a | 6.5c | 54.5a |

The fact that the highest harvest index of 54.5% was also measured for the treatment with complete residue removal (Table 1), it is indicative of the possibility that photosynthates were not efficiently transferred to the grains because of the prevalent abiotic stresses and unfavorable edaphic conditions during the critical stages of corn growth.

Conclusions and Recommendations

Whereas the high proportion of residue retention (50 to 200%) may delay the drainage and warming of the seedbed in a poorly-drained and heavy-textured soil at Hoytville, residue mulching is advantageous to corn growth and production for a silty loam soil at South Charleston. While some residue removal (25 to 30%) may improve corn growth and yield for a poorly-drained clayey soil, any amount of residue removal may have adverse effects on a well-drained soil. Further, the adverse effects of residues removal may be exacerbated on sloping lands prone to runoff and accelerated erosion. Despite the reduction in grain yield on a clayey soil, residue retention may favorable impact the soil organic carbon budget even on a poorly-drained soil through increase in carbon sequestration. These trends necessitate long-term research on the impacts of residue management for diverse soils and agro-ecoregions in Ohio and elsewhere in agroecosystems.

**4. Accomplishment Summaries.**

* Clayey soils with restricted internal drainage and under sub-optimal soil temperatures during early spring may experience a delayed seed germination, inhibited seeding growth and reduced corn grain and stover yields under included no-till fields.
* Silt loam soils with good internal drainage and those developed on a gently undulating terrain under drought-prone and supra-optimal soil temperatures during the reproductive stages of corn, may produce high corn grain and stover yields under mulched no-till fields.
* Residue retention, combined with no-till (and cover cropping) can create a positive soil carbon budget, enhance soil organic carbon stocks, ad improve soil health and functionality.
1. **Impact Statements.**

The data generated from the multi-location, long-term residue management project has ecological, economic and social impacts as follows:

1. Ecological, it improves soil health, soil carbon budget, water quality and soil biodiversity.
2. Economically, it increases crop growth and yield, especially in drought/erosion prone and well-drained soils.
3. Socially and culturally, it improves aesthetic value of the soil and the landscape.
4. **Published Written Works.**

*Refereed Journal Articles*

Daigh, A.L.M., W.A. Dick, M.J. Helmers, R. Lal, J.G. Lauer, E. Nafziger, C.H. Pederson, J. Strock, M. Villamil, A. Mukherjee, R. Cruse. 2018. Yields and yield stability of no-till and chisel-plow fields in the Midwestern US Corn Belt. Field Crops Research 218:243-253.

Feng, Q., J. Xu, Y. Zhang, X. Li, J. Xu, H. Han, T. Ning, R. Lal, Z. Li. 2017. CO2 fixation in above-ground biomass of summer maize under different tillage and straw management treatments. Scientific Reports 7:16888.

Jha, P., S. Verma, R. Lal, C. Eidson and G.S. Dheri. 2017. Natural C-13 abundance and soil carbon dynamics under long-term residue retention in a no-till maize system. Soil Use and Management 33(1): 90-97.

Nath, A.J. and R. Lal. 2017. Effects of tillage practices and land use management on soil aggregates and soil organic carbon in the north Appalachian region, USA. Pedosphere 27(1): 172-76.

Nawaz, A., R. Lal, R.K. Shrestha and M. Farooq. 2017. Mulching affects soil properties and greenhouse gas emissions under long-term no-till and plough-till systems in Alfisol of central ohio. Land Degradation & Development 28(2): 673-81.

1. **Scientific and Outreach Oral Presentations.**

Lal, R. 2017. Soil organic carbon sequestration: importance and state of science. Global Symposium on Soil Organic Carbon, 20-23 March 2017, Rome, Italy.

Lal, R. 2017. Soil conservation for mitigating climate change. University of Lleida, 12-14 June 2017, Lleida, Spain.

Lal, R. 2017. The importance of soil in managing the anthropocene. Global Soil Partnership/Technical Panel on Soils (ITPS), 20-22 June, Rome, Italy.

Lal, R. 2017. Soil organic matter in the Anthropocene. 6th International Symposium on Soil Organic Matter, 3-7 September, Rothamsted, Harpenden, U.K.

Lal, R. 2017. Making agriculture a solution to climate change and water scarcity. International Conference Global Climate Change and its Impact on Agriculture, 14-16 December, Aurangabad, India

**8. Fund leveraging.**

**9. Other relevant accomplishments and activities**.

**NC1178 2017 Report**

Sandeep Kumar, Associate Professor; Jose Guzman, Assistant Professor; Jasdeep Singh, Graduate Research Assistant; Navdeep Singh, Graduate Research Assistant

Department of Agronomy, Horticulture and Plant Science, South Dakota State University, Brookings, SD

**Impacts of Cover Crops and Diverse Rotations on Soil Properties**

1. **Impact Nugget**: Crop diversification helps in improving soil health parameters. Crop rotational diversity and tillage management influence soil microbial properties. A study of three crop rotations [maize (*Zea* *mays* L.)-soybean (*Glycine* *max* L.) (2-yr); maize-soybean-wheat (*Triticum* *aestivum* L.) (3-yr); maize-soybean-wheat-oat (*Avena* *sativa* L.) (4-yr)] in combination with no-till (NT) and conventional-till (CT) was conducted to assess the impact on select soil health parameters such as microbial biomass carbon (MBC), nitrogen (MBN), soil carbon fractions, soil urease enzyme, and soil β-glucosidase. The study site was established on Egan soil series (Udic Haplustolls) in 1991 at Beresford, South Dakota, USA. Data showed that after 25 years, the NT with 4-yr rotation increased the MBC, MBN, hot water extractable carbon (HWC) and urease activity in both the phases as compared to the other treatments. The β-glucosidase enzyme activity was significantly higher under 2-yr cropping system with NT system as compared to other treatments. Data from the present investigation revealed that diverse cropping system (maize-soybean-wheat-oat) managed with NT system can be beneficial in building MBC, MBN, HWC, and soil enzymes activities.
2. **New Facilities**:
3. **Unique Project Related Findings**:

Inclusion of cover crops with no-till enhanced the soil health parameters.

1. **Accomplishment Summary**: (i) **Study 1: Soil health indicator measurements**

In first quarter of year 2018, lab analysis was performed on soil samples collected in the last quarter of 2017 from the rotation x tillage x cover crop experiment at the Beresford. This site has 3 rotations and 2 tillage systems with and without cover crops; that give us total 48 plots. We are looking for long term impact of rotations and tillage (> 25 years) with cover type treatments (> 4 years). Samples were collected from surface depth (0-7.5 cm) at three times (before planting, after planting and flowering stage) in vegetation season of maize. The soil samples from producer farm will be collected in May 2018. Once, the data from producer’s farm from both sampling intervals (Fall 2016 and Spring 2018) get analyzed, a complete report of soil performance will be shared in extension activities and with producer’s itself.

**Parameters analyzed**:

* + - * + Microbial Biomass Carbon and Nitrogen
				+ Soil carbon and nitrogen fractions
				+ Urease and β – Glucosidase enzyme activity
				+ PLFA (Phospholipid fatty acid) analysis

**Report:** Analysis of soil biological parameters are now fully completed. We already showed the results of our two samplings in previous quarterly reports. Here, we are showing the results of third sampling (at flowering stage of maize). A complete manuscript of these parameters will be submitted to Soil Tillage journal in this quarter (April-June). Please, find the snapshot of the results at the end of the report.

**Study 2. Measurements of corn yield and Economic Analysis.** The data for corn and soybean yield over the years is under process. The impact of cover crop on yield enhancement of grain crop is being analyzed, separately. We are setting up the baseline cost for each rotation and tillage treatments. Further, extra cost of introducing cover crop in rotation will be assessed. Net economic benefits of planting cover crops will be estimated for each rotation system. At end, three rotation systems will be ranked in terms of economic profit and cover crop benefit.

**Results:** The following table represents results of third sampling (at flowering stage of corn).

**Table 1. Soil** Microbial Biomass Carbon (MBC) and Nitrogen (MBN), Urease and β – Glucosidase enzyme activity, Water Soluble Carbon (WSC) and Nitrogen (WSN), Hot Water Extractable Carbon (HWEC) and Nitrogen (HWEN) as influenced by different tillage and rotation systems.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **MBC**  | **MBN** | **Urease activity** | **β- Glucosidase****activity** | **WSC** | **WSN** | **HWEC** | **HWEN** |
|  |  |  |  |  |  |  |  |  |
| Tillage (T) |  |  |  |  |  |  |  |  |
| NT | 413 | 27 | 66 | 74 | 441 | 37 | 1874 | 66 |
| CT | 441 | 26 | 53 | 77 | 425 | 35 | 1745 | 63 |
| Rotation (R) |  |  |  |  |  |  |  |  |
| 2-yr | 375 | 24 | 68 | 86 | 445 a | 35 | 1799 | 65 |
| 3-yr | 414 | 26 | 50 | 69 | 351 b | 41 | 1682 | 60 |
| 4-yr | 488 | 30 | 61 | 72 | 503 a | 33 | 1935 | 68 |
| Cover type (C)  |  |  |  |  |  |  |  |  |
| CC | 473 a | 28 | 67 a | 92.5 a | 441 | 33 | 1917 a | 69 a |
| NC | 377 b | 25 | 52 b | 59.0 b | 425 | 39 | 1694 b | 60 b |

NT, no-tillage; CT, conventional tillage; 2-yr, 3-yr and 4-yr are two-year rotation, three-year rotation and four-year rotation respectively; CC, cover crop; NC, no-cover crop; † Within each factor, means in the same column followed by the same letters are not statistically significant at P <0.05 (LSD test).

1. **Impact Statements**:
* Inclusion of cover crops help in enhancing the microbial activity.
* Long-term diverse crops rotations increase the soil organic carbon.
1. **Published Written Works**

Alhameid A., Ibrahim M., Kumar S., Sexton P., Schumacher T. (2017) Soil Organic Carbon Changes Impacted by Crop Rotational Diversity under No-Till Farming in South Dakota, USA. Soil Science Society of America Journal 81:868-877.

Alhameid A., J. Singh, U. Sekaran, S. Kumar and S. Singh. 2018 Crop rotational diversity impacts soil physical properties under long-term no-and conventionally-tilled soils (*Submitted*)

Alhameid A., J. Singh, U. Sekaran and S. Kumar. 2018 Soil Biological Health: Influence of Crop Rotational Diversity and Tillage on Soil Microbial Properties *(First revision)*

1. **Scientific and Outreach Oral Presentations:**

Singh J., and S. Kumar. 2017 Impacts of Diverse Crop Rotations and Cover Crops under different tillage systems on Soil Health in South Dakota, US. Poster Presentation at the MANAGING GLOBAL RESOURCES FOR A SECURE FUTURE CSA/ASSA Annual Meeting | October 22-25 | Tampa, FL

Alhameid A., J. Singh, E. Ozlu and S. Kumar. 2017. SOC Changes and Other Soil Properties as Impacted by Crop Rotational Diversity Under No-Till Farming in NGP. Oral Presentation at the 72nd Soil Water Conservation Society; International Annual Conference, Wisconsin-Madison July 30 – August 02, 2017.

1. **Fund leveraging: None**
2. **Other Activities: None**

**NC-1178 Annual State Report**

**Year:** 2018

**Institution:** University of Wisconsin-Madison

**Committee Representative:** Francisco J. Arriaga

1. **Impact Nugget:**

Corn silage is a common forage used to feed dairy cows. The entire corn plant is harvested for corn silage, leaving the soil surface vulnerable to erosion and long-term reductions in soil health. The University of Wisconsin-Madison demonstrated that cereal rye used as a cover crop reduce water runoff and soil loss in dairy forage systems, while improving soil health. Additionally, the cover crop can be harvested in the spring as additional forage feed. Yields of the corn silage system with cover crop was similar or greater than growing corn for silage alone.

2. **New Facilities and Equipment:**

Additional laboratory equipment was acquired and installed to measure soil plant water availability, an important soil health factor that relates to the amount of water a soil can hold for plants to use. A field sprinkler infiltrometer was modified to be used in the laboratory to measure the stability of soil aggregates, another important soil health factor that relates to soil porosity and strength.

3. **Unique Project Related Findings:**

Cereal rye as a cover crop increased soil microbial activity, which in turn improved soil health. Similarly, the cover crop increase the amount of water stable soil aggregates. Growing corn silage one season eliminated any benefits of growing alfalfa 3-years prior on soil aggregation.

4. **Accomplishment Summaries:**

Data from a survey administered shows significant use and interest on the sue of cover crops in Wisconsin. However, there is a segment of farmers that are not using cover crops because of labor and economic concerns. Additionally, those farmers using cover crops recognize that more scientific based information is needed to make informed decisions. We have address these issues by continuing research on cover crop impacts to soil health and through outreach efforts to disseminate existing information.

Cereal rye as a cover crop was effective at reducing runoff volume, sediment losses, and phosphorus losses. Research efforts have expanded to investigate the impact of manure application method to a cover crop, and examination of the relationship of operationally defined phosphorus fractions (i.e. defined by the procedure used) versus advanced measurement techniques that provide actual chemical structure. These relationships will help improve the understanding of phosphorus behavior in the environment and improve modeling approaches, including P indices.

5. **Impact Statements:**

The University of Wisconsin-Madison determined that cover crops reduce soil erosion, improve soil health, and reduce the environmental impact of dairy farming operations by improving water quality.

6. **Published Written Works:**

M.S. Thesis:

Adams, L.C. 2017. Quantifying cover crops and reduced tillage impacts on corn silage production and water quality. M.S. thesis, University of Wisconsin-Madison.

Peer-reviewed Scientific Publications:

Adams, L.C., F.J. Arriaga, and M. Bertram. 201X. Cover crop reduces erosion and phosphorus losses in a low residue cropping system. Soil Science Society of America Journal (in revision).

7. **Scientific and Outreach Oral Presentations**:

Arriaga, F.J., L.C. Adams, M. Stock, P. Vadas, L. Ward-Good, M. Bertram, and K.G. Karthikeyan. Can cover crops and tillage help reduce erosion and phosphorus losses? North American Manure Expo, Aug. 22-23, 2017, Arlington, WI.

Adams, L., F.J. Arriaga, and M. Bertram. Cover crop benefits and barriers in Wisconsin: Runoff and productivity. American Society of Agronomy-Crop Science Society of America-Soil Science Society of America Annual International Meetings, Oct. 22-25, 2017, Tampa, FL.

Arriaga, F.J, and L. Adams. Cover crop survey results. Soil, Water, and Nutrient Management Updates Meetings, Univ. of Wisconsin-Extension, Nov. 29 – Dec. 5, 2017. Held in Deforest, Eau Claire, Sparta, Dodgeville, Juneau, Kiel, Cecil, and Marshfield locations in WI.

Arriaga, F.J., L. Adams, and M. Bertram. On the effectiveness of cover crops for erosion control. Wisconsin Agribusiness Classic, Jan. 9-11, 2018, Madison, WI.

Arriaga, F.J. Reducing erosion and improving water infiltration with cover crops and no-tillage. Wisconsin Cover Crop and Soil Health Lunch-and-Learn Webinar Series, Jan. 16, 2018, on-line based webinar.

Arriaga, F.J. Linking soil health to water quality. North Central Region Water Quality Network Webinar Series, June 13, 2018, on-line based webinar.

8. **Fund leveraging, specifically, collaborative grants between stations and members:**

Additional financial support for this work has been received for this work from the Agronomic Science Foundation, and the Monsanto Company.

9. **Other relevant accomplishments and activities:**

A graduate student worked on this research project as part of her M.S. degree requirements and successfully graduated in the fall semester of 2017.