Investigating Nutrient Solubility and Retention in a "No Till" and "Till" Agriculture Fields

Background and Project Description:

Recently, the United States Department of Agriculture Natural Resources Conservation Service has been in an active campaign towards improving soil health though the use of conservation practices such as No-Till agriculture, cover crops, among others. Soil health is the overall term for improving soil physical, biological, and chemical properties (Doran et al. 2000). The first step of improving soils health is to restore the natural soil structure by reducing soil compaction, which is one of the most detrimental forces in a soil's health (Beare et al. 1994). Soil Compaction can be eliminated by utilizing several different methods, one of which is No-Till agriculture. When a soil is tilled, the tilling device, such as disking, rips ups and destroys the soil structure and in turn causes compaction. Soil compaction limits root growth, which can also influence crop yields (Paul et al. 2013) and can limit soil biological and chemical processes due to reduced water infiltration. When a soil is not tilled, the natural structure of the soil begins to develop and biological and chemical process help further develop the natural aggregated structure (Mikha et al. 2004). Healthy soil aggregation has many benefits such as less compaction, which in turn reduces surface runoff, increases water infiltration, and possibly helps the soil hold and retain nutrients better than a tilled unaggregated soil (Jiao et al. 2006). In this study, I seek to find out if there is a difference in nutrient retention between a No-Till field and a conventional-tilled field. I hypothesize that No-Till agricultural management will result in soil aggregates that retain nutrients more effectively than a conventionally-tilled field. If my hypothesis is true, my findings could help landowners and farmers make better conversation choices to improve their soil health and realize the benefits of healthy soils. In addition to the landowners, benefits of reducing nutrient runoff through No-Till management could mean fewer nutrients in our waterways, which would ultimately reduce the size of dead zones in our oceans. Overall, No-Till management may be an effective way to retain soil nutrients, and results from this study would provide evidence for a way to improve soil health and reduce nutrient pollution.

Methods:

In summer of 2018, I will visit the University of Nebraska – Lincoln's Rogers Memorial agricultural research Farm outside of Lincoln, Nebraska to collect my samples (Fig. 1). Rogers is a 121.5-hectare (300-acre) research farm that studiess different crop traits, genes, and tillage types. The site has two tillage study sites a Northern and Southern site, which have been used for tillage research since 1981. Both sites are silty clay loam soils with a corn-soybean rotation. Within each site, there are six 9 x 23 meter plots which have a set type of tillage that then is repeated three times. I will be utlalizing the North no-till (NT) plots and tilled (T) plots (Fig. 1).

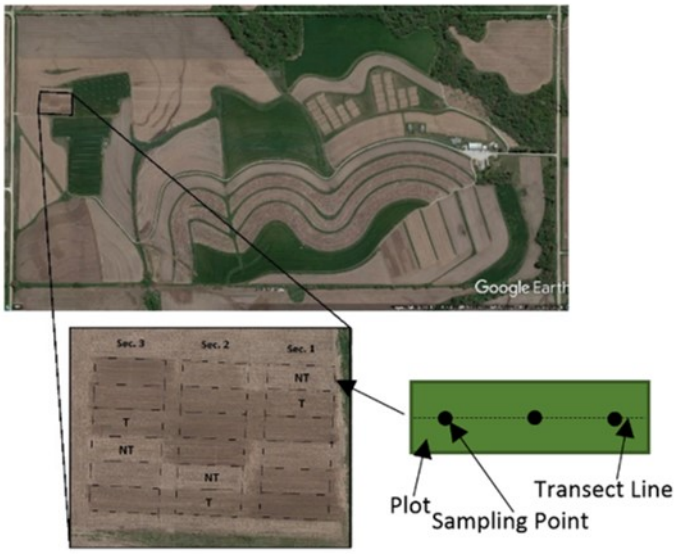

Figure 1. Aerial photo of Rogers Farm, with subset of North tillage research plots. Within these plots, I will sample three No-Till (NT) and three till plots following the sampling scheme on the far right.

Within each of the three plots I will take three 750 gram loose aggregate samples from each of the no tilled plots and tilled plots along a transect line. After my samples have been collected (18 in total) I will send 250 grams of each sample to Ward Labs in Kearny, Nebraska for soil nutrient (Nitrate, Phosphate, and Organic Carbon). The remaining 500 gram samples will be air dried for two weeks. After drying, I will begin my infiltration test (Fig. 2). Each sample will be placed in a perforated container over a larger container and then slowly pour 500 ml of distilled water over each sample. This process will be repeated three times for each of the samples. After each infiltration test run I will collect 40 ml of the infiltrated water for nutrient analysis. Of this 40 ml, 20 ml will go to University of Nebraska – Lincoln Water Lab for dissolved organic carbon (DOC) content. The other 20 ml will go to the University of Nebraska - Omaha Chemistry Department for nitrate and phosphate analysis. When lab results are complete, I will then compare my results by looking at the original nutrient content compared to how much has been leached into the water. Finally, I will compare my results from the tilled field and No-Till field to see if my hypothesis is correct or not.

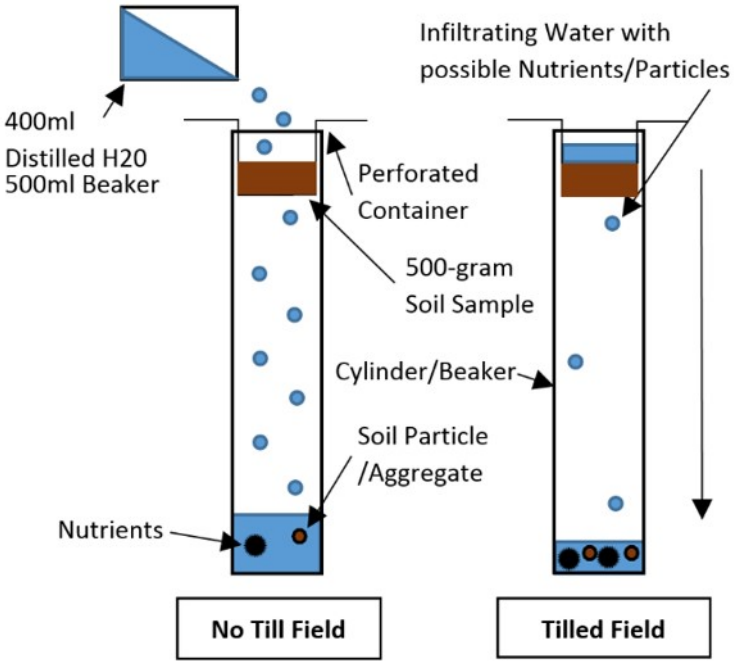

Figure 2. Diagram of experiment infiltrating test set up to test for nutrient leaching from soil aggregates collected in No-Till or tilled agricultural fields.

Project Timeline:

Date	Activity
December 2017	FUSE Proposal Submitted
January 2018 – April 2018	FUSE Grant Reviewed for Possible Funding
May 2018	FUSE Funds Awarded/Supplies Ordered
June 2018	Samples Collected and Allowed to Dry for 2 Weeks
July 2018-August 2018	Samples Tested/Lab Test Conducted and Data Logged
September-December 2018	Data Summarized and Abstract Created/FUSE Report
January 2019	Abstract/FUSE Report Submitted
March 2019	Project Presented at Student Research Fair

Student/Faculty Mentor Roles:

For my proposed FUSE project, I will work closely with Dr. Ashlee Dere at the University of Nebraska at Omaha. Dr. Dere in my advisor and mentor in physical geography. Dr. Dere, along with my internship involvement with the USDA Natural Resource Conservation Service, have greatly spark my interest in soils. With my student/faculty mentoring roles my role in the project will be collecting the samples and running the experiments and then finally writing the final report and creating the poster. Dr. Dere will offer basic support throughout my project by helping collect soil samples and set up laboratory experiments, and analyze data; Dr. Miller in Chemistry will help analyze water samples.

Budget Justification:

Budget Table	
Item	**Cost**
Student Stipend	$1236.97
Travel	$0
Supplies:	
40 One Quart Ziploc Freezer Bags for holding samples (2 boxes of 38 at $4.29 per box)	$8.58
20ml Clear Glass Screw Top Vials (72pk)	$71.12
20ml Amber Glass Screw Top Vials (72pk)	$125.38
16oz Plastic Containers (for holding samples for infiltration testing)	$12.45
10 gallons of Distilled Water*	$0
4 500ml Beakers*	$0
10ml Pipet with 120 Tips*	$0
Sampling Shovel*	$0
Labeling Tape*	$0
Lab/Work Place*	$0
2 Flat Rate Shipping Boxes with Shipping Cost (for sending samples for analysis)	$60.00
Analysis Costs:	
Ward Labs bulk soil nutrient test (S-1A NPK Organic Matter, CEC & S) ($16.00/sample; 18 samples total)	$288.00
Ward Labs Organic Carbon % tests ($8.75/sample; 18 samples total)	$157.50
Dissolved Organic Carbon Water Analysis University of Nebraska-Lincoln Water Lab ($10/sample; 54 samples total)	$540.00
UNO Chemistry Department Water Chemistry Analysis: Nitrates and Phosphates* (54 samples total)	$0
Project Total	$2,500.00
Total Grant Amount Requested	**$2,500.00**

*Dr. Dere will provide

I am requesting a total of $2,500 to investigate nutrient solubility and retention in a “No Till” and “Till” agriculture fields with Dr. Dere at the University of Nebraska at Omaha. Of the $2,500 being requested, $277.53 will go to the cost of needed supplies to compete my proposed research project. Dr. Dere has generously offered to share some of her personal equipment and lab space to me to cut down on supplies costs. A total of $985.50 will also go to the cost of analyzing soil Nitrate, Phosphate and Organic Carbon at Ward Labs located in Kearny, Nebraska. In addition, 54 water samples will be sent to the University of Nebraska at Lincoln Water Lab department for dissolved organic carbon analyses. For analyzing Nitrate and Phosphate water samples, Dr. Miller of the University of Nebraska at Omaha Chemistry Department has generously offered to run the test for Nitrate and Phosphate on the 54 water samples at no cost using Inductively Coupled (IC) spectroscopy equipment. The remainder of the budgeted amount, $1236.97, will go towards student compensation for completing the proposed research project (estimated 124 hours at $10 per hour, including travel to and from the sampling site).

References:

Beare, M. H., Hendrix, P. F., & Coleman, D. C. (1994). Water-stable aggregates and organic matter fractions in conventional-and no-tillage soils. *Soil Science Society of America Journal*, *58*(3), 777-786.

Doran, J. W., & Zeiss, M. R. (2000). Soil health and sustainability: managing the biotic component of soil quality. *Applied soil ecology*, *15*(1), 3-11.

Jiao, Y., Whalen, J. K., & Hendershot, W. H. (2006). No-tillage and manure applications increase aggregation and improve nutrient retention in a sandy-loam soil. *Geoderma*, *134*(1), 24- 33.

Mikha, M. M., & Rice, C. W. (2004). Tillage and manure effects on soil and aggregate-associated carbon and nitrogen. *Soil Science Society of America Journal*, *68*(3), 809-816.

Paul, B. K., Vanlauwe, B., Ayuke, F., Gassner, A., Hoogmoed, M., Hurisso, T. T., ... & Pulleman, M. M. (2013). Medium-term impact of tillage and residue management on soil aggregate stability, soil carbon and crop productivity. *Agriculture, Ecosystems & Environment*, *164*, 14-22.

December 1, 2017

Dear FUSE Proposal Committee,

I am writing to express my support of Dillon Klein's FUSE proposal, entitled, "Nutrient solubility and retention in a no-till and till agricultural field." Dillon is currently a geography student in the Department of Geography/Geology at UNO. I first had the pleasure of working with Dillon in my "Critical Zone Science" course. More recently, Dillon participated in the inaugural UNO Soil Judging Team. Soil Judging is an undergraduate competition sponsored by the Soil Science Society of America and the Natural Resource Conservation Service (NRCS) that provides students with practice in the field observing and classifying soil properties to make interpretations about best uses for the soil. The skills practiced reflect those required by many environmental jobs. The regional competition this year took place in Redfield, South Dakota, and Dillon was one of four team members who spent three days learning the local soils and practicing soil description skills then one day of competition, which involved two soil pits described individually and three described as a team. Despite having no formal soils training prior to this week-long experience, Dillon placed in the top third in his individual efforts and help the team earn second place in the group soil judging competition. Overall, the team took fourth place out of seven teams, all of whom had extensive experience in soil judging. I was highly impressed with Dillon's dedication to learning as much as possible through this experience and he demonstrated an ability to gather appropriate data to draw conclusions about how the soils formed and could be best utilized.

Since returning from the Soil Judging experience, Dillon has persistently worked on his idea for the FUSE proposal. Dillon's project was inspired by work he did during an NRCS internship this past summer focused on soil health. The intensive week in the field during Soil Judging seemed to catalyze his interest in learning more about soils. He developed the FUSE idea and experimental design largely independently, taking the initiative to consult with several experts at the NRCS in Lincoln as well as UNL farm managers to get feedback on the best way to test his research question. Thus, the methods he proposes to use to answer his research question are based on current NRCS research methods. The budgeted costs are appropriate for the types of analyses necessary to answer his question, with some of the analytical capability currently available at UNO through the Soils Lab and the Chemistry Department.

The proposed project is related tangentially to my research activity focused on investigating how land use impacts soil and water quality, but the methods Dillon plans to employ and his focus on soil health is a new direction that I am interested to pursue in the future. My role will be to help Dillon with field sampling and laboratory work, but he plans to continue interfacing with the soil health experts in Lincoln to interpret his findings within the context of their current investigations. The proposed work would fill a knowledge gap in our understanding of how conservation tillage can be used to help minimize nutrient losses. Farmers are especially interested in data that would demonstrate the potential benefits of switching from conventional to conservation tillage, but the extent to which management can influence nutrient stability is still unknown.

Dillon has demonstrated a high level of initiative and self-motivation in designing and writing the FUSE proposal and I think he has the necessary skills and drive to successfully complete the proposed research. He is prompt and diligent about meeting with me and makes steady progress in tackling his goals. I thank you for considering Dillon's proposal and please do not hesitate to contact me if you have any further questions.

Sincerely,

Ashlee Dere

Ashlee Dere
Assistant Professor of Geology
Department of Geography/Geology
University of Nebraska – Omaha
Omaha, NE 68182
(402) 554 – 3317
adere@unomaha.edu