Minutes of the NCERA 59 TN Meeting (July 9-10, 2019) – M.S. Coyne Recording

Present: Jagadamma, Coyne, Poffenbarger, Tiemann, Ruark, Ugarte, Gutknecht, Cihacek, Castellano, Olk

Brief Introductions: Matt Ruarke (WI), Jessica Gutknecht (MN), Carmen Ugarte (IL), Mark Coyne (UK), Mike Castellano (IA), Larry Cihacek (NDSU), Hanna Poffenbarger (UK), Lisa Tiemann (UK), Sindhu (Jagadamma)(UTK)

Discussion of 2019 Manuscript, Book and book chapters, General Chit Chat

Specific Business

**1. Discussion of report preparation and submission**

Report: Do the long version or the sort version? Short version.

Compile the short reports and the longer committee report based on committee actions. Check with Ron Turco about the required format.

Next Year meeting: Where when how.

Secretary position: Put together the report.

Chair: Host meeting, put together the mid-term report. Check with Christina (?). Submit the meeting reports within 60 days of this meeting.

This project active through 2021.

These are 5-year terms. 3rd year is a mid term review of accomplishments and activities. 4th year is the idea of continuing renewal of project and outline what’s going on in the new review. Project not as long as a research group. Have objectives. Next year the committee needs to plan for renewal and new objectives. There is a midterm posted May 2019.

**2. Meeting Locations**

Hosting in Kentucky next year (2020). Who hosts in 2021? Nebraska.

Madison (2017), MN (2018), TN (2019), KY (2020), Nebraska (2021)

Location of the 2021 meeting to be finalized later (Nebraska). Secretary to be determined later.

**3. Increasing Participation**

Castellano: Recruiting additional members of the committee. Ashly Kaiser (UMass Amherst), Stewart Vandy?

Currently 25 members but about 1/3 show up for meetings

Ruark: Have the committee meeting associated with a national meeting every other year. Soil ecology for example

Tiemann: To be president of Soil Ecology next year? PNL at Richland Washington next year.

Sindhu: Talked about meeting with the Soil Quality group

Castellano: How long is Soil Ecology. 2-3 days so easy to design a session within that meeting. A way to recruit new membership.

Ruark: Losing steam, revitalize, double dip

Cihacek: Also can do as SWCS session.

Ruark: 2-3 hours in off years to do more extensive meeting.

Ugarte: Timing. Is July best? After the 4th most could make it, but many cancelled.

Cihacek: Middle of summer often works best for field schedules.

Tiemann: Send out ‘when is good’ poll in early spring. Lock down dates.

Ruark: KY in 2020, Soil Ecology the next year (2021) would have a long lead in for an abstract

Tiemann: New chapters for old chapters

Gutknecht: Perspective piece on state of affairs.

Cihacek: Heroic effort by Wander on putting together the paper.

Overview of State Reports

**1. TN Report**

*Overview of the University of TN System: Knoxville, Martin, Memphis (Health Center)*

UTIA = UT Institute of Agriculture. Actually separate from UTK. It has a separate research and extension system. Soon to be a part of UTK as with many Land Grants. Changing to 9-mo appointments.

5 compartments (Herbert College of Ag, TN State Botanical Garden, Vet Med, Res, Extn)

8 Departments: Biosystems Engineering and Soil Sci. Plant Sci

10 Research Centers – Most Long Term Experiments are in West TN

*Research Projects*

Cropping, Soil Health, Env. Controls on C Cycling

Long term mgmt., cover crops, biochar, organic matter

Soil Health: Comparing Haney, Cornell, Alabama (Extension – has their own protocol); Soil Conditioning and RUSLE (revisiting an old concept)

Env. Control: Moisture by texture (lab scale); In field soil manipulation (rainout shelter)

*Focus on Soil C fractions in 40-yr Soybean study*

Don Tyler’s plots West TN No tillage promotion; a 1979 study with multiple tillage treatments (6 trts)

 85% of croplands are under no-till (?) In TN

Most soil analyses were standard assessments

SOC, WEC, POXC, Resistant C (that oxidized by H2O2), aggregate size distribution, aggregate associated C

NT still benefits from cover crop C. But only 1.2% higher % C after 40 years. Look at C mass by measuring BD as well.

POXC similar trends (> 300 mg/kg)

WEC and Resistant C - no trt effect.

Mean weight diameter favored by No-till

Wet aggregate stability all favored by No-till treatments

NT with wheat, very large aggregates – root exudates and their influence an unknown (Cihacek)

Discussion – Grazing beneficial (Cihacek). Wheat for residue or wheat for harvest matters. What additional data should be collected?

**2. Wisconsin State Report (Ruark)(10:20 – 11:00)**

Random Powerpoints (Long term and Unstructured Sampling)

Grain-based systems lost C; Alfalfa Grazed systems were about 0; Pasture gained C

*Indicators of Soil Health*

Mgmt. associated with C use efficiency was associated with necromass (stable SOM)

1989 long term system study: corn, corn forage, pasture with rotational grazing

Microbial carbon use efficiency (CUE), Amino sugar, POM, Mineral associated organic matter (MAOM), Oxidative enzymes

More C as mgmt intensity decreases; POM C:N declines with less intensity

CUE and Total amino sugar increase with lower intensity

Fungal microbial biomass increase with lower intensity.

Destabilized Mineral OM in corn year.

Polyphenol oxidase activity higher in COA so is peroxidase

What is the turnover rate of the necromass? CUE = 13C glutamate in biomass/(13C in biomass + 13CO2 evolved).

When you measure matters? N-acetylglucosmainodase (chitinase)

*New Experiments – Unstructured Sampling*

27 variables measured plus the meta data

Long and short term management practices

Regression tree analysis: Rotation (Y/N), region (Y/N); Year (2016/2019); Manure (< or >); texture (< or >)

Coordinate results from long-term expts. into public data base into a publicly available data base

Build a data base via unstructured sampling design 10,000 sample points for WI. Could connect to yield data.

GEMS platform in MN

Cornell Soil Health Data Base/Soil Health Partnership

Std sampling design? Location? Types of analyses?

SOM – Soil properties, texture, drainage

Soil Health – Mgmt

Discussion: Is SOM a direct effect on yield? Do conservation approaches work? What’s the gap in what we know and what farmers need. Who participates and why or why not?

**3. MI Report (Tiemann) (11:00 – 11:35)**

Cover crop diversity, early interseeding, soil health functions and edge of field water quality, soil health in potato production; soil C accrual in Malawi; transitioning to organic row crop; soil health for veg. production; organisms benefitting from biochar

Interseeded corn (V3 and V6 interseeding)(1/2, 1x, 2x rates)

Peptidase, N-acquisition (NAG, peptidase, Urease combined) marginally significant in no cover

Nitrification/Denitrification - No cover higher, no difference in all others

Soil DON higher with cover crop

No difference in microbial biomass

Organic N more in cover crop systems even when fertilized

Higher N in corn i.e. a less leaky system. No significant corn yield difference.

Also doing on-farm and aerial assessment

In MI, interseeding must occur while crop is in, have evaluated the optimum day for interseeding.

*Biochar Effects*

Christmas tree – high value long term

Biochar affects chemical signaling

Pot study N leaching declines as biochar increases

Sequencing with up to 100 Mg/ha microbial community change based on biochar addition

Alpha diversity changing, mostly decreasing with increasing biochar; fungi trends not as obvious

Biochar all pine material

NMDS analysis says the amount of biochar changed composition of both the fungal and bacterial community

Field study – 10 year study

Carbonized wood pallets and woody pine biomass

2 rates 1X application

Mortality (2016) increases with biochar addition (some benefit to Balsam fir)

Next year (2017) Less mortality in Balsam fir, blue spruce much more mortality

Biomass increase less as biochar increases

Weed biomass slightly increases

Biochar absorbs pre-emergent herbicide

3rd growth season pH remained slightly elevated

Less nitrate available, but probably in the weed biomass

No trends with microbial biomass

Some stimulation of enzymes (might be due to weeds)

Biochar and Type matter (smaller tree size)

Response varies by tree

Meta analysis: annual vs. perennial

Short vs. long term effects on soil health

**4. MN (Gutknecht)(11:40 - )**

Projects: Sustainable High Tunnel; Exploratory analysis with NRCS; Perennialization (Kernza); other efforts on soil health

Sugar beets difficult crop for incorporating cover crops.

MN office for Soil Health

Vetch in high tunnel. Various soil health measures including gases: POX, C/N, Labile C, Extractable N, Min N, biomass N

*Soil Health assessment – 25 farms*

Paired design, lots of measurements

Vess smell test smell of earthiness (geosmin)(calibrated nose)

Full soil sci survey (1x sampling)(samples 1-3 years in cover)

Soil health and storm simulation (50 year storm event)

Results very variable; no correlation with how well soils did.

Different soil characteristics differentially related to one another.

Overall storm management was not affected significantly. Varied by location.

Kernza – perennial grain, economically viable, from Land Inst. Measuring various soil health parameters. Cool season grass. Severe yield decline after 3-years.

High root biomass to 60 cm. What about deep C storage.

Barely starting to see changes in soil health parameters.

Climate change adaptation study (NIFA Project). Starting with high quality soil to follow degradation and then impose various rotations

New C tool, cover crop tool for farmer decision management

New MN office for soil health, increase adoption and awareness of soil health practices, collect people and resources. Fit with Soil Health Inst?

**5A. KY Report – Poffenbarger**

Report on newly established experiment

5-6” start seeing the tillage/treatment benefit.

Lots of good suggestions for how to do the experiment and what to look at.

See appendix for extended report

**5B. KY Report – Coyne**

*State Research Overview*

Faculty associated with soil health research (11) in terms of Physical, Chemical, or Biological processes

*Physical*

*Spatial and temporal dynamics of C flux in different land use systems (Wendroth)*

Use of a photoacoustic gas monitor

qCO2 could be stable

qCO2 varied with temperature

Nugget/Range shows the best representivity when conditions were warm and moist (i.e. high qCO2)

*Biological*

*The Influence of Long-term Rotations on Soil Microbial Communities and Soil Health (****McNear and Grove****)*

26+-year-old managed plots

Samples from all rotations at the highest N level (224 kg N /ha)

Corn; Soybean; Corn-Corn-Soybean –Soybean; Corn-Wheat-Soybean (Double crop)

Assessed every Month for 2 years by PFLA

Measure β-glucosidase β -xylosidase, Cellobiohydrolase, Total SOM, POM, Non Particulate SOM

Rotation effect could be linked to changes in microbial community.

Predicted relative abundance based on physiochemical parameters of a) gram positive, b) gram negative, c) actinobacteria, d) fungi, e) AMF, f) protist PLFA microbial biomarker group proportions in each cropping treatment (SS, CC, CS, and CWS) estimated using physiochemical and climate variables showed seasonal and annual trends

*C Mineralization in Litter-amended Fields – Application Methods and Temperature Effects (****McGrath and Ritchey et al****.)*

Rapid decrease in N2O and CO2 evolution rates when optimum moisture is maintained (within 2 weeks

*Chemical*

*Fragipan Busting by Ryegrass (****Murdock, Matocha et al****.)*

Fragipans alter water and nutrient distribution in a landscape.

Research investigates if ryegrass breaks up fragipan horizons to promote vertical movement of water and nutrients.

Intact soil cores monitored over 6 weeks of ryegrass growth.

Soil solution extracted and quantified for novel exudates.

Cores assessed by tomography in the UK Medical Center to evaluate changes in fragipan depth and structure.

*Assessing soil organic carbon responses to synergistic effects of no- tillage and cover crops under climate change (1970-2099): Integration of long-term field trials and agroecosystem modeling (****Ren and Huang****)*

Climate-smart agriculture management with cover crop offers multiple benefits (e.g., increasing soil carbon stocks) that can reduce the effects of climate change on crop production.

We applied agroecosystem modeling in combination with a long-term field experiment (1970-2018)

Field observations and simulations results show that NT leads to greater carbon gains (0.22 Mg C ha-1 yr-1) in the topsoil than conventional tillage.

Model attribution analysis further explores that: 1) soil carbon sequestration was highly correlated to biomass carbon inputs from **both winter rye cover crop and maize**; 2) elevated CO2 and warming effects are main contributors to benefiting SOC gains mainly through promoting cover crop growth.

Model projections show that SOC levels in NT-cover crop management would be enhanced with an increasing rate of 0.089 Mg C ha-1 yr-1 under high-emissions scenarios (RCP8.5) from 2019 to 2099, largely due to enhanced biomass production by cover crop.

Cover crops are of vital importance for soil carbon sequestration; a combination of NT and cover crop would be an effective management strategy for climate change mitigation.

*Sensitivity of global soil carbon stocks to combined nutrient Enrichment (****McCulley et al****.) (Published in: Crowther, T.E. et al. 2019 Sensitivity of global soil carbon stocks to combined nutrient enrichment. Ecology Letters doi: 10.1111/ele.13258)*

We used the Nutrient Network global change experiment to examine how fertilization influenced grassland soil carbon storage at a global scale.

In isolation, N & P had minimal effect on soil carbon storage.

When K and micronutrients were included, soil carbon stocks changed considerably, with an average increase of 0.04 Kg Cm2 year 1

These effects did not correlate with changes in primary productivity, suggesting that soil carbon decomposition may have been restricted.

Although nutrient enrichment caused soil carbon **gains in most dry, sandy regions**, considerable **absolute losses of soil carbon may occur in high-latitude regions** that store most of the world’s soil carbon.

These mechanistic insights into the sensitivity of grassland carbon stocks to nutrient enrichment can facilitate biochemical modelling efforts to project carbon cycling under future climate scenarios.

**6. IL Report – Ugarte**

1. Organic farming and climate change
2. Corn and soil health
3. Dynamic Soil properties for Soil Health assessment

*Organic Farming and Climate Change*

Farmers in IL transitioning out of no-till into conservation tillage due to wet spring soils

18 samples for 10 acre field for C sequestration

CSP (Conservation Measurement Tool)

Looking at utility of tool

Looks at various practices associated with soil function (CAP)

Management tool seemed to overestimate soil C loss in conventional till relative to what TOC and POX measure.

*CASH = Corn and Soil Health: Participatory network, On Farm Testing and Trials, Business Structure and Sharing.*

Fields producing consistently different flavors with the same variety

Farm to table program

Top performing varieties in organic showed more complex and steeper root systems – Root architecture was affected

Root architecture and soil health

*Dynamic Soil Properties*

Repeatability of Soil Health Measurements: NCSU, KSU, WSU, T A&M, Chco State, U, WIS, U MN, U IL, Oregon State

Respiration 4-day resp, Available organic N, PFLA, Active Soil C, Multi enzyme test, Aggregation Water Stable aggregates and aggregate size stability, Infiltration, SOC

Good to have a systems that will use multiple labs to codify data

Citrate extractable Protein content – Std for protein analysis is Kjeldahl in plants

Metadata norms for soil Health assessment. Factors: rotation fertility tillage

Functions Physical chemical and biological

Commentary paper: What meta data is needed?

Mine data in Dryad and individual soil data sets to see what kind of data is considered valuable.

Mine for data (Web of Science, Google Scholar)

Go to Meta analysis people that are already done to look for data that is missing.

Strickland paper.

10 July 2019 Day 2

Present: Coyne, Olk, Ugarte, Castellano, Jagadamma, Cihacek, Ruark, Poffenbarger

**7. N. Dakota Report (8:55 – 9:35 )**

*N Mineralization from Crop Residue*

N required for residue decomposition

50-105 lbs required for surface residue decomposition

Wheat N recommendations – Extn recommendations (Based on a calculator)

Adding and subtracting N based on years in N till and other practices

Study: 6 residues with varying C:N aerobic mineralization over 12 weeks using avg. seasonal temp. (22 C)

*Study 1 15 g soil + 15 g sand + residue Periodically leach*

Incorporated residue mostly immobilizes except for pea and radish

*Study 2: Surface applied*

Radishes dumping a lot of N into the soil

Radish and pea have the most N released

Is the benefit credit from soybean overstated?

Does a pulse before wheat stimulate AMF in wheat.

*Study 3: Soybean Soil Interactions at senescence*

Incubation of plant parts

Potential N mineralization 14 ppm more N at harvest than senescence.

*Study 4: PMN = Pot Min N*

61 farmer soils with range of SOM (1.6-7.1%)

Nice linear relation between PMN and % SOM 7.4 ppm per % OM or 15 lbs N per % OM (N. Dakota)

Long Term Grazing - More N in spring wheat after grazing

2014 and 2016 data r2 = 0.21 for PMN vs % OM

C:N main driver of residue decomp; Changes in SOM after 4 cycles; continue soybean work; continue grazing work

Residue management recommendations cold means more N for residue; Data poor.

Does the literature in biofuels have useful information

Harvest index as a means of predicting the amount of residue as a means of predicting N application rates.

Edge of field effect of radishes on N loss. Denitrification losses. 30% recommendation because of nutrient dumping by winter kill radish.

**8. Iowa State Report (9:40 – 10:00 )**

Does SOM Matter? Yes but think about where you are

* Develop regionally specific SOM models
* Cover crop in cold wet soil will still not dry out a soil.

Published review on OM quality – litter quality doesn’t matter as much as we think.

Mineral Associated OM – high quality litter accumulated more with time. But not as efficiently (used natural abundance to track )

Residue input higher with continuous maize than maize soybean rotation staying as POM and POC

Temperature and moisture trumps in colder environments water for N

Soybean N credit 30% less N to produce more corn

Net contributor, more rapid N mineralization, something else

1. Soybean is a net remover of N from the soil (IA) based on grain removal
2. Does soybean residue release N faster?

- oats and alfalfa trump corn and soybean
- C:N ratio wasn’t the key driver, by death, the N in soybean is in the grain not the residue

1. Meta analysis Corn vs corn/soybean no benefit

Developed a decision tree

* can make tillage and stover removal look like a corn/soybean rotation in terms of yield and economical N fertility rate.
* Economic optimum rate about 1 lb N per bushel grain.

Does inorganic affect SOM and NUE?

Direction – Mechanims – Mode of action

Gross ammonification rate. Fert application suppressed mineralization, reduced the effect with higher rates

Gross ammonification lower as NH4+ in soil increases

**10. Iowa USDA Report (10:05 – 11:00)**

Why extract SOM fractions?

NIR scan of residues to assess quality.

Age varies from days to millennia.

Issues develop over periods of months.

Extract fractions meaningful to functions.

Relate properties to functions.

Chemical/Physical/Biological Methods: Vol 30 of SSSAJ May 2006 p, 711-871

Multiple critical reviews of humic fractions

2019 JEQ Theme on alkali extraction of HA: JEQ 2019 48:207-216

Misconceptions – Chemical extraction fatally alters chemical nature of material; belief in one model of humic chemical structure; gradual chemical alteration (humification) does not exist.

Fatal alteration: optical behavior of extracted and unextracted material is similar for functional groups; pyrolysis GCMS of extracted and unextracted are similar; spectral analysis of extracted lignite similar; aquatic C separated into fractions with comparison to original water showed 13,000 different types of chemical species reverse osmosis conserved 89% of formulas similar with humic and fulvic acid extractions. Not huge chemical changes.

Core form of HA structure Contradicted by MW data says OM is relatively small molecules (2-3000)

All SOM consists of known biological molecules?

Evidence for: increasing depth in forest litter layer causes more and more change; commonly observed in composting (Bernal et al. 2009)

Relative longevity of lignin? Yes and no.

Older 14-C signal for more humified fractions

Humification: preferential loss of carbohydrates and proteins with the accumulation of aliphatic and aromatic compounds.

Accumulation of aromatics in fossil fuels. Lignin starting to disappear in younger than older coal.

Humic fractions key to understanding env. processes.

1. Binding of persistant pollutants
2. Modeling metal ion binding in soil
3. Pesticide sorption in soils
4. HA as measure of compost maturity
5. Responsiveness to soil amendments – detect signatures of what you added to soil in HA
6. Involvement in nutrient cycling – N binding
7. Lack of infectivity of prions in high C soils

**11. Book Discussion:**

Turco/Horwath/Drijber - Editors

One chance to respond to book then open up to rest of committee as book project

Methods and applications

Some chapters written and coming. Go through or release as individual online chapters

Lots of chapters seem to have been written number proposed.

Anne-Marie, Rhae, Michelle to provide new chapters no more new chapters

10 chapters with the new ones

Editors must coordinate reviews of the chapters and sign off after a synthesis chapter. Not bundled as a book or as random articles on TriSci Website. Will be missing some possible chapters.

Look for new editors? One person has indicated they would be open to editing.

Introductory chapter and synthesis chapter

Where is stuff at? What is here and what is gone?

Does it build on the old? Supposed to me a methods of soil analysis

23 proposed chapters initially. Historical perspective, C cycle, sampling for C, biostatistical approaches; total C methods, dissolved organic C, mass spec and pyrolysis, FTIR, NMR, chromatography – carbs and AA, non c elements and soil, case studies in characterization; physical methods; biomass methods and biomass diversity, biomass methods and biomass recovery, enzymes, mineralization,; field assessment, SOM assessment and crop production, measurement of cycling and turnover, meta-analysis, simulation models, integration chapter = synthesis

[10 present + intro and synthesis]

Will be an electronic book?

Post it as a living book?

What is the purpose of this book?

Discussions about what should be in or out.

Original visions an updated and separated methods book linked primarily to soil C. Package and revision around the chapters that are available.

Olk to send out something about where we stand in the chapters: Vision, Approach, What’s needed to fill, What exists, What future plan. October is the end.

Meeting concluded at noon.