

Minutes of NCR-59
Technical Committee on Soil Organic Matter: Formation, Function and Management
Columbia, Missouri
July 15-16, 2003

Administrative Advisor:

Dr. Gerald Miller
Associate Dean, College of Ag.
132 Curtiss Hall
Iowa State University
Ames, IA 50011-1050

Chair:

Dr. Peter Motavalli
Environmental Soil Science
302 ABNR Bldg.
University of Missouri
Columbia, MO 65211

Secretary

Dr. Serita Frey
Natural Resources
215 James Hall
Univ of New Hampshire,
Durham, NH 03824

Members in Attendance:

Peter Motavalli, Missouri; Serita Frey, New Hampshire; Sieglinde Snapp, Michigan; William Horwath, California; Deborah Allan, Minnesota; Ronald Turco, Purdue; Rhae Drijber, Nebraska; Dan Olk, National Soil Tilth Lab; Gerald Miller, Administrative Advisor

Additional members and federal representatives participating through conference call: Leslie Cooperband, Wisconsin; Michelle Wander, Illinois

Members absent:

Richard Dick, Oregon; Larry Halvorson, Iowa; Robin Harris, Wisconsin; Laurie Osher, Maine; Larry Cihacek, North Dakota; Ray Weil, Maryland;

Guests:

Odie Swanegan, USDA-NRCS; Manjula Nathan, Missouri; Ray Knighton, USDA, CSREES, on July 15, 2003 via telephone conference call

Detailed notes from the annual meeting:

The meeting was held in the School of Natural Resources at the University of Missouri. Peter Motavalli, NCR-59 Chair, organized the meeting.

Day 1—July, 15 2003

Peter Motavalli called the meeting to order at 8:00 am, made introductions, and distributed state reports and minutes from last year's meeting.

Ray Knighton, CSREES/USDA, joined the meeting by conference call to give an update on the current USDA budget and overview of current and new programs.

- increase in NRI of 40 Million dollars (120 to 166M in NRI)
- supplemental request for applications with July 31 due date
- joint (USDA, NSF, NASA, NOAA, DOE) RFA for global change research program will come out within the next year.
- recently signed MOU with NASA to work more closely together within 5 existing programs; Nancy Cavallaro will be contact person for this program
- number of programs to be cut back but award amounts to go up to achieve better post-award management; two NRIs in future: Integrated NRI and NRI "classic"

- update on climate change science program: climate change research initiative folded into Climate Change Science Program; small amount of new money for modeling and sources of uncertainty in climate change research

William Horwath asked for clarification of the difference between NCR and NC committees. Jerry Miller indicated that the purpose of a NCR committee is for members to coordinate and exchange information about integrated research and extension activities around a common set of objectives; whereas, NC committees provide members an opportunity to work together on common research objectives.

Ron Turco updated the committee on CASMGs activities including a series of workshops that will be coordinated by Task 5. Purdue will be offering a workshop on soil organic matter measurement techniques.

The objectives and anticipated outputs of NCR-59 were reviewed.

Specific ideas for the coming year were discussed:

1. Write Nature/Science paper on C sequestration targeted toward policy makers and practitioners. The paper will not duplicate information already in the literature, but will emphasize the importance of active soil management for long-term C storage (Horwath/Turco will take the lead).
2. Organize ASA symposium on the pros and cons of physical, chemical and biological approaches to soil organic matter measurement (Motavalli/Olk)
3. Co-sponsor CASMGs workshop noted above (to be held at Purdue)
4. Organize ASA symposium focusing on how biotechnology can be applied to increase C storage (Motavalli). The question was raised as to whether enough research has been done to support a symposium on this topic at this time.
5. Organize ASA symposium on quality of organic inputs and synchrony of nutrient release to plant needs (Allen/Snapp)
6. Write regional extension bulletin as follow up to above symposium (Snapp)

Ron Turco reminded the committee about the NCR-59 list serve <NCR59-L@purdue.edu>

Mike Gold, Associate Director of the Center for Agroforestry at the University of Missouri (www.centerforagroforestry.org) gave a presentation describing the agroforestry program. A field trip to the center's research and demonstration farm followed in the afternoon.

Day 2—July 16, 2003 Business Meeting

Approved minutes from previous meeting

Jerry Miller gave committee update:

- All members need to submit appendix E to their respective experiment station director in order to continue to be a member of the committee
- Suggested that current members who do not routinely attend the meeting be contacted to see if they want to continue to be state representatives. If not, they should arrange for someone else to be appointed

- Gave information on official NCR-59 website and discussed how materials can be added. Committee members can post information to the website by sending materials to Jerry Miller. Peter Motavalli suggested that each member link to the committee website from their personal homepage
- Reminded committee that the mid-term review and his recommendation is due in December
- Noted that the NCR administration is recommending that the officer structure be changed such that there are three officers (Chair, Chair-elect, Secretary) each with 2 year terms

A website subcommittee was formed with Peter Motavalli, Ron Turco and Debra Allen as members

A motion was passed to change the name of the officers but to maintain the one year rotation. Officers for 2004 are: Chair, Serita Frey; Chair-elect, Sieglinde Snapp; Secretary, Leslie Cooperband; Past Chair, Peter Motavalli (on executive committee).

A motion was passed that the Chair will be responsible for general organization of the annual meeting, the Chair-elect will have responsibility for the program, and the Secretary will summarize and post information to the NCR-59 website.

Peter Motavalli initiated a discussion on whether future committee meetings should be held in conjunction with the ASA meetings to encourage greater attendance. Members in attendance were not in favor of this change, but agreed that members should be polled to determine why they do not come to the meeting (e.g., financial reasons?). Serita Frey will send out a member survey.

A motion was passed to continue having the annual committee meeting at a different location each year (to be determined by Chair) and not in association with ASA.

Next year's meeting was tentatively set for the week of July 19 at Harvard Forest in Petersham, MA. Serita Frey will organize.

Committee accomplishments from the past two years were outlined.

FY02:

- A soil quality website was designed by Michelle Wander and Susan Andrews and is located at <http://129.186.1.36:8080/SoilQualityWebsite/home.htm> (site location is in flux so may not be active). They requested that committee members send powerpoint presentations on soil quality and that members link to the site from their personal homepage. The site will also be linked to the official NCR website. (Objective 3)
- An update on the collaboration between NCR-59 and the Consortium for Agricultural Soils Mitigation of Greenhouse Gases (CASMGs) was presented by Chuck Rice.
- Planned two symposia for 2002 ASA annual meeting in Indianapolis (Objective 3)

FY03:

- Organized two symposia at the 2002 ASA annual meeting in Indianapolis (Objective 3)
 1. *Economics of Managing for Soil Quality*; attendance: 70; NCR-59 members organized and four NCR members participated
 2. *Environmental Impact of Transgenic Crops on Soil Biological Processes and Functions*; attendance: 70; chaired by Peter Motavalli and Robert Kremer; resulted in five refereed journal articles have been submitted for publication in the Journal of Environmental Quality and a synthesis paper to be published in the American Journal of Alternative Agriculture
- Several committee members wrote chapters for a book published by CRC press entitled Soil Organic Matter Management, Advances in Agroecology. Magdoff, F. and Weil, R. (eds). (Objective 1)
- Several research proposals were submitted (Objective 1 and 2):
 1. Linking Soil Aggregation, Organic Chemistry, and Microbial Community Composition, Diversity and Activity to Understand the Turnover and Sequestration of Soil Organic Matter in Agroecosystems. Consortium for Agricultural Soils Mitigation of Greenhouse Gases, Task I--Basic Processes and Mechanisms- Research to develop an understanding of processes and mechanisms of soil C sequestration and soil greenhouse gas emission mitigation. 2002-2004. (Turco, Rice, Frey)
 2. Persistence of toxicity of Bt endotoxin from transgenic corn resistant to corn rootworm. Illinois Missouri Biotech Alliance. 2003-2005. (Motavalli and Wander)
 3. Cropping intensity and organic amendments in transitional farming systems: Effects on soil fertility, weeds, diseases and insects. USDA: Integrated Research, Education, and Extension Competitive Grants Program – Integrated Pest Management/Organic Transition. 2003-2007. (Wander and Cooperband are among several other PIs)
 4. Plant Introduction Performance Screen (PIPS) for cover crop assessment. SARE preproposal (Snapp and Allen)
- Leslie Cooperband organized and she and Michelle Wander participated in a Soil Ecology Workshop held at the annual NACAA meeting in Green Bay WI, July 15 (Objective 3)
- Rhae Drijber and Dan Olk participated in the Natural Organic Matter (NOM) workshop held in Ames, Iowa and planned a joint meeting of NOM and NCR-59 (Objective 4)
- Several NCR-59 members attended the Soil Quality Working Group at the ASA meeting in Indianapolis and gave a report of NCR-59 activities (Objective 4)

- Several research collaborations were initiated at the NCR-59 annual meeting:
 1. Rhae Drijber and Serita Frey will collaborate on a project examining how the composition and diversity of wetland plant communities influences microbial community structure using microbial fatty acids.
 2. Rhae Drijber and William Horwath are collaborating on a project to quantify extraradical hyphae of VAM fungi using complex lipid biomarkers. The grant is entitled *Biocomplexity of the common mycorrhizal network: Active or passive channels?* The grant is supported by the National Science Foundation and funded at \$3.2 million. Horwath is a PI.
 3. Rhae Drijber and Dan Olk will characterize labile humus fractions formed under cedar vegetation and its relationship to Ca cycling.
- Turco and Horwath planned to write a Nature/Science paper on C sequestration with a focus on the importance of active soil management for long-term C storage (Objective 2)
- Wander and Driber are collaborating with Denis Angers and Martin Chantigny (both with Agriculture Canada, international interest in NCR-59) on a paper on the Morrow Plots.

We visited the Sanborn Plots on the University of Missouri campus.

We acknowledged the wonderful job that Peter Motavalli and Julie Rhoads did to organize this year's program.

The meeting was adjourned at 11:45 am.

Signed: *Serita Frey*
 Serita Frey
 NCR-59 Secretary 2003

Signed: *Gerald Miller*
 Gerald Miller
 NCR-59 Administrative Advisor

Abbreviated State Reports of the NCR-59 Committee

Dr. Deborah Allan
Soil, Water & Climate
University of Minnesota
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A. A two year project funded by SARE to assess soil quality in a long-term cropping systems trial at Lamberton, MN is almost completed. This study, established in 1989, compares a 2 and 4 year rotation for each of 4 management systems: high and reduced input conventional systems, organic inputs, and minimum inputs. Every crop is represented in every system in every year, and there are restored prairie strips within the experiment for comparison. The two best cropping systems were the organic system and the reduced tillage conventional system, which had high values for biological activity, active OM fractions and aggregation. Manure inputs and the oat-alfalfa component of the 4 year rotation in the organic system appeared to compensate for the negative effects of more intensive tillage. NRI Managed Ecosystem funding has recently been obtained for a 4 year study at the same site, in collaboration with Jeff Strock, Jennifer King, Jay Bell and Jane Johnson. The objectives of this study are to: (1) determine amounts and quality of residue, root and manure inputs; (2) use ^{13}C and ^{15}N labeled inputs to measure the storage and turnover of C and N in active and resistant organic matter pools; (3) measure C and N losses from soil via NO_3 leaching and gaseous emissions of CO_2 , CH_4 , and N_2O , and (4) evaluate how management effects differ depending on landscape position and soil type.

B. SOM-related research in Minnesota

1. Rod Venterea and his post-doc Martin Burger (USDA-ARS stationed at UM St Paul campus) have been working in the long-term tillage treatment plots at the Rosemount Field Station. One objective is to look at the impact of tillage management on C storage and total greenhouse gas impacts. There are 4 tillage intensities (moldboard, chisel, strip chisel, and no-till) that have been applied to corn-soybean rotations and continuous corn for 11 years. They are currently measuring for the first time total greenhouse gas emissions from soils (CH_4 , N_2O , CO_2) in the corn (following soybean) plots, and also measuring NO emissions and soil N dynamics in the same plots. They also are analyzing archived soils from 1991 and 2000 for total C and N.
2. Jennifer King (UM Soil, Water and Climate) is working on the Lamberton Research and Outreach Center long-term cropping system plots to examine trace gas fluxes, including soil respiration rates. She and Tim Griffis (also UM Soil Water Climate) are working at Rosemount on studies involving decomposition and SOM turnover. Jennifer will be conducting flask isotope sampling alongside his TDL isotope measurements to allow them to differentiate between "old" and "new" soil carbon in plots which are switching between corn and soybeans.
3. Ed Nater and Paul Bloom (both UM Soil Water and Climate) are completing an NRI funded study on the bonding of Hg^{2+} and methyl- Hg^+ to SOM and soil humic acids.

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No report.

Dr. Larry J. Cihacek
Soil Science
North Dakota State University
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No report.

Dr. Leslie Cooperband
Soil Science
University of Wisconsin
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No report.

Dr. Richard Dick
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Non-thermal Biomass/Min Tillage Management in Grass Seed Systems: The goal of this research is to determine the degree, type of effect and length of the effect on soils after rotating from a perennial grass seed crop to row crops under conventional or no-till system on soil quality. Preliminary results are showing that in conventional tillage, properties for some soils requires up to 3 years, after full decomposition before soil quality improves.

Cover Crop Management and Soil Ecology: This research is investigating no-till vegetable and winter cover crops systems in relation to soil compactions. Soil ecology and microbial community research is in progress on whether manipulating cover crop residues to improve earthworm activity can improve soil quality. Also, farm-scale research is being conducted on 6 vegetable farms where two treatments (conventional vs. integrated-winter cover crops/reduced till planting) are being assessed with the Oregon Soil Health Scorecard and a soil quality kit (USDA/NRCS).

Organic Matter Inputs and Disease Suppression: Research is investigating mechanisms for disease suppression of Verticillium wilt in potatoes using cover crop green manures. Soil ecology studies are in progress but preliminary work shows cover crops can suppress this disease but may be confounded by soil pH.

C Sequestration in Forests: At the ecosystem level, forest stand age influences rates of litter accumulation and quality and micro-climatology, which could affect the microbial community structure and C sequestration processes. To investigate this we are using a novel approach that combines stable isotopic tracking with molecular techniques. We are doing paired comparisons of old growth stands with 1977 and 1994 clear cuts. This is being done with *in situ* microcosms containing ¹³C-labeled needles and root material to study time course ¹³C incorporation into labile pools including microbial community members (“active” players), and humic fractions. If the subsequent data collection and more detailed analysis follow preliminary observations; we theorize that the younger stands have higher levels of C decomposition and that soluble products of decomposition are more readily leached out of the litter in these younger stands than out of the old growth litter layers.

Dr. Rhae Drijber
Agronomy and Horticulture
University of Nebraska
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My research program aims to quantify microbial community structure and function using newer biochemical (i.e. lipids) and molecular approaches in both natural and agroecosystems. Ecosystems under study include intensively managed cropping systems and turfgrass, dryland winter wheat, afforested grasslands, and native prairie. Specific functions addressed include carbon sequestration, nutrient cycling (N and P), aggregation and plant stress (water, nutrient & disease). Currently funded projects are as follows:

1. Role of Nutrient Dynamics in Soil Microbial Diversity and Early Season Corn Growth. J.S. Schepers, J. Shanahan, R. A. Drijber. *Fluid Fertilizer Foundation*
2. Yield Potential and Optimal Soil Productivity in Irrigated Corn Systems of the North Central USA. Tim Arkebauer, Ken Cassman, Achim Dobermann, Rhae Drijber, John Lindquist, Lenis Nelson, Jim Specht, Dan Walters, and Haishun Yang. *Fluid Fertilizer Foundation and Potash & Phosphate Institute*
3. Long-term Forest Establishment on Prairie Soils: Effects on Soil Microbiological, Mineralogical, Physical and Chemical Properties. C.W. Zanner, R.A. Drijber. *University of Nebraska, Lincoln*
4. The Fate of Bt corn and Non-Bt Corn Residue in a Ridge Till Surface Irrigated Soil. D. Tarkalson, A. Dobermann, R. Drijber. *Anna Elliott Foundation*
5. Changes in Soil Microbial Community Structure with Natural Systems Agriculture Management Practices. J.A. Quincke, R.A. Drijber. *The Land Institute*
6. Genomics of Nitrous Oxide Flux Associated with Carbon Sequestration in Major Agroecosystems of the North Central USA. R. Drijber, P. Staswick, P. Blum. *DOE EPSCoR*

Dr. Serita Frey
Natural Resources
University of New Hampshire
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There are two ongoing projects in my lab related to NCR-59 activities:

- (1) Microbial contributions to carbon sequestration in agroecosystems. USDA-NRI.
- (2) Linking Soil Aggregation, Organic Chemistry, and Microbial Community Composition, Diversity and Activity to Understand the Turnover and Sequestration of Soil Organic Matter in Agroecosystems. CASMGS, Task I--Basic Processes and Mechanisms.

Both of these projects examine the microbial mechanisms that regulate the retention and accumulation of soil C in agroecosystems. In particular we are investigating the interactions between soil structure and the dynamics of microbial-derived soil organic matter (SOM). Bacterial and fungal cell wall constituents (muramic acid, galactosamine and glucosamine) are being measured to quantify the relative contribution that bacteria and fungi make to the production and stabilization of microbial-derived SOM. ¹³C-labeled plant residues are being used to trace the movement of substrate C into bacterial and fungal products to examine the rates

of bacterial versus fungal product formation and decomposition. Soil physical fractionation procedures are being applied to relate the dynamics of microbial-derived C to the location of this material within the soil aggregate structure.

Dr. Larry Halverson
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Iowa State University
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No report.

Dr. William Horwath
Land, Air and Water Resources
University of California--Davis
Phone: 530-754-6029

No report.

Dr. Peter Motavalli
Natural Resources
University of Missouri
Phone: 573-884-3212

My research has been addressing the effects of management practices on soil microbially-mediated C and N processes. The relevant research projects I currently am working on include:

- Examining the effects of transgenic Bt corn residues on soil C and N mineralization, soil microbial diversity and activity, and on subsequent growth of soybeans in rotation. This project will be expanded in 2003 in collaboration with Dr. Michelle Wander, a member of NCR-59, to include evaluation of the persistence of Bt toxin from corn rootworm Bt corn in corn-soybean rotations.
- Determining spatial variation in soil C and N fractions in long-term temperate alley-cropping practices. This project will be modified in 2003 to include evaluation of spatial variation in C and N fractions and soil CO₂ and N₂O gas efflux in paired watersheds with contrasting alley cropping practices, including warm-season grass buffer strips and tree plus grass buffer strips.
- Evaluating the initial and residual effects of soil surface compaction on soil C and N mineralization in claypan soils. This project is also evaluating the effects of compaction on soil microbial diversity and activity.
- Testing a method using apparent soil EC to rapidly estimate and map spatial variation in soil test P in pasture landscapes receiving poultry litter. This rapid evaluation would assist in selecting appropriate management practices to reduce loss of P in runoff.

I have been active in organizing a NCR-59-sponsored symposium at the 2002 American Society of Agronomy Meetings entitled "The Environmental Impact of Transgenic Crops on Soil

Biological Processes and Functions". This symposium has produced 5 papers which have been submitted to the Journal of Environmental Quality for publication and 1 paper which will be submitted to the American Journal of Alternative Agriculture. I also presented a two-day workshop entitled "Setting Priorities for Research on Carbon Sequestration in Thailand"(June 12- 13, 2003) for scientists in Thailand with sponsorship from Kasetsart University in Bangkok, Thailand and NCR-59.

Dr. Daniel Olk
National Soil Tilth Lab
USDA_ARS
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In my first year of active research as a soil biochemist with the National Soil Tilth Lab, I set up ¹⁵N-labeled fertilizer microplots in a rice field experiment run by Dr. Merle Anders, University of Arkansas. In the more anaerobic rotation of continuous rice, crop uptake of ¹⁵N was less than for rice rotated with soybean. Under conventional tillage, late season crop uptake of unlabelled N nearly ceased for continuous rice, matching field observations of a late season slowing of crop growth and lower grain yields, due to a presumed nutrient disorder. Analysis of whole soil and a young humic fraction by CuO oxidation demonstrated an accumulation of phenolic compounds under continuous rice cropping. This association of phenol accumulation with an inhibition of soil N cycling agrees with my previous work in tropical lowland rice. Additional years' data will be acquired for the Arkansas project. Analysis by new generation nuclear magnetic resonance spectroscopy of humic samples from my work in tropical rice demonstrated covalent linkage of N with lignin residues in a young humic fraction; the amount of stabilized N was agronomically significant

Dr. Laurie Osher
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No report.

Dr. Charles Rice
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No report.

Dr. Sieglinde Snapp
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A major research focus in my lab is investigating quality versus quantity of organic inputs and the effect of diversity of substrate on N and C dynamics in irrigated cropping systems. A mixed quality residue with soluble and recalcitrant C and N compounds appears to be the most effective means to pulse N availability in synchrony with plant demand, although there appear to be tradeoffs between building the N mineralization pool, the light large fraction organic matter pool, and longer-term soil organic matter pools. A long-term trial comparing three potato-based rotation sequences is underway at several sites. This research evaluates different residues that vary in soluble C content and diversity of recalcitrant and semi-recalcitrant C-compounds. Soil aggregate stability, inorganic N dynamics, soil C pools and root versus shoot growth and productivity are being monitored. On-farm monitoring in potato-based systems is also being conducted to evaluate spatial heterogeneity of soil bio-physical characteristics. Geo-referenced farm records and intensive monitoring are being used to investigate how cropping system management and organic inputs influence performance and soil quality of sandy textured versus sandy-loam textured sites across the landscape. Consequences for N mineralization, N losses and long-term cropping system performance is being monitored and interactions with climate predicted using simulation modelling with DSSAT.

Dr. Ron Turco
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No report.

Dr. Michelle Wander
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No report.

Dr. Ray Weil
Natural Resource Science and Landscape Architecture
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This is the first year that Maryland has been represented in NCR-59. My group's work on organic matter management through tillage, rotations, organic amendments and cover crops is the main NCR-59 research being conducted in Maryland. We are currently working on four projects. First, we are studying nutrient cycling in intensively grazed dairy farm watersheds, where we have found that nearly half of the total dissolved phosphorous leaching to groundwater (about 0.01 mg/L) is in organic forms. Second, we are continuing to refine the use of our active carbon method (by dilute alkaline KmnO_4) in terms of interpretation and calibration. Although we initially expected that the ratio of active to total organic C in soils would be the best predictor

of soil quality functions, our data suggest that the absolute concentration of active C is more important than this ratio. Tentatively, we suggest that soils with less than 350 mg/kg active C are limited by lack of OM and will likely respond profitably to improved organic matter management, while those with more than 600 mg/kg active C are in good condition and will not likely respond to further enhancements of SOM. Third, we are studying the relationship between SOM – related soil properties and the botanical composition of native prairie in Kansas (at the Land Institute). In this work, principal component and multiple regression analysis has suggest that active C is the most significant property distinguishing among the four study sites and between sites with varying levels of legumes in the vegetation community. Finally, we are beginning a project to investigate multiple effects of Brassica family (radish, rape) cover crops on soil quality, including the effects of decay products on nematode, weed and disease suppression. Along with Fred Magdoff of Vermont, I am editing a new book to be published this fall by CRC Press, entitled Functions and Management of Soil Organic Matter in Agroecosystems.