

MINUTES OF NCERA-59 ANNUAL MEETING
USDA Multistate Research Project on
Soil Organic Matter: Formation, Function and Management
Sims Executive Room, ACES Library, University of Illinois, Urbana, Illinois
May 26th-27th, 2005

Administrative Advisor:

Dr. Gerald Miller
Associate Dean
College of Agriculture
Iowa State University

Chair:

Dr. Sieglinde Snapp
Dept. of Horticulture
Michigan State Univ.

Vice-Chair

Dr. Deborah Allen
Dept. of Soil, Water and
Climate
Univ. of Minnesota

Members in Attendance:

Deborah Allen, Minnesota; Douglas Archibald, Pennsylvania; Larry Cihacek, North Dakota; Richard Dick, Ohio; Rhae Drijber, Nebraska; William Horwath, California; Peter Motavalli, Missouri; Sieglinde Snapp, Michigan; Alexandra Stone, Oregon; Michelle Wander, Illinois

Members Absent:

Teri Balsler, Wisconsin; Cindy Cambardella, USDA-ARS; Serita Frey, New Hampshire; Ed Gregorich, Canada; Thomas Moorman, USDA-ARS; Daniel Olk, USDA-ARS; Laurie Osher, Maine; Charles Rice, Kansas; Ronald Turco, Indiana; Raymond Weil, Maryland;

Advisors:

Gerald Miller, Administrative Advisor, present.

Other Agency Representatives and Guests:

None.

Detailed notes:

The meeting began Thursday morning and was led by Sieglinde Snapp. Michelle Wander made local arrangements and organized the site tours. Some of the NCERA-59 members attended a Wednesday afternoon workshop on 'Biotic Indicators, Their Interpretation and Relationship to Resource Condition' that Sieglinde and Michelle arranged for the Soil Ecological Society (SES) 10th Biennial Meeting held at Argonne National Lab near Chicago.

Day 1 – Thursday May 26th, 2005

Sieglinde Snapp presided over the meeting.

Attendees briefly introduced themselves. The only first-time attendee was Alexandra Stone.

Attendees were notified that state report summaries are due in one week. State reports can include not only the work of the representative, but also other relevant work at the representative's experiment station.

Two business issues that will be addressed in day two were mentioned:

- The need to organize a committee to rewrite the NCERA-59 project statement for the upcoming renewal
- The need to elect a new chair

Two important recent collaborative accomplishments of NCERA-59 were noted:

- organization of a session at the 2004 SSSA annual meeting in Seattle,
- organization of a symposium at the 2005 SES meeting in Chicago

Most of the morning was spent laying out topical issues and identifying items to be addressed by the business meeting subcommittees later in the morning and continuing the following day. The items identified for action by the national project and the assigned sub-committee chairs and members were:

1. Organization of a collaborative synthesis paper on the topic of the influence of agricultural cropping practices on carbon sequestration
 - o William Horwath
2. Development of a symposium or workshop on indicators for the complex functional properties of cover crops (e.g., C-sequestration ability, N-mineralization rates, disease suppression, root health)
 - o Sieglinde Snapp, Deborah Allen, Alexandra Stone, Douglas Archibald
3. Establishment of a soil quality web site or e-journal geared toward issues of sustainability
 - o Michelle Wander
4. Coordination of the next NCERA-59 meeting with both the next annual meeting of the Soil and Water Conservation Society (SWCS) in New York, and NC-1017 (North Central project on 'Organic Carbon and Eroded Landscapes', formerly NC-174)
 - o Larry Cihacek, Peter Motavalli, Michelle Wander
5. Development of a strategy for the committee to contribute symposia or sessions to upcoming scientific meetings (Asilomar SOM meeting in October 2005, 2006 International Soil Science Society Meeting in Philadelphia)
 - o William Horwath (Asilomar meeting), Deborah Allen and Raymond Weil (ISS meeting poster)

One other new issue was mentioned by Peter Motavalli for informational purposes. He noted that pharmaceutical crop production acreage is expanding, and widespread cultivation of such crops presents some potential environmental and commercial impacts that have yet to be evaluated scientifically.

The afternoon tours of University of Illinois research sites were arranged by Michelle Wander and included:

- WORT – Windsor Road Organic Transition Study
- Soy FACE – soybean crop Free Air Carbon-dioxide Enhancement study

- Graduate project on evaluation of miscanthus as a biomass crop for IL
- The Morrow Plots – the nation’s oldest long-term cropping systems trial

Day 2 – Friday May 27th, 2005

The committee sought advice from Gerald Miller about what to do about dropping NCERA-59 members who have not attended recently. He indicated that the participants should be contacted by the chair, and if that is inconclusive, the chair must make member modification requests through their experiment station leadership. Non-land-grant participants don’t count for committee participation and so are less of a priority to correct. Deborah Allen will follow-up with the Maine representative who has not attended in five years..

Another issue is recruiting for NCERA-59. South Dakota and Iowa representatives are needed. Suggestions on people to contact may be sent to Deborah Allen.

Gerald Miller’s Administrative Advisor’s report.

Gerald reviewed the list of current membership and asked for corrections to the contact details. He counted 16 land grant committee members including ten from north central, three from ARS and one from Canada. Ten members were present.

The impact statement for NIMSS was written in 2004 by Dan Olk and Sieglinde Snapp and is available on the web.

This is the fourth year of a five year project, and therefore a rewrite is needed. Upon renewal, everyone will need to file a new ‘Appendix E.’ The first deadline of the renewal process is September 15th, 2005. A writing committee needs to be appointed.

The new officers need to be established by a vote.

Gerald gave an update on the status of agricultural funding in the federal budget. Major components of the budget are still being debated.

Subcommittee discussions:

The group was small enough that it was not necessary to break out into planning sub-committees to discuss the five priority topic areas. Hatch funds, which support multistate projects, are threatened.

Summary of discussion on topic 1. Synthesis paper.

William Horwath led the discussion.

The focus of the paper is to be a meta-analysis of carbon sequestration by cropping systems such as no-till. The theme is that intensive and extended management is required to build and maintain soil carbon. The issue was raised about whether or not the paper should have a regional focus because of region-specific factors and the availability of published data. The answer is expected to be known

once the literature is reviewed.

It was mentioned that an SSSA committee is writing a paper on soil organic carbon and carbon sequestration. The focus of the NCERA-59 paper may be adjusted as details become known.

There was some discussion of the intended audience and the publishing vehicle. The consensus was that the information needs to be summarized for scientists and policy makers and published in the SSSA Journal and then circulated by press release to influential newspapers and journals. The CASGMS group would be an important user of the paper.

The interpretation for practitioners and the general public would be made subsequent to the journal article and should be appropriate for an e-journal or web site. Peter Motavalli noted that e-journal communications need to be provocative and personal to be read. He suggested that debunking misconceptions or 'Myths of SOM Management' would be a good way to catch attention and make some important points in a memorable way.

William Horwath agreed to take the lead in writing the policy paper with as much committee input as possible, mainly by e-mail.

It was suggested that William Horwath could use the debunking approach to moderate the group writing process through e-mail discussions that address tightly written 'myth' questions that are then followed-up with a comprehensive and critical assessment of the published data relevant to the myth statement.

Summary of discussion on topic 2. Symposium on indicators.

Evaluation of indicators for assessment of northeast cover crops was identified as an important issue.

Michelle Wander and Richard Dick noted that the snake-oil-problem is great for 'alternative soil testing' that is offered commercially. Thus there is a great need for science-based unbiased assessment of technologies.

The option to participate in regional soil-testing and organic-based nutrient workshops was also discussed. Since the conferences where these workshops are offered are many and frequent, it was concluded that it is better to train the trainers.

Larry Cihacek suggested that there could be some coordination with NCR- 13, which is focused on extension soil testing. Many of the states in NCERA-59 also have members in NCR-13.

Two components of indicator technologies are:

- Soil organic fractions
- Biological indicators / assays

Attendees of the recent SES meeting noted that biological indicators fall in several categories:

- Macrofauna
- Nutrient mineralization and microbiology

- Habitat quality (e.g., aggregate stability)

Alexandra Stone noted that a consensus paper is needed in the area of biological indicators before recommendations can be made to field extension educators.

Summary of discussion on topic 3. Soil quality web site or e-journal.

Michelle Wander led the discussion.

A substantial amount of discussion was made on the mechanics of the proposal including:

- whether the vehicle should be an informational web site or an e-journal
- if it should be sponsored by a publisher, society or organization
- the kind of content to be included (editorials, articles, PowerPoint, etc.)
- how we would establish credibility as an information provider
- who would maintain the site financially and editorially
- who would establish editorial policy (scope of issues, development of priorities)
- what audience is to be targeted
- how committee members and the committee would get credit for review, editorial and organizational work
- how the site would complement related informational sources

There was consensus about the need for coordinating the information and efforts of various organizations around the topic of ‘Soil Ecological Management,’ which serves as a working title. The identified stakeholders included NRCS, ARS, SWCS and the extension service/experiment stations. Additionally, there was the widely held belief that much of the advice that field extension educators and similar groups provide on SOM management has seen no review and is uninformed about the relevant peer-reviewed science. On the other side, policy makers also need readily accessible summaries of the peer-reviewed science. Thus the target audience for the web resource is to be field extension educators and regional policy makers. Furthermore, an e-journal with critical review was seen as adding value to the information and providing a basis for committee members and e-journal contributors to receive professional credit for their contributions to the effort.

The ‘e-extension’ web site (<http://intranet.extension.org>) was identified as a model and a resource that could overcome some of the implementation issues to the proposal. That model includes ‘communities of interest,’ ‘community of practice’ and ‘locally-branded publications.’ Michelle Wander offered to prepare a draft proposal and solicit contributions from the committee members. There was some expressed concern that the effort would become an ‘extension publication clearinghouse’ which would both cloud the message to be delivered by this NCERA-59 effort, and unnecessarily duplicate other efforts.

Possible topics for the proposed e-journal were discussed and include:

- Soil quality
- Cover crops
- Soil microbiology

With emphasis on three aspects:

- Management (possibly divided regionally)
- Indicators

- Processes

And with an issues-centered interpretive framework:

- C-sequestration
- Biodiversity
- Sustainability
- Environmental impact

Summary of discussion on topic 4. Coordination of NCERA-59 2006 with other meetings

Peter Motavalli volunteered to explore how to coordinate with the 2005 Soil and Water Conservation Society meeting in Rochester, New York at the end of July

(http://www.swcs.org/en/swcs_international_conference/2005_annual_conference/).

Larry Cihacek is also a member of NC-1017 (North Central project on 'Organic Carbon and Eroded Landscapes', formerly NC-174). He agreed to explore ways to coordinate the efforts of NCERA-59 and NC-1017.

Summary of discussion on topic 5. NCERA-59's role at Asilomar and ISS meetings

Deborah Allen agreed to work with Raymond Weil to develop a poster to describe the history of the NCERA-59 committee for presentation at the 2006 ISS meeting in Philadelphia.

The 2nd International Conference on Mechanisms of Organic Matter Stabilization and Destabilization in Soils will be held October 9-13, 2005 at the Asilomar conference center near Monterey, California (<http://wwwdata.forestry.oregonstate.edu/SoilConf/>).

William Horwath plans to contact Dr. Phil Sollins to enquire about organizing a session or symposium.

Election of NCERA-59 officers

The membership in attendance held elections for officers.

- Raymond Weil resigned the position of Vice-Chair of NCERA-59 in 2004, and so a new Chair was needed. Deborah Allen was nominated to become Chair and was elected unanimously. She was elected under the condition that she receives help in hosting the 2006 annual meeting.
- Douglas Archibald was nominated to Vice-Chair and approved by a unanimous vote.
- Alexandra Stone was nominated to Secretary and approved by a unanimous vote.

Project statement revision committee

A committee was formed to organize revision of the five-year project statement. The effort is to be led by Deborah Allen, with support from Daniel Olk, Sieglinde Snapp and Richard Dick. Members are encouraged to respond to e-mail requests in a timely fashion.

- The one-page project justification statement section is due September 15th, 2005.
- The section containing action items for the next five-years is due December 15th, 2005.

The committee agreed that group goal of understanding SOM function and management are the most important unique components of the project and are still relevant.

There was some discussion of how to deal with criticism received by the committee because of its use of the phrase 'soil quality' in some earlier project statements.

The discussion about revising the project statement started with the NCERA-59 title: Soil Organic Matter, Formation, Function and Management. The members present developed the following preliminary project statements:

1. Determine the effects of soil ecological management practices on organic fractions related to nutrient cycling/cropping system nutrient use efficiency; environmentally important biogeochemical processes such as soil carbon maintenance; and agricultural and environmental stress response/resilience.
2. Identify and evaluate indicators for soil ecological management
3. Engage field scientists/practitioners to promote soil ecological management practices that repair or sustain functionally important soil organic matter fractions

The statement needs to be inclusive of both undisturbed and managed systems.

Other business

It was announced that state activity reports for the past year are due to Douglas Archibald in electronic form. The minutes, including state reports, are due to Gerald Miller in sixty days (July 27th, 2005). Gerald will submit the SAES-422 into the NIMSS system. Gerald clarified two points about the NCERA-59 web page (http://lgu.umd.edu/lgu_v2/homepages/home.cfm?trackID=1985)

- There is a 'Photo Album' section for snapshots from the meeting
- The site is indexed by Google and is accessible by the general public

Michelle Wander raised the issue of the need for a multi-institutional message about the importance and value of long-term soil management trials, since many of these are threatened by development and declining agricultural funding. The NCERA-59 committee should consider developing an inventory of long-term trials within member institutions and evaluate the potential for research collaborations that utilize multiple sites.

The attendees thanked Michelle Wander for making the local arrangements for the meeting, the field tours and the social events.

In the late afternoon after the meeting adjourned, Alexandra Stone and Sieglinde Snapp each gave presentations of their research to the small fraction of committee members who had not departed.

Meeting Adjourned at 11:00 a.m. Friday, May 27, 2005

Approved:

Signed Sieglinde Snapp
Sieglinde Snapp
NCERA-59 Chair, 2005

Signed Gerald A. Miller

Gerald A. Miller
NCERA-59 Administrative Advisor 2005

State Reports for 2004

California Report - William Horwath

I have spent considerable effort determining the effects of conservation tillage (CT) on soil C dynamics in arid irrigated environments over the last few years. CT and cover cropping are sustainable agricultural practices that may provide solutions for California's declining soil, air and water quality. These practices can increase soil organic matter, reduce dust production conserve water and increase soil C. We looked at changes in total soil C and particulate organic matter (POM) within three physical fractions: free POM, microaggregate protected POM, and mineral associated organic matter. With the decrease in soil disturbance under CT and increased C inputs with cover cropping, we expect microaggregate protected POM to increase in both the CT and the cover crop treatments over the long term. Increases in microaggregate protected POM may indicate future C storage. Initial inspection of soil C numbers suggest that cover cropping increases total soil C in both CT and standard tillage on the order of 4500 kg C/ha in the top 30 cm over a 4-year period. In the CT treatments, the increase occurred in the surface 15 cm, while in the standard tillage treatments, it was distributed throughout the top 30 cm. In the treatments without cover crops, there was no change in soil C in the 0-15 cm depth and an overall loss in the 15-30 cm depth, ~1000 kg C/ha in standard tillage and ~2000 kg C/ha in CT. In dry hot irrigated systems, cover cropping was more important for soil C accumulation than tillage practice. Over the next year, we will complete the ¹³C labeled residue decomposition portion of the study. Through this we hope to differentiate between root and shoot C and discover if the root and shoot C are incorporated into aggregates differently under the different tillage and cover crop treatments. In addition, I continue other work on basic soil C dynamics in forest systems. Specifically I have examined the effects of mixed litters on soil C dynamics.

Doane T.A. and W. R. Horwath. 2004. Annual dynamics of soil organic matter in the context of long-term trends. *Global Biogeochemical Cycles*: 18: 1-11.

Kraus T. E. C., R. J. Zasoski, R.A. Dahlgren, W.R. Horwath and C.M. Preston. 2004. Carbon and nitrogen dynamics in a forest soil amended with purified tannins from different plant species. *Soil Biology and Biochemistry* 36 (2): 309-321.

Illinois Report – Michelle Wander

We have completed several studies this year. Three manuscripts that address the influence of long-term use of organic management practices on soil organic matter characteristics are in review. The general effects of organic management on promising indices of SOM status (POM and a rapid measure of base hydrolyzable N) were determined by comparing the characteristics of organic and conventionally managed soils obtained from nine long-term trials in North America (Emily Marriott). In addition, a more detailed study was conducted of POM and of hydrolyzable N fractions (including amino-acids, amino sugars) at a site where use of organic practices failed to increase SOM (Yun Wang). In the multi-site comparison, legume- and manure-based organic systems performed equally well in their ability to increase the quantity of SOM as well as enrich the proportion of particulate organic matter, where POM was assessed using a variety of methods. The

quantity of C and N in the coarse fraction, loose light fraction, and aggregate occluded fraction were similar in soils from legume and manure-based systems. The amount of POM-N recovered using a variety of methods was equal to the amount of N recovered by base hydrolysis and was more than twice that required to support a full crop of maize. Base hydrolyzable N was no more sensitive to management than was total N. We were able to differentiate between the manure- and legume based organic systems by assessing the quality of the aggregate occluded POM fraction ($< 2.0 \text{ g cm}^{-1}$); this fraction was most humified and contained a greater amount of plant available N in the manured soils. In a related study of an aberrant organic site, where SOM levels remained low and maize yields lagged in the legume based system, the only SOM attribute that differed among the three systems was amino acid N contents. Contents were least in the conventional and greatest in the manure based organic system. Whole soil and POM C/N ratios were quite low and were accompanied by extremely high amino sugar levels. Fraction characteristics suggest an imbalance in soil C and N reserves and that disease, rather than N insufficiency, may be limiting yield. This, and possibly C priming by surplus N, may constrain organic matter accumulation. Through using multiple measure of labile SOM, and considering C and N together, we begin to use SOM diagnostically. We conclude disproportional responses in labile fractions can identify resource limitations or surpluses within a system.

A series of manuscripts based on the dissertation work completed by Gayoung Yoo are in press or review. In this series of papers we develop an understanding of physical controls over C mineralization that will help us explain, and possibly anticipate, the variable influence no-tillage tillage practices have on C sequestration. A laboratory study showed efforts to understand SOC dynamics should consider soil aggregation and pore size distribution which control spatial variability in soil water influencing microbial activity. Field based work showed use of NT practices increased SOC sequestration at Monmouth IL (silt loam soil), where tillage practices altered physical properties enough to affect trends in C mineralization, but did not alter SOC storage in DeKalb IL (silty clay loam), where higher clay contents provided a protective capacity not altered by tillage. The least limiting water range (LLWR), an index of structural quality, predicted observed soil CO₂ efflux patterns. Follow up work found specific SOC mineralization rates (RESP_{sp}) were also reduced by use of NT management at Perry (silt loam soil), a third site where use of NT practices had thus far failed to increase SOC contents. Based on RESP_{sp}, use of NT practices only enhance physical protection of SOC where soil bulk density is relatively high (1.4 g cm^{-3}). Reductions in the volume of small macropores (15-150 μm), which are important for microbial activity, occurred in NT soils at Monmouth and Perry. The LLWR also successfully predicted RESP_{sp} patterns at Perry. Indices of soil structural quality (LLWR, RESP_{sp}, macropore volume) can be used to predict where use of NT practices will or will not enhance SOC sequestration by increasing physical protection of SOC.

Active research includes studies of particulate organic matter fractionation techniques, Bt toxin persistence in soils, the influence of organic transition strategies on SOM and soil biology, and the influence of miscanthus and switchgrass on soil C sequestration and trace-gas emissions.

Indiana Report –Ronald Turco, Purdue University

PROJECT TITLE: TILE DRAINAGE AND DISSOLVED ORGANIC CARBON FLUX PROJECT
PARTICIPANT: MATT RUARK (GRADUATE STUDENT)
PIS: SYLVIE BROUDER, MARIANNE BISCHOFF AND RONALD TURCO*

* MEMBER NCERA 59

Leaching of dissolved organic carbon (DOC) from surface to subsurface soil represents a fraction of agricultural system C that has not been consistently accounted for in C budgets. When DOC reaches the carbon-limited subsurface soils, it may be used as an energy source for denitrifying microorganisms. Dissolved OC loss from soils during drainage events has not been adequately measured to determine total C outputs of tile drained agroecosystems, which dominate the Eastern Corn Belt. This information is important when assessing land use impacts on watershed level carbon cycling.

The objectives of this study were: (1) to quantify the effect of fertilizer source and timing on DOC loss from discrete drainage events and (2) to assess the interaction effect of fertilizer application and rainfall/drainage events. Large (10x24 m) in-ground lysimeters were fitted with an ISCO sampling device that collected subsamples from tile drain water on a flow volume proportional basis. Subsamples were filtered and analyzed for DOC using a Shimadzu TOC-V Analyzer. The experiment was set up as a randomized complete block design. Three treatments were selected: spring applied manure, fall applied manure, and spring applied UAN. In 2003, seven discrete drainage events occurred (Figure 1). Drainage event characteristics and DOC mass loss per event are shown in Figure 2. Events differed with respect to duration of flow and total volume of flow, while DOC mass loss appears to be strongly correlated with total volume of flow.

When averaged over all eight events, there appears to be no effect of fertilizer application (data not shown). However, when DOC mass losses from fertilizer treatments are compared within each event, it appears that timing (of application and rainfall) is an important factor in DOC loss (Figure 3). Table 1 shows an ANOVA using Event as a split plot treatment. Results indicate that alone there is no effect of treatment, while there is a significant effect of event and there is a significant interaction effect.

These results are important when assessing the effect of adding additional organic carbon (as manure) to soil. From Figure 3, we see that certain drainage events have increased DOC mass loss from the spring or fall manure applications. Further investigation is needed to understand the effect of time between drainage events and time between application and event. Understanding the interaction of climate and management is important for understanding when DOC is likely to be leached into the subsurface and its potential to influence the subsurface C and N cycle.

Ongoing Work: Samples were also gathered for 2004 and are currently being analyzed. Determination of nitrate and DOC loss are ongoing to predict subsurface denitrification potential. Additionally, within event effects (DOC concentrations and flow rates) are being analyzed and further timing factors of event and drainage interaction are being explored.

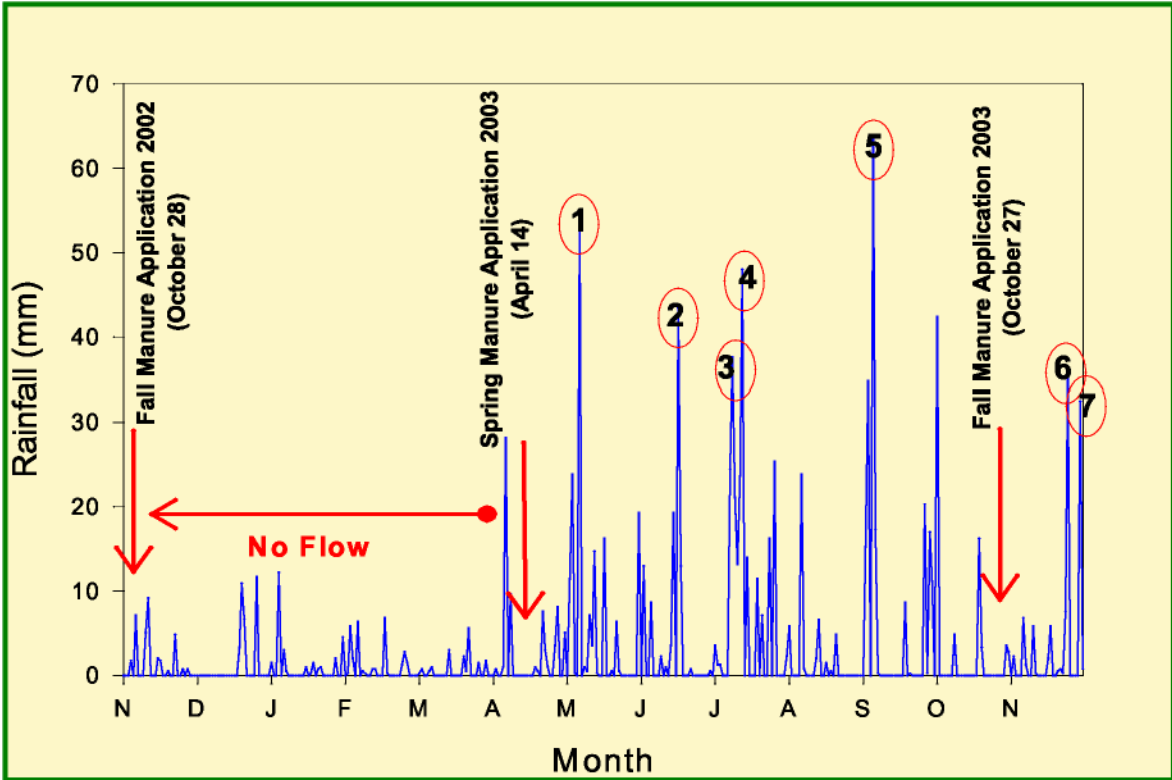


Figure 1. Rainfall and Timing of Management (November 2002 – December 2003)

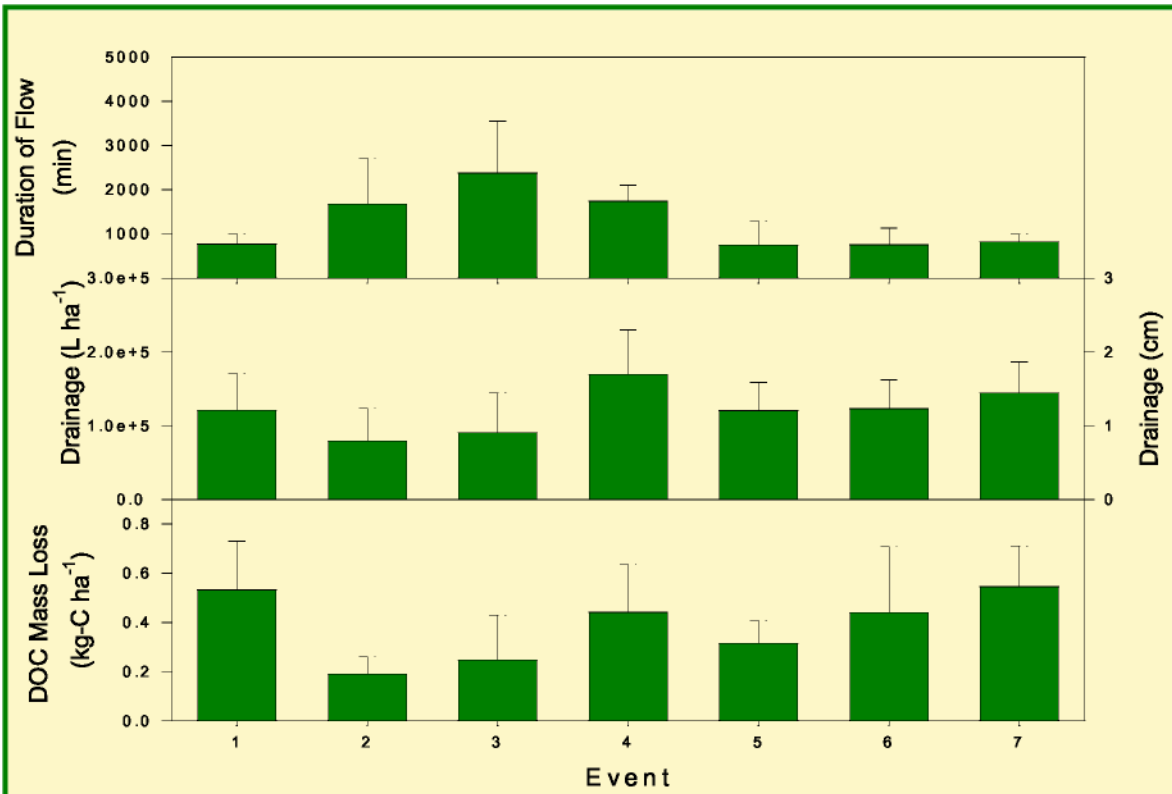


Figure 2. Drainage Characteristics and DOC Loss from Discrete Drainage Events

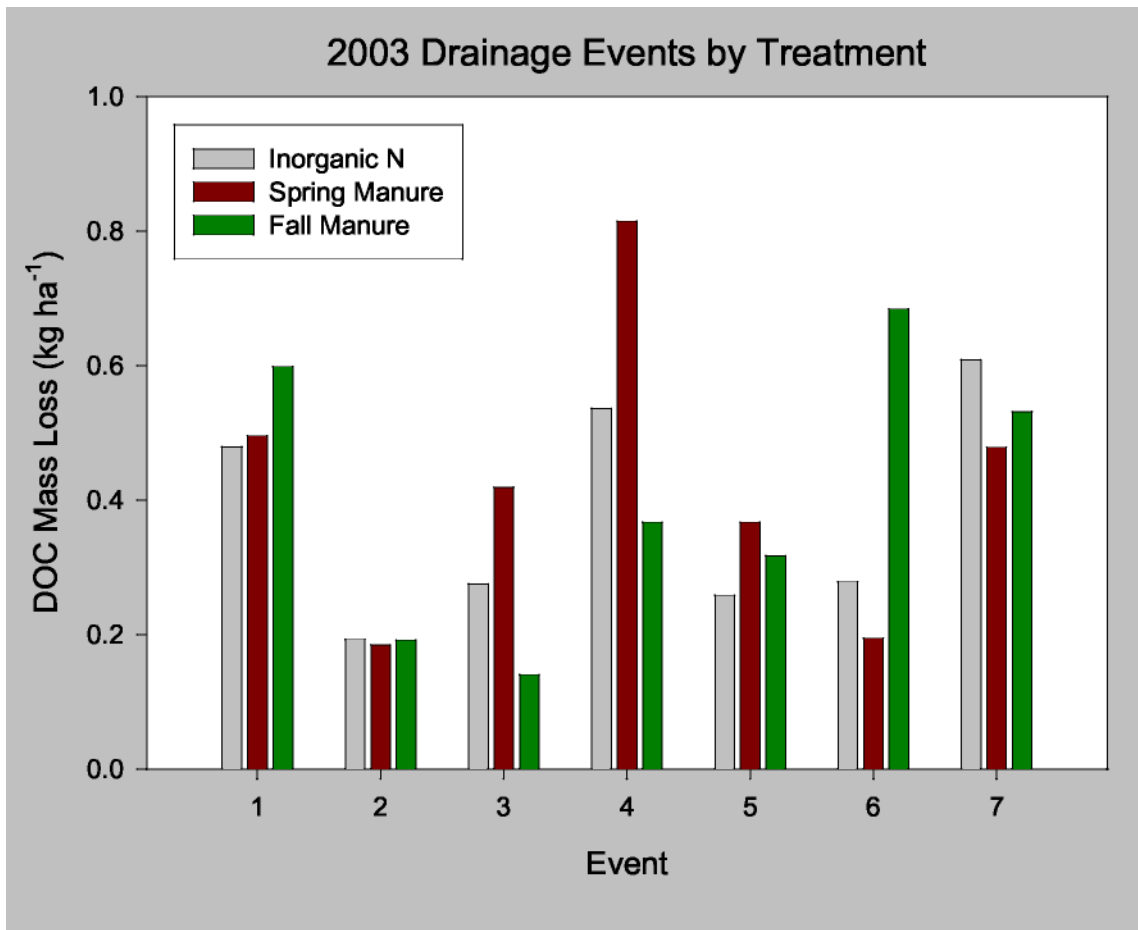


Figure 3. DOC Loss from Treatments Grouped by Event.

Table 1. Analysis of Variance

	dF	F	p
Block	3	14.48	<0.001
Treatment	2	0.88	0.481
Block X Treatment (E)	4		
Event	6	13.66	<0.001
Event X Treatment	12	4.78	<0.001

Kansas – No Report

Maine – No Report

Maryland – No Report

Michigan Report – Sieg Snapp

My primary research focus is on managing inorganic and organic inputs to optimize nitrogen and

carbon assimilation in potato and related cropping systems while maintaining yield goals. In 2004, this led to co-authorship of three publications. This research is making contributions to our understanding of nitrogen cycling in Alfisol, coarse soil, irrigated agroecosystems. In two recent review articles I have evaluated how ecological principles can relate multiple functions, soil consequences and economic factors to help choose cover crops in relationship to cropping system niches (*Agronomy Journal*), and on how to apply biogeochemical principles to design environmentally-friendly nutrient management systems (*Ecosystems*). My research continues in the area of managing root health, living cover and residue quality input for rhizosphere management to enhance N and P availability and efficient nutrient cycling.

I have related research in southern Africa, Malawi where informal irrigation systems are the subject of a project funded by USAID-Bean Cowpea CRSP. These are environmentally sensitive and potentially highly productive agroecosystems of expanding importance to livelihoods of smallholder farmers in Africa. I work with an interdisciplinary team of local and international social scientists, soil scientists, a plant breeder and agronomist to develop a sustainable cropping system approach to these highly degradable, vulnerable soil types.

Recent publications:

Snapp, S.S. Ms. In Press. Early planting enhances root growth in fresh market tomatoes. *J of Vegetable Crop Production*.

Snapp, S.S., S.M. Swinton, R. Labarta, D. Mutch, J.R. Black, R. Leep, J.

Nyiraneza and K. O'Neil. 2005. Evaluating benefits and costs of cover crops for cropping system niches. *Agronomy J* 97:322-332

Drinkwater, L.E. and S.S. Snapp. Ms. accepted. Nutrients in agroecosystems: Re-thinking the management paradigm *Ecosystems* Snapp, S.S. and H. Borden. 2004. Enhanced nitrogen mineralization in mowed or glyphosate treated cover crops compared to direct incorporation. *Plant and Soil* 270:101-112.

Minnesota Report - Deborah Allan

We are in the second year of a study at Lamberton, MN, where we are using ^{13}C and ^{15}N labeled inputs to investigate the storage and turnover of C and N in active and resistant organic matter pools under different cropping systems. We were successful in achieving a $\delta^{13}\text{C}$ of 300 in the above ground corn residues we labeled. Aggregate size distribution and microbial biomass measurements are completed for the first year's samples and we are currently analyzing LF in 3 aggregate size fractions. Two collaborators, Jennifer King and Jeff Strock, are measuring C and N losses from the labeled microplots via NO_3 leaching and gaseous emissions of CO_2 , CH_4 , and N_2O .

We completed a three year assessment of differences in yield, nitrogen supply and soil quality resulting from applications of digested versus raw manure or inorganic fertilizer at the Haubenschild Dairy Farms in Princeton, MN. We were unable to detect differences in yield and few differences for most nutrient or soil parameters with any of the three amendments. These results are available as a 2 page fact sheet at <http://www.mnproject.org/pdf/soils-web.pdf>.

In a third project, we are monitoring effects on soil quality and fertility of alternative organic management systems, relying on compost vs. manure applications and with and without cover crops.

Missouri - Peter Motavalli

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:

- Determining spatial variation in soil 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. This research has highlighted the importance of variations in climate, varying depth to a restrictive claypan layer, and differences in vegetation on N₂O gas efflux.
- Evaluating the effects of flooding regimes on decomposition of plant residues in floodplain soils and production of soluble and insoluble phenolics that can be phytotoxic or reduce plant-available N. This project is in collaboration with Dr. Dan Olk, a member of NCERA-59, who is with USDA-ARS. The collaboration was stimulated by the 2003 NCERA-59 annual meeting in Missouri and a field visit to the Flood Laboratory of the Center for Agroforestry at the University of Missouri.
- Determining the relationship between N fertilizer source (urea and polymer-coated urea), and soil water content on N₂O gas efflux in corn production on claypan soils with different artificial drainage and irrigation systems. This project has expanded in 2005 to examine the concept of “variable-source” N fertilizer management in which the polymer-coated urea would be applied to areas of a field with high risk for N loss and conventional urea to areas of low risk.

Several papers have been published or are in preparation from research 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. A project on the persistence of Bt toxin from corn rootworm Bt corn was also conducted in collaboration with Dr. Michelle Wander, a member of NCERA-59.

Recent Publications:

Mungai, N.W., P.P. Motavalli, K.A. Nelson and R.J. Kremer. In review. Differences in yields, residue composition and N mineralization dynamics of Bt and non-Bt maize. *Nutr Cycl in Agroecosy.*

Pengthamkeerati, P., P.P. Motavalli, R.J. Kremer, and S. H. Anderson. In review. Soil compaction and organic amendment effects on soil physical properties and nitrogen mineralization in a claypan soil. *Soil Tillage Res.*

Udawatta, R.P., P.P. Motavalli, H.E. Garrett, and J.J. Krstansky. In review. Soil nitrogen losses in runoff from three adjacent agricultural watersheds with claypan soils. *Agric. Ecosys and Environ.*

Mungai, N.W., P.P. Motavalli and R.J. Kremer. In review. Soil organic C and N fractions in

- long-term alley cropping systems. *Comm. Soil Sci. Plant Anal.*
- Pengthamkeerati, P., P.P. Motavalli, R.J. Kremer, and S. H. Anderson. In press. Soil carbon dioxide efflux from a claypan soil affected by surface compaction and applications of poultry litter. *Agric. Ecosys and Environ.*
- Mungai, N.W. and P.P. Motavalli. In press. Litter quality effects on carbon and nitrogen dynamics in temperate alley cropping systems. *Applied Soil Ecology*
- Mungai, N.W., P.P. Motavalli, R.J. Kremer, and K.A. Nelson. In press. Spatial variation of soil enzyme activities and microbial functional diversity in temperate alley cropping systems. *Biol. Fertil. Soils*
- Fang, M., R.J. Kremer, P.P. Motavalli, and G. Davis. In press. Bacterial diversity in rhizospheres of non-transgenic and transgenic corn. *Applied and Environmental Microbiology.*
- Jung, W.K., N. R. Kitchen, K. A. Sudduth, R. J. Kremer, and P. P. Motavalli. 2005. Relationship of apparent soil electrical conductivity to claypan soil properties. *Soil Sci. Soc. Am. J.* 69:883-892.
- Udawatta, R.P., P.P. Motavalli, and H.E. Garrett. 2004. Phosphorus loss and runoff characteristics in three adjacent agricultural watersheds with claypan soils. *J. Environ. Qual.* 33:1709-1719.

Nebraska – No Report

New Hampshire – No Report

North Dakota - Larry J. Cihacek

The major effort in research on soil organic matter in North Dakota has been part of a regional effort of the Plains CO₂ Reduction Partnership (PCOR). North Dakota State University has responsibility for the terrestrial component of the effort which includes CO₂ inventory and abatement and strategies for terrestrial and geo-storage of CO₂.

The work during the past year has included an intensive sampling of a series of long-term soil management plots at the NDSU Hettinger Research and Extension Center as well as soil carbon (C) inventories in central Montana and northwestern South Dakota. Approximately 320 cores were collected to a 2 ft (60-cm) depth at the Hettinger site in 2004. Management systems include cropland converted to permanent grass and rangeland converted to cropland. Within the two differing management histories, grass (grazed and ungrazed) as well as wheat, oats and barley are being grown under no-till or conventional crop-fallow management. The objective of this portion of the research is to compare changes in C under the different management treatments with C that was originally in the soil at the beginning of the experiment in 2000 and to evaluate the potential for C sequestration in a semi-arid region.

The Montana survey was conducted in June 2004 in Musselshell and Golden Valley Counties in MLRA 58A in central Montana. Three sites were sampled in Musselshell county and two sites were sampled in Golden Valley County. A total of 28 cores were collected in this survey on 5 different soil series. This data is currently being compiled into a technical report for the PCOR

program.

Eight sites were sampled in Corson, Perkins and Harding counties of northwestern South Dakota in MLRA 54. A total of 48 cores were collected and are currently undergoing processing and analysis.

The objective of the surveys is to gather C storage information on soils that have not previously been studied. A secondary objective is to evaluate the amount of C stored in soil carbonates in soils of this region and to attempt to determine if C is being sequestered as inorganic c as well as organic C.

This work will continue through the next year and the Ph.D. student that is working on this project will be evaluating the utility of USDA-NRCS's COMET-VR model in interpreting changes that may have occurred especially at the Hettinger site.

North Dakota is also participating in the NC-1017 (Carbon Sequestration and Distribution on Eroded Landscapes) Regional Research Committee.

Ohio - Richard P. Dick

Cover Crop and Tillage Management and Soil Ecology: This research is investigating no-till vegetable and winter cover crops systems in relation to soil ecology and microbial communities, soil fauna including specific studies on earthworms. 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). The most immediate response to the addition of cover crops and reduction of tillage was with the microbial properties and the soil faunal communities. This is due to the greater C inputs with cover cropping which stimulates the microbial community with added energy sources as well as food sources for soil fauna. Reducing tillage reduces disturbance which projects habit and results in less direct physical damage to organisms. Physical properties responded somewhat differently, such as water stable aggregates (WSA) was consistently lower with conventional tillage but otherwise the results from WSA and soil compaction for would indicate that reduced tillage was actually having negative impacts on soil physical properties. There may be several reasons for this. First it may simply be a function of time and that more time is needed to enable the higher levels of biological activity to have measurable effects on soil physical properties with reduced tillage. Secondly, the nature of the dominant soils and its climate in western Oregon; silty soils and a long winter rainy season disperse particles and fill pores. We are encouraged by evidence that there is greater earthworm activity with less disturbance and cover cropping but this apparently is not enough (after 3 years) to off set compaction under the type of strip till system we are using. We have made considerable progress in identifying soil quality indicators. Soil enzyme activity and key soil fauna are sensitive to management effects. We also successfully demonstrated that earthworm midden counts can be a good index of management effects as a simple and statistically robust indicator.

C Sequestration in and Microbial Community Dynamics as a Function of Forest Stand age: Stand age

and harvest disturbances can have significant impacts on forests ecosystems. The objective was to use phospholipid fatty acid (PLFA) profiling alone and in combination with ^{13}C -isotope tracking to determine the influence of clear-cutting and seasonal changes on the soil microbial community (SMC) composition and physiological status. Microbial PLFA profiles and the relative amount of ^{13}C incorporated ($^{13}\text{C}\%$) into PLFAs were developed and compared for soils from sites 9 and 25 years after clear-cutting (CC94 and CC77, respectively) and in paired sites from old-growth coniferous forest stands (OG1 and OG2, respectively). PLFA patterns revealed that SMC composition and physiological status were affected by time since clear-cutting but that season had an even bigger effect on microbial communities. The microbial biomass (total PLFA concentration), and bacterial and fungal biomass were significantly reduced in CC94 but not in CC77 sites relative to paired OG sites. The combined effect of soil moisture and temperature stress in August samples was reflected in changes to the SMC structure and physiological status. These stressors likely resulted in the modification of microbial membranes as indicated by increases in the ratio of cy17:0 to 16:1 ω 7 and a decreased degree of unsaturation, which requires a rapid turnover of lipids and would induce metabolic stress and death of microorganisms. The latter effect resulted in the overall reduction in active microbial biomass.

Oregon – No Report

Pennsylvania – Douglas D. Archibald

Investigations over the last year resulted in a USDA NRI proposal on development and application of novel molecular spectroscopic approaches to characterization of soil organic matter. The proposal focuses on understanding the soil transformations occurring in two long-term soil management trials in central Pennsylvania, a rotation by fertility trial and a tillage trial. Preliminary studies resulted in poster presentations at two scientific meetings. I continue to collaborate with Jim Kubicki on use of infrared spectroscopy to characterize the molecular interactions between organic molecules and mineral surfaces. Over the past year several undergraduates and graduates have gained research experience in my laboratory, including P. Drew Mather, who has completed requirements for an M.S. in soil science. To facilitate collaboration with and among my local Penn State University and USDA-ARS colleagues we had an informal monthly discussion group on the topic of soil organic matter research.

D. D. Archibald, A. L. Shober, and R. K. Randhawa, "Evaluation of two types of infrared methods to characterize soil organic carbon. FACSS 2004, The 31st Annual Conference of the Federation of Analytical Chemistry & Spectroscopy Societies : Final Program and Book of Abstracts : October 3-7, 2004 : Portland, Oregon (poster).

P. D. Mather, R. C. Stehouwer and D. D. Archibald, "Organic material transformation during composting and vermicomposting," Soil Science Society of America – 68th Annual Meeting : Oct. 31 – Nov. 4, 2004 : Seattle, Washington (poster).

Wisconsin – No Report

USDA-ARS – Dan Olk

A significant accomplishment for NCERA-59 was organization of the symposium described below:

Symposium on
Meaningful Pools in Determining Soil C and N Dynamics
joint meeting of the Soil Science Society of America
and the Canadian Society of Soil Science,
Seattle, Washington
Wednesday, November 3, 2004.

Dan Olk¹, Ed Gregorich² and Cindy Cambardella¹

¹USDA-ARS, National Soil Tilth Laboratory; 2150 Pammel Drive; Ames, IA 50011; USA

²Agriculture & Agri-Food Canada; Ottawa Research Centre; Central Experimental Farm; Ottawa Canada K1A 0C6

Statement of purpose

The broad purpose of this symposium was to summarize the knowledge gained from the most common procedures for extracting and fractionating soil organic matter. We focused on knowledge that helps us better understand the functions of soil organic matter in meaningful, i.e. real world, issues. Ultimately we intend to help organic matter researchers design their research programs more effectively.

This symposium arose from the desire to promote much needed interaction among practitioners of different extraction procedures. A great deal of work has been done during many years with these different procedures, but integrative discussion has been lacking, creating some points of concern. These include: (i) the need to summarize expanding bodies of knowledge; (ii) multiple variants exist for some procedures, but their differences are not clearly documented despite the potential for divergent results; (iii) differences in nomenclature create confusion, especially for specific fractions of organic matter; and (iv) most importantly, no single extraction procedure has proven to be the best choice for all research issues and all soil types.

Hence specific goals of this symposium were to: (a) summarize the current state of knowledge on meaningful issues, (b) clearly state a recommended protocol for each of the major extraction procedures and clarify inconsistencies in nomenclature; (c) for the first time state for each procedure its strengths and weaknesses and categorize the situations (research issue, soil type) for which it is the most appropriate choice; and (d) suggest paths for the development of integrated procedures, for example a combined physical and chemical extraction.

In order to give the audience a broad perspective of the various procedures, speakers presented an overall review of each topic, rather than focus exclusively on their own research. The methodology was presented in summary form and was not the focus of the presentation. Each presentation objectively discussed the pros and cons of the procedure in question - when does it work and when not with regard to research objectives and soil type.

Manuscripts were prepared for seven of the presentations and are currently under review for publication in the Soil Science Society of America Journal. The symposium was co-sponsored by S-3 (Soil Biology and Biochemistry) of the SSSA, the Canadian Society of Soil Science, the Canadian and U.S. chapters of the International Humic Substances Society, and the NCERA-59 regional committee, “Soil organic matter: Formation, function and management.”

Symposium Speakers

7.55 – 8.00.AM	- Ed Gregorich (and Dan Olk)	Intro remarks
8.00 – 8.25	- Bill McGill	Overview of Meaningful Pools in Determining C and N Dynamics.
8.25 – 8.45	- Johan Six	Physical Separation and Chemical Characterization of Aggregate-associated Carbon Fractions to Measure and Understand Soil Organic Matter Dynamics.
8.45 – 9:05	- Bent Christensen	Particle Size Fractionations.
9.05 – 9.25	- Ed Gregorich	Light Fraction and Particulate Organic Matter as Sensitive Indicators of Soil C Changes.
9.25 – 9:45	- Jan Skjemsted	Charcoal Carbon.
9.45 – 10.05	- Annemeike Farenhorst	Will More Information on Soil Organic Matter Fractions Increase Our Ability To Model Pesticide Sorption At The Soil-Landscape And Regional Scales?
10.05 – 10.15	Break	
10.15 – 10.40	- Michael Hayes	Principles of solvent systems and of the structures that these isolate.
10:40 – 11:00	- Myrna Simpson	Molecular-level examination of organic contaminant and soil organic matter interactions.
11.00 - 11.20	- Dan Olk	A Chemical Fractionation for Structure-Function Relations of Soil Organic Matter in Nutrient Cycling.
11:20 – 11:40	- Denis Angers	Soil Carbohydrate Composition: Use in the Study of Soil Organic Matter Quality and Dynamics.
11:40 – 12:00 PM	- Martin Chantigny	Dissolved Organic Matter: Usefulness in Elucidating Soil C, N and P Dynamics.
12.00 – 2.00 PM	Lunch and Poster Session	
2.00 – 2.20	- Eldor Paul	Do acid hydrolysis and incubation measure meaningful soil organic matter pools?
2.20 – 2.40	- Peter Bottomley	Is There a Link between Microbial Community Composition and Microbial Processes in Soils?
2:40 – 3:00	- Rhae Drijber	Structure and Function of Soil Microbial Communities within Physical Fractions of Soil.
3.00 – 3.10	Break	
3.10 – 3.30	- Henry Janzen	Fractions and extractions - their relevance to carbon sequestration.
3.30 – 3.50	- Ben Ellert	Soil organic carbon pools inferred from long-term radiocarbon dynamics (or closely related assigned topic).
3.50 – 4.10	- Michelle Wander	Measures of biologically labile nitrogen.
4.10 – 4.30	- Cindy Cambardella	Meaningful Pools in Determining Soil C and N Dynamics: Symposium Synthesis.
4.30 – 4.40	Break for cash bar	
4.40 – 5:10	Round-Table Discussion	

Dan Olk's publications in the previous 12 months that are related to soil organic matter:

- Mitra, S., M.S. Aulakh, R. Wassmann, and D.C. Olk. 2005. Triggering of methane production in rice soils by root exudates: Effects of soil properties and crop management. *Soil Science Society of America Journal* 69:563-570.
- Olk, D.C., M. Becker, B.A. Linquist, S. Pandey, and C. Witt. Integrated nutrient management – Experience/concepts from South East Asia. In M.S. Aulakh and C.A. Grant (ed.) *Integrated nutrient management for sustainable agriculture*. Haworth Press (in press).
- Olk, D.C. Organic forms of soil nitrogen. *In: J.S. Schepers and W.R. Raun (ed.) Nitrogen in Agricultural Soils*, 2nd edition. Soil Science Society of America (in press).
- Olk, D.C. and D.A. Martens. Organic forms of nitrogen. *In: M.R. Carter (ed.) Soil sampling and methods of analysis*. CRC Press, Boca Raton, FL (in press).
- Olk, D.C., K.G. Cassman, M.M. Anders, K. Schmidt-Rohr, and J.-D. Mao. 2004. Does anaerobic decomposition of crop residues impair soil nitrogen cycling and yield trends in lowland rice? *Proceedings, World Rice Research Conference, 04-07 November 2004, Tsukuba, Japan*. Japanese Ministry of Agriculture, Forestry, and Fisheries: (in press).
- Anders, M.M., D.C. Olk, T. Harper, T. Daniel, and J. Holzhauser. 2004. The effect of rotation, tillage, and fertility on rice grain yields and nutrient flows. CD-ROM. North Carolina Agricultural Research Service Technical Bulletin 321. Raleigh, NC.