Annual Report

NCERA 217, Drainage Design and Management Practices to Improve Water Quality

Reporting period: July 2011 through June 2012

Annual Meeting: April 17-19, 2012, Dundee, Michigan

Annual Meeting Attendees: The annual meeting was a joint meeting of the NCERA 217 committee and the Agricultural Drainage Management Systems Task Force. Additional attendees including representatives from agribusiness, extension educators and others with an interest in drainage and water quality were welcome to attend. A list of meeting attendees is attached.

Meeting agenda: The full meeting agenda is attached. A brief description of meeting activities, events and discussions follows. The minutes of the NCERA 217 business meeting is attached (pg 18).

Tuesday afternoon, April 17

Introductions: Tim Harrigan welcomed everyone to Michigan, and all participants introduced themselves. A full list of participants is on page 21.

Agenda Overview
(Complete agenda page 19)

- Tuesday afternoon – presentations
- Wednesday morning – Phosphorus mini-symposium; Discussion
- Wednesday afternoon – Field Trip
- Thursday morning – NCERA 217 business meeting; Presentations; Discussion on next steps.

Charlie Schafer gave an update from the Agricultural Drainage Management Coalition, including the current saturated buffer project and other industry topics of interest.

Xinhua Jia, Chair of the North Central Extension and Research Activity (NCERA) 217, briefly introduced the committee and its objectives for those not familiar with the committee. This is a multistate research committee sponsored by USDA National Institute for Food and Agriculture (NIFA), with the following objectives:

- Evaluate and demonstrate the impact of integrated drainage system design and agronomic management practices on reducing nitrate-N and soluble phosphorus loads from drained agricultural lands.
- Coordinate research on the water quality impact of manure application on drained agricultural land.
- Assess the need for further research in other aspects of environmental quality from drained agricultural lands, such as salinity, implications of emerging feedstock production for biofuels, and potential greenhouse gas production in drained agricultural lands.
- Develop Extension and outreach educational materials, develop strategies to facilitate communication between scientists and policy makers, and promote partnerships with stakeholders interested in drainage, soil and crop management, and environmental quality in agricultural landscapes.

This group has worked closely with the Ag Drainage Management Systems Task Force for many years, but this is the first meeting where the two agendas have completely overlapped.

Paul Sweeney discussed the NRCS Ag Water Management Team. The Team's Action Plan includes:

- Communication: Summit, presentations, State Technical Committees, outreach tools. All are available at http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/water/manage.
- Technology: Map of acres suitable for DWM, web-based application, and development of technical standards. (Map and others available at web site)
- Training and policy (state ag water management action plans), changes to programs, wildlife habitat.

Doug Toews discussed various standards that are in development or review. He also introduced Andrew Pursifell, NRCS engineer in Indiana, who is planning to study adoption of drainage water management as part of leadership training. Andrew briefly described his project and invited input on barriers to adoption and other ideas that people have related to adoption. (It was pointed out that in Missouri the best adoption takes place where state cost-share of $300 adds to federal incentives.)

Norm Fausey described the many activities that ARS is doing related to drainage, beyond projects represented here. He shared information about the Soil Drainage Unit's work under two major CRIS projects, and invited collaboration. Asked to reflect on phosphorus, he noted that phosphorus is a separate issue from drainage, but is not clearly exacerbated by subsurface drainage. Yes, we have soluble phosphorus in the environment, and we're moving water out through drainage. Drainage moves another few inches of water out of the profile annually. He pointed out that the electrochemical bond between orthophosphate and the soil material is complex, including ligand exchange sites and other chemical properties.

Kelly Nelson presented drainage research in Missouri, focusing on agronomic aspects. They are stacking *integrated water management systems* with fungicide and insecticide applications and polymer-coated urea. Overall they have found a 20% increase in corn yield with drainage and 40% increase in yield with subirrigation. They are also studying air quality impacts of wet soils (ammonia volatilization and nitrous oxide). Water quality studies showed that managed drainage reduced annual water drained by 60%, and loss of TSS, ortho-P, and nitrate-N by more than that. Some pumped drainage is being introduced due to lack of an outlet. He also presented drainage in a perennial crop. Their 2012 drainage workshop was very successful, and produced interesting survey results and increases in knowledge.

Larry Goehring described Cornell University's research funded by a Conservation Innovation Grant on "Subsurface Drainage Water Management to Reduce Manure Contaminated Drain Discharge". Drainage sites have been installed near Lake Champlain, with measurements in a control structure, an uncontrolled tile, and outlet into the stream. The influence of manure application on phosphorus and *E. coli* is clear, with TP levels reaching 2.5 mg/L. The tile with the control had slightly less loss overall.

Chris Hay: There is huge interest in drainage in South Dakota, with lots of installation of new drainage; not so much drainage water management. They have held very successful drainage workshops together with Minnesota and North Dakota, with 250 people attending. They have developed a drain spacing calculator (http://climate.sdstate.edu/water/DrainSpacingCal.html), and it was noted that 3-inch tile is popular in the Red River Valley. He was asked about drainage coefficient used, but no work currently

being done. They are looking at evapotranspiration of cover crops, since some are convinced that drainage not needed with cover crops.

R. Sri Ranjan presented a great deal of research related to **"**Better Water Management through Tile Drainage/Subirrigation Systems". Much interest in drainage in Manitoba, especially related to flooding. They are focusing on agronomic aspects for potatoes, and environmental impacts including soil salinity. They have controlled drainage with subirrigation, free drainage with overhead irrigation (highest yield and also highest nitrogen and phosphate export), and no drainage with and without irrigation. He presented the field monitoring, including groundwater, drainage flow (using sharp crested weirs with level logger), soil moisture, and salinity. (And I note had particularly wonderful photos.)

Bruce Shewfelt discussed activities in Southern Manitoba of Agri-Environment Services Branch of Agriculture and Agri-Food Canada related to agricultural drainage management systems. These include capacity building activities; the Hespler and CMCDC projects to study controlled drainage with various irrigation systems, cover crops, and nutrient management. They are also studying Water Footprints on irrigated/tiled land in the Boyne River Valley, and he discussed the conclusions regarding controlled drainage contained within the "Red River Retention Authority Report" which discusses the international Red River Valley watershed. He brought up other potential areas of international cooperation such as training, education and case studies. He noted that the Agri-Environment Services Branch is planning to do a case study on a field-scale tile installation in Southern Manitoba, including adoption barriers.

Mark Sunohara described a paired watersheds study, where most fields in an intervention watershed had controlled drainage, and most fields in the "control watershed" did not. The non-statistically-significant results were that nitrate-N was reduced by 30% but Total P *increased* by 10%. (He speculated that the increase in P could be due to P mobilized, manure application, error, or in-stream inputs.) However, field scale studies consistently showed reductions of up to 80% in pollutant loads, and slight (3-4%) yield increases possibly a result of more uniform crop growth. They are also trying to identify barriers to DWM and inform future policy and program development. Why Is DWM not practiced broadly given environmental and economic benefits? They completed a survey on the research question: Why do farmers choose, or not choose, to adopt controlled tile drainage in the Eastern Ontario? They found that producers are aware of DWM, but don't adopt, and that agronomic benefits are a primary motivation. The uncertainty around agronomic benefits for different crops is a barrier, and producers would adopt in absence of incentives if yield improvements were consistent at significant levels. They also found that drainage contractors, who are a key source of information for producers, are not promoting the technology.

Eileen Kladivko discussed advances being made in cover crop adoption, and the Midwest Cover Crops Council (http:// www.mccc.msu.edu) which has achieved considerable success in the last 7 years. The goal is to facilitate widespread adoption of cover crops across the Midwest, for water and soil quality and economic productivity. She also discussed her research at Purdue including N cycling with oilseed radish cover crop, and using bicultures to reduce loss of sediment and P from oilseed radish cover crops. They are also looking at erosion and P loss in runoff and sediment.

Mohammed Youssef discussed the history of DRAINMOD-related models. The latest development is DRAINMOD –FOREST. Integrated forest ecosystem model. Also DRAINMOD-DSSAT, which provides a major improvement in crop yield.

Jane Frankenberger led a brief discussion of what was learned and items we should follow up on Thursday, and **Tim Harrigan** provided an overview of Wednesday's field trip.

Wednesday morning, April 18 – Phosphorus Mini-Symposium

Jane Frankenberger opened the session with some background on the issue, and how it came to be discussed by this drainage group which usually focuses on nitrogen. Although some people have been raising concerns about phosphorus in tile drains for years, the levels are relatively small compared to nitrogen levels, and most models based on classical soil physics would not predict tile drainage to be an important transport pathway. In December 2011, NRCS asked a group of scientists to present conservation recommendations for decreasing phosphorus loading to the Western Lake Erie Basin and Grand Lake St. Marys. One result was the realization of the potential importance of the tile drainage pathway, but a lack of consensus on how important it was in the watershed and in fact how it worked. Some interests have used this scientific uncertainty as a reason for doing nothing in response to the phosphorus. For examples of this, she presented excerpts from letters attached to the Ohio Agricultural Nutrients and Water Quality from March 2012.

She stated that the goal of this mini-symposium is to reach consensus on the most important mechanisms for phosphorus transport to tile drains, and factors influencing transport. Speakers include Steve Davis, NRCS Watershed Specialist who has worked on this issue for many years and can provide a broad background as well as data collected by Dave Baker of Heidelberg University who was unable to participate due to illness; and four researchers who have done extensive research in the region at the plot, field, and small watershed scales:

- Kevin King, ARS Columbus, Ohio
- Doug Smith, ARS West Lafayette, Indiana
- Chin Tan, Agriculture and Agri-Food Canada
- T.Q. Zhang, Agriculture and Agri-Food Canada

She has asked two researchers with extensive experience in this field, Wayne Skaggs and Larry Geohring, to lead the discussion with their thoughts on key processes, and this will be followed by a discussion of processes, and finally how to move forward to improve science and policy.

Kevin King presented several data sets, including his small watershed study in the Upper Big Walnut Creek watershed, central Ohio. The drainage area is 389 ha; soils are Bennington silt loam (52.9%); Pewamo clay loam (46.2%). Land use is **Agriculture** (88.9%); Woodland (10.4%); Urban (0.4%). Cropping system is corn-soybean rotation; mostly rotational tillage and 78% of watershed drainage area systematically tile drained. He reported the following findings:

- Tile drainage accounts for approximately 46% of the watershed discharge, approximately 41% of the DRP, and 34 % of the TP measured at the watershed outlet.

- At the watershed outlet DRP (0.59 kg/ha/yr) accounts for 64% of the TP (0.92 kg/ha/yr) losses. At the tile outlets, DRP (0.3 kg/ha/yr) accounts for 77% of the TP (0.39 kg/ha/yr) losses.
- Median annual flow weighted DRP concentration at the watershed outlet was 0.127 mg/L compared to 0.132 mg/L for tile. Median annual flow weighted TP concentration at the watershed outlet was 0.187 mg/L compared to 0.175 mg/L for the tile.
- There are bimodal distributions of P concentrations in tile, with peaks in growing season and after harvest.

He has also set up edge-of-field monitoring at 16 sites in the Grand Lake St. Marys watershed, which will provide in-depth information on some fields with very high soil test phosphorus levels.

Doug Smith presented a comparison of surface and subsurface P losses in the St. Joseph River, Watershed, Indiana. He noted that relative to nitrate-N, P concentrations in tile drains are very small. But these small values are sufficient to induce eutrophication in Lake Erie. The amount of loss, 1 lb. P/acre is agronomically insignificant, but 1 lb. /acre is resulting in harmful algal blooms in Lake Erie. They have looked at alternatives to tile risers that minimize loss of productive land, allow farm traffic, require minimal or easy maintenance, are approved for cost share, and effectively drain the landscape, developed a 10x10 foot blind inlet which reduced phosphorus. He presented data on four fields, all of which exceeded the phosphorus loss per acre of the Maumee as a whole. (Total phosphorus from surface runoff plus tiles ranged from 0.5 to 6 lbs. P2O5, while Maumee during the same time was less than 1lb).

Chin Tan emphasized the important role of weather and climate. They have worked on a water balance for the tile drain plots and estimate the following average values in their southern Ontario plots:

- P (100%) =ET (55%) + Surface Runoff (8%) + Tile Drainage (30%) + Change in Water Storage (7%)

He described their wetland/reservoir subirrigation research, which found that for regular free drainage, from 3 to 5 % of the total soil P loss was in surface runoff water, while 95 to 97 % was in sub-surface tile drainage water. For the controlled drainage subirrigation system, from 29 to 35 % of the total soil P loss was in surface runoff water, while 65 to 71 % was in sub-surface tile drainage water. The CDS-reservoir system consistently increased corn and soybean yields relative to DR system, for example in the drought years of 2001 and 2002, corn yield was increased by 91 % and soybean yield was increased by 49 %.

TQ Zhang described phosphorous loss in tile drains from agricultural lands, in comparisons with surface runoff. They found phosphorus export in surface runoff, matrix, macropore and drain flow. Most previous research and nonpoint source control efforts have emphasized P losses by surface erosion and runoff because of the relative immobility of P in soils. P leaching and losses of P via subsurface runoff have rarely been considered important pathways for the movement of agricultural P to surface waters. They consistently find concentrations similar in surface runoff and subsurface drainage, resulting in much higher losses in subsurface drainage because of greater flow. Continuous sod increases soil P loss in tile drainage. He noted that he has looked at published papers over the last 25 years and found 1600 related to P loss, of which < 10% related to subsurface flow, and < 1% compared surface and sub-surface flow.

Steve Davis, Ohio NRCS, presented a fascinating look at "Lake Erie – Our Great Lake". Lake Erie has a $1 billion sport fishery, producing more fish than all other Great Lakes combined. Toxic algae bloom of 2011 was the largest recorded. Major recent studies and reports have provided a great deal of information and some strategies for moving forward:

- Ohio Lake Erie Phosphorus Task Force
- Lake Erie Millennium Network Synthesis Team
- Agricultural Nutrients and Water Quality (March 2012)

When he talks to agricultural groups, they point to lawns, lawn points to municipal waste water and they in turn point to agriculture. The average annual export from Maumee watershed is 1.1 pounds of P per acre as measured by Heidelberg University. "We're not doing a bad job, but there are so many acres that it becomes a large problem". Since 1995, dissolved P has increased, and that has mirrored the algae growth. The timing of the storms seems particularly important. Winter broadcasting of fertilizer, when followed by a rain event, means large runoff. The farther away from application you have the rain event you will have smaller concentrations. P moves in a few major events in a year. 65% of soybeans are grown using no-till, but only 19% of corn.

Discussion of P in tile drainage

Since P in drain tiles was quite unexpected for many people, the discussion began with ***reflections by distinguished researchers.***

Wayne Skaggs pointed out that we all have a different definition of "normal". In North Carolina, less that 0.03 kg/ha was typically found coming from tile drains, with levels at least 10 times higher in surface runoff. But clearly the soils in the Lake Erie watershed are very different, emphasizing different processes. High P losses in tile drains seem to be caused by "surface-like processes" rather than subsurface processes. Water moving through soil cracks and root-holes is not the same as matrix flow. (When you see muddy coming out of tile you've got surface flow.) He also discussed what we know about flow paths when the field is ponded. In that case, most water moves over the surface above the tile (Kirkham equation) and drainage rate greatly increases. He noted that more than half of flow comes from within plus or minus one drain depth (width) from tile. This process would make macropore flow as well. One process-based way to address this would be to bed over tiles, so that surface water never ponds in those areas. This mounding would reduce the short-circuiting directly to tiles. He also noted that in North Carolina, controlled drainage did reduce P loss, because there the drainage includes surface flow, which had more time to sorb to sediment in controlled systems.

Larry Goehring reflected on phosphorus transport mechanisms, and the need to think more about the phosphorus exchange (adsorption and desorption) at the surface. In heavy clay soils with macropores, the drainable porosity is nearly the same as the macropores, and drainage is especially this portion of the flow. He discussed the unstable wetting front which is typical, including in the Michigan state soil. He also showed images available at http://nmsp.cals.cornell.edu/publications/factsheets/factsheet12.pdf and http://nmsp.cals.cornell.edu/publications/factsheets/factsheet13.pdf.

Discussion

We looked in depth at three studies:

- Kevin King: Tile drainage was the flow path for 41% of DRP, 34% of TP in a small watershed.
- Doug Smith: Tile drainage was the flow path for 2-100% of TP in several fields (most 30% to 50%).
- Chin Tan and TQ Zhang: Tile drainage was the flow path for 97% of the phosphorus in small plots.

Are these sites representative? If not, why not? Millions of dollars have been spent to determine these. What else should be monitored?

- Group members felt that it is important to separate true no-till, defined as 3-6 years of no stirring of the soil, from rotational tillage where just soybeans are no-tilled. For clarification, one field monitored by Doug Smith has 20 years continuous no-till. Another is rotational tillage.
- If we are only considering problem in Lake Erie, then yes the sites are sufficient. However, for the entire Midwest, then they are not representative enough. Need more sites with soils that do not contain many macropores (no cracking)
- We should separate morainal soils (which includes much of the Indiana portion of Lake Erie basin) from the lake bed soils which are heavier and include shrink/swell clays.
- Terminology: Need to be careful about calling water from surface inlets "subsurface drainage" – Refer to it as "surface processes" or " Surface Induced subsurface flow"

How can models be improved to include phosphorus transport through macropores to tiles?

Add macropores/preferential flow to models

- Need a better idea of mechanisms that cause P travel through soil
- There are some models that include preferential flow for herbicides, etc. that could be looked at, but are not the same as it would be for P.
- Challenge: shrinking and swelling of soil.
- Challenge: reaction of P with Ca and Fe

Surface processes bring P into the drain, but if the drain is controlled, the P has a chance to go back out through matrix. Modeling this process will be a real challenge

What else should be looked at?

- Can't prevent P from escaping so need to get solutions to prevent P from reaching the lakes---is there a short term step?
- Can't stop the cracking of soils. What has happened to water recycling?
- Clearly state that tile riser is different from pure subsurface. Surface-induced subsurface flow. Other suggestion: Direct entry.

Follow-up from this discussion: Two groups were formed with volunteers and conveners as noted.

- **Modeling**: Initial focus: Proposal to develop macropore/preferential flow components for major models used in planning and assessment. It was noted that some models already have this capability, especially for dealing with pesticides. *Volunteers:* Mohammed Youssef (convener), Xinhua Jia, Sri Ranjan, Hamid Farihani, Kevin King, Doug Smith, Jane Frankenberger.
- **Education:** Initial focus: publication focusing on helping farmers understand how phosphorus gets off the farm. Could have one beyond Lake Erie that covers tile drains and phosphorus. *Volunteers:* Jane Frankenberger (convener), Larry Geohring, Bill Kuenstler, Natalie Rector, Carrie Vollmer-Sanders, Paul Sweeney, Xinhua Jia, Eileen Kladivko, Doug Smith, Steve Davis.

End-of-pipe solutions: No specific volunteers, but this needs to be researched and findings disseminated.

Wednesday afternoon Field Trip

The group traveled to two sites:

- Stop 1: Livestock Reservoir Wetland Sub-irrigation System—Bakerlad's Dairy, Clayton, MI. (Handout: http://www.lenaweeconservationdistrict.org/centerforexcellence/LRWSIS%20report.pdf)
- Stop 2: Two-stage ditch, Hillsdale, MI. **Jon Witter** from Ohio State University presented background information on two-stage ditches and how this one was designed and is performing.

Thursday morning, April 19

NCERA217 Business Meeting

Notes from this business meeting were taken by Tim Harrigan, NCERA-217 Secretary, and will be distributed separately to NCERA-217 members. Chris Hay, South Dakota State University was elected incoming Secretary, and will become Chair in 2013. Tim Harrigan will become Chair after the meeting, and Xinhua Jia is Past-Chair.

Discussion of next meeting (Spring 2013), which will likely be held together with ADMS Task Force as this one was. The date should be the last week in March. Location options suggested include Purdue (could visit bioreactor, two-stage ditch); South Dakota (lots of activity; Chris Hay will be organizing); and North Carolina. Further discussion will take place by email. The meeting minutes is attached.

Presentations

Xinhua Jia described her extensive agricultural water management research in North Dakota. At Fairmount, they are looking at the feasibility of subsurface irrigation. They have collected ET measurements in corn and soybeans, and are completing DRAINMOD simulations. She pointed out that a complicated field makes DRAINMOD very complicated... Salinity is also a concern, with TDS reaching nearly 10,000 mg/L. They also have a SARE (Sustainable Agriculture Research and Extension) project at North Moorhead, MN. She also discussed future Upper Red River Basin projects

Roxanne Johnson presented "Red River Valley Water Quality Assessment: Tile Drainage in Saline Soils". Very little water quality research has been done, so preliminary studies of tile drain outlets and comparable untiled areas. Found high levels of sulfate and nitrate-N (average 30 mg/L). Other parameters were in normal range.

Umesh Adhikari and Tim Harrigan presented their work on Pathogen removal efficiency of constructed wetlands subjected to pulsed pathogen loading. They concluded that pulsed pathogen loaded constructed wetlands can significantly reduce pathogens, but cannot eliminate them. They also found that bacterial removal in constructed wetlands is better than virus removal, subsurface flow wetlands were superior to surface flow wetlands in both bacteria and bacteriophage removal, and that pathogen removal performance of constructed wetlands in summer is similar to or better than in winter

Kyle Brooks and **Jane Frankenberger** discussed the new Krohne electromagnetic flow meters recently installed, which can capture forwards or backwards flow which can be an issue in very flat areas with poor outlets. The meters seem to be capturing a wide range of tile flows well. Kyle discussed the meter installation, and programs he wrote to process the data automatically.

Siddharth "Sid" Verma discussed innovative bioreactors that include steel turnings to remove phosphorus. Found that it was very effective, as long as steel turnings were after the woodchips. If the steel turnings were first, followed by the woodchips, some of the P removed by the steel turnings was replaced by flow through the woodchips. Future research required to see how long they would last, and if the steel turnings would start to release P at some point. This presentation elicited lively discussion, since the need to reduce phosphorus from drain tiles is clear. The work is preliminary so far. He also presented the temporal variability of loads, showing that the top 5 events produce most of the phosphorus loads.

Discussion – Next Steps

Doug Toews, who will be retiring June 1, looked back on what the ADMS Task Force has accomplished in its ten years of existence. He noted that we are considered superstars in terms of what can go right in a Partnership Management Team group. It has been useful to make sure that research fits the needs of the implementers, and the NRCS Ag Water Management Team that Paul Sweeney is leading will continue to interact closely with the Task Force. There will be another national water management engineer in the future, and in the meantime, ***Paul Sweeney*** will be the primary NRCS contact for ADMS. For future directions, he suggested going beyond water management structures, and taking up the concept of integrated water management. Reusing water wherever possible, like the livestock system we saw yesterday, will be important. A role for this group might be to look more broadly at integrated water management, including rainfed agriculture, to optimize the use of our water resources in agriculture. He is moving to the central coast of California, where the state is requiring irrigators to have zero discharge which should lead to many interesting challenges.

What issues should we address next?

What work is going on related to **manure**? Phosphorus discussion relates to this.

- Discovery Farms starting in ND. Two sites have livestock, third site is tile drainage site.

- Integrated water management and livestock wetland reservoir systems yesterday. Tim Harrigan has additional work on wetland treatment. Also integrating manure with cover crops.
- Water recycling is a huge issue in Manitoba. Moratorium on expansion of livestock systems.
- Pat Dumoulin reminded the group to keep in mind that manure varies between species. United Soybean Board - National Board and Illinois -have designated livestock as a number one priority. Good source for funding.
- Can we integrate treatment with management in the field to make a good thing better?

Idea of **soil health** has exploded. Need to go from anecdotal information to research measurements. There are many farmers that have excellent practices. This group aimed at drainage. Don't want to convert to soil health people. Can we work with people who work on that?

- Work on systems for monitoring (in Canada) might provide more tools for lower-cost research.
- Systems monitored are too short so far. Need 10 years. Tan/Zhang have some long-term data on cover crops.
- What impact does soil health have on infiltration and runoff? Need to measure total water balance to make sure we get at that. (Tan/Zhang setup is good for this.)

Future meetings:

It was decided to hold an ADMS meeting in the Fall, then hold the spring 2013 meeting in conjunction with the NCERA217 meeting like this year. Possible locations for the Fall 2012 meeting:

- Arkansas, because of all the drainage work. Possibly Memphis (convenient location) or Little Rock (NRCS National Water Management Center)
- Iowa. Could visit saturated buffers and bioreactors.

- At future meetings, presenters should provide handouts of their presentation, or maybe post on web site when possible.

Additional Thoughts and Future Activities

- Research should meet the needs of the implementers.
- We have interactions with other groups focusing on other interests like cover crops.
- Also should interact with SERA17, focusing on phosphorus. Mostly soils people are there, and it would be helpful to have hydrologists.
- Suggestion: If someone is going to or is a part of another group, could have a liaison. Bring back a report. Find out key scientists, bring them into our meetings.
- How about forming international task team by integrating ecosystem approach? We could identify field sites representing typical areas.
- International benefits of this project. We share the soil, we share the water.

Additional State and Station Reports
The following state and station reports were submitted after the annual meeting.

Iowa: submitted by Matt Helmers

Research and extension efforts at Iowa State University relative to drainage design and management practices to improve water quality continue to center on nutrient export from tile drainage systems and nutrient management practices to minimize this export of nutrients, specifically nitrate-nitrogen. Work is also continuing that is evaluating drainage water management and cropping practice impacts on drainage volume and drainage water quality. New work is specifically examining impacts of various biomass production systems including continuous corn with stover removal and a diverse restored native prairie system. Water quality and water quantity are being monitoring from seven drainage water quality research sites.

Work continued examining impacts of perennial based biomass production either restored native prairie or monoculture switchgrass on subsurface drainage water quality. Results indicate dramatic reductions in nitrate concentrations and losses in drainage water with the perennial based systems. This was even the case when nitrogen fertilizer was applied to the perennial based systems. This work is important for assessing environmental impacts/benefits of perennial based biomass production strategies.

Work has continued examining the potential for subsurface drainage bioreactors as treatment systems for nitrate from drainage water. This work is specifically examining field-scale performance. Initial results indicate a mean nitrate-nitrogen removal of 43% but the range for individual sites was 12-75%. Work also examined retention in bioreactors through tracer tests. Overall, this work has been used in designing numerous bioreactors within Iowa.

Work during 2011 examined the farm-scale economics of seven nitrate reduction practices and specifically examined which practices provide lowest cost per unit of nitrate removal. Overall, modification of nitrogen rate and timing were most cost effective, and wetlands, bioreactors, and controlled drainage were all similar from a cost-effective standpoint. The least cost effective were in-field vegetative practices including cover crops and crop rotations. Publications are in-review relative to these topics.

Work continued in 2011 and 2012 examining the impacts of manure (poultry and liquid swine) on drainage water quality. This work is continuing to examine nutrient loss but has been expanded to include bacteria and antibiotic resistant bacteria assessments.

Extension work has focused on disseminating information relative to drainage water quality and economic design of drainage systems. This has included statewide, regional, and local programming events. In collaboration with colleagues at the University of Minnesota and South Dakota State University, the IA-MN-SD Drainage Research Forum was held in November 2011 and was attended by approximately 100 stakeholders. In August 2011, an Iowa Drainage School was held near Nashua, IA that focused on hands-on design of drainage systems. Approximately 45 individuals participated in this event.

*Impacts:*The research work on nitrate concentration as a result of cover crops, living mulch, perennial cover, and timing and rate of nitrogen application is being used by the Statewide Nutrient Strategy Technical Team

within the State of Iowa. This strategy will be important for developing a course of action for Iowa to meet the Hypoxia reduction goals.

An outcome from the IA-MN-SD Drainage Research Forum is that we are providing research-based information on drainage water quality to stakeholders including state agency personnel in Iowa and the Midwest with a goal of improving the knowledge of drainage water quality issues and practices that can be used to minimize drainage water quality impacts. Feedback from the IA-MN-SD Drainage Research Forum continues to indicate attendees valued the research based presentations, the cooperation of Iowa State University, University of Minnesota, and South Dakota State University on drainage issues, and the mix of basic and applied studies that were presented at the meeting.

With Greg Brenneman and Kapil Arora the 5th Iowa Drainage School was organized. Participants rate this program as good to excellent and nearly all participants indicate that the program will help them design more effective drainage systems that will improve their bottom line.

The work on subsurface drainage bioreactors has been used in designing numerous bioreactors within Iowa. Overall, the work on bioreactors by many in the state of Iowa including ISU, USDA-ARS, local watershed groups, and the Iowa Soybean Association has dramatically increased the producer level interest in this practice.

Iowa: ARS National Laboratory for Agriculture and the Environment. Submitted by Dan Jaynes.

Fall-Planted Cover Crops. **Accomplishment.** Much of the NO_3 in the riverine waters of the upper Mississippi River basin in the United States originates from agricultural land used for corn (Zea mays L.) and soybean (Glycine max [L.] Merr.) production. Cover crops grown between maturity and planting of these crops are one approach for reducing losses of NO_3. In this experiment, we evaluated the effectiveness of oat (Avena sativa L.) and rye (Secale cereale L.) cover crops in reducing NO_3 concentrations and loads in subsurface drainage water. The oat fall cover crop was broadcast seeded into living corn and soybean crops before harvest in late August or early September and was killed by cold temperatures in late November or early December The rye winter cover crop, which had already been used annually for four years, was planted with a grain drill after corn and soybean harvest, overwintered, grew again in the spring, and was killed with herbicides before main crop planting. These treatments were evaluated in subsurface-drained field plots with an automated system for measuring drainage flow and collecting proportional samples for analysis of NO_3 concentrations from each plot.

Outcome. The rye winter cover crop significantly reduced drainage water NO_3 concentrations by 48% over five years, but this was less than the 58% reduction observed in its first four years of use. The oat fall cover crop reduced NO_3 concentrations by 26% or about half of the reduction of the rye cover crop. Neither cover crop significantly reduced cumulative drainage nor nitrate loads because of variability in cumulative annual drainage among plots. Both oat and rye cover crops are viable management options for significantly reducing NO_3 losses to surface waters from agricultural drainage systems used for corn and soybean production. **Impact.** This research has quantified the potential water quality benefits from using fall-planted rye and oat cover crops in Iowa for keeping nitrate out of tile water.

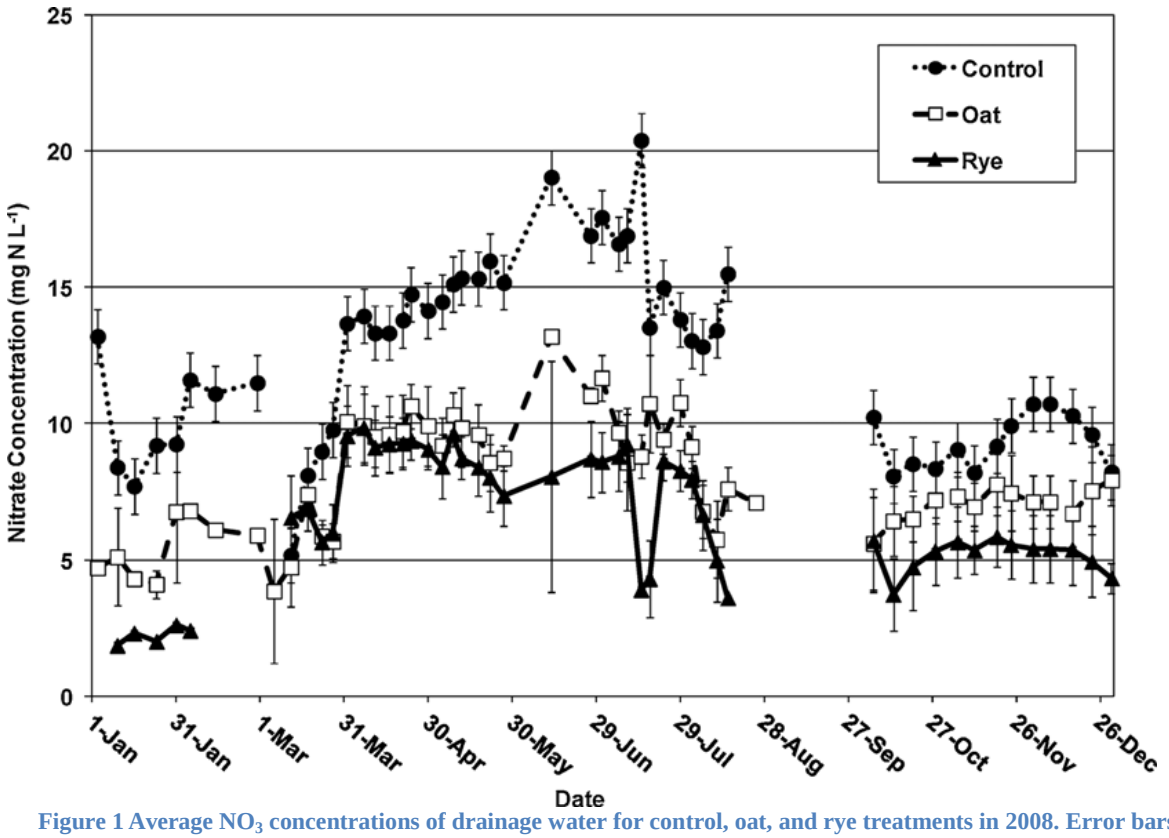

Figure 1 Average NO_3 concentrations of drainage water for control, oat, and rye treatments in 2008. Error bars are standard errors of the means (n = 4)..

Saturating Riparian Buffers. **Accomplishment.** In this project we are investigating the efficacy of reconnecting tile drainage to shallow ground water flow through riparian buffers for removing nitrate. By diverting a fraction of the tile discharge through a distributary tile installed along the top of the buffer, we are diverting a fraction of the tile water into shallow ground water flow through the buffer. Within the shallow ground water, both denitrification and sequestration processes known to be active in buffers will remove nitrate before it can enter the adjacent stream. We have connected a diverter box to an existing field tile that exits through a riparian buffer before emptying into Bear Creek. The diverter box is used to divert a fraction of the tile discharge into the distributary tile installed along the field side of the buffer. The diverted water flows as shallow groundwater to the stream and the nitrate contained within the water is subjected to denitrification and plant uptake and sequestration in the buffer.

Outcome. We are measuring the water volume and nitrate concentration diverted into the buffer and following the fate of the nitrate through four transects of wells as it moves to the stream. Tile flow diverted into the buffer rather than flowing into the stream has been measured since fall of 2010. The diversion of flow for 2011 is shown in Figure 2 where flows from the field into the diverter box and distributory tile and out of the diverter box to the stream are shown. The cumulative nitrate load diverted into the buffer is also shown and amounts to almost 250 kg-N for 2011. During this year, the buffer was able to absorb about 50 gallons per minute of the tile drainage leaving the field. Thus, overall the system appears to be functioning as hypothesized in the proposal for this research. It will be critical to see how much of the tile flow the buffer can

absorb during subsequent years. It will also be critical to determine if the nitrate entering the buffer continues to be removed before flowing to the stream in the shallow groundwater. Currently, none of the nitrate being diverted into the buffer appears to be reaching the stream. Continued monitoring will determine if this continues over time. **Impact.** This research has quantified the potential nitrate removal capacity and water quality benefits from reconnecting a portion of field tile flow to riparian buffers.

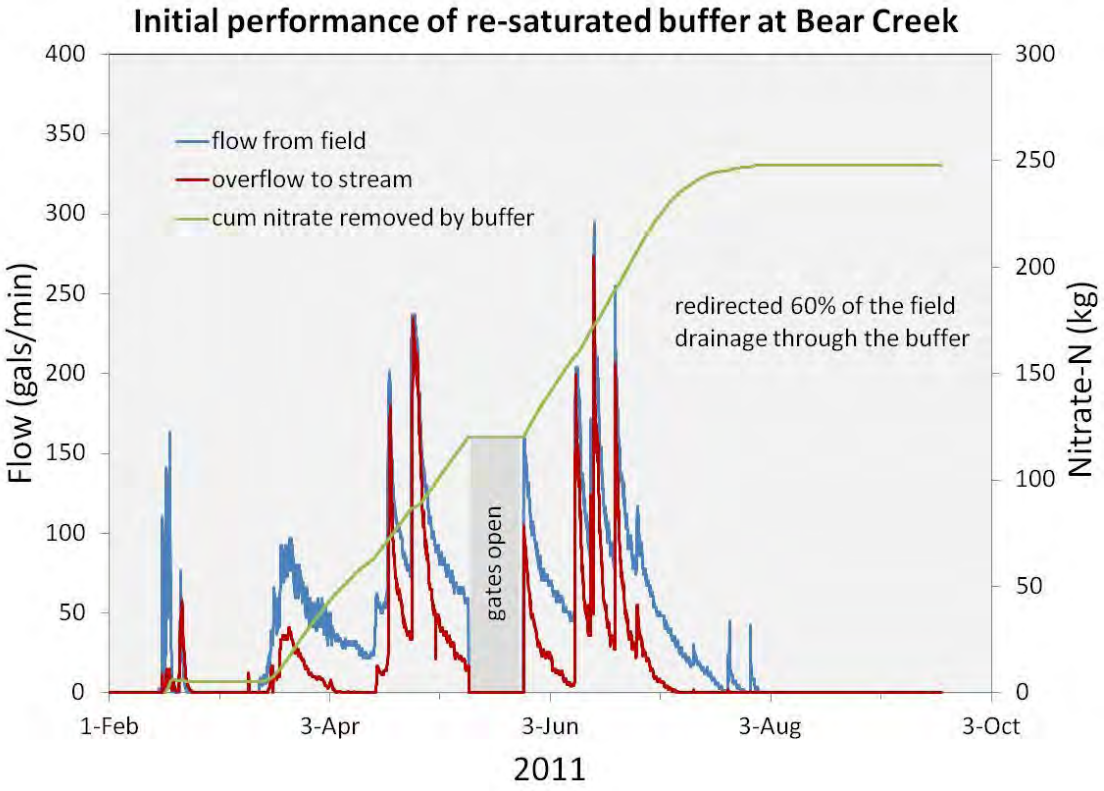

Figure 2. Flow and nitrate diversion for first year for saturating Bear Creek riparian buffer.

Michigan: submitted by Tim Harrigan

Work is in progress to evaluate the pathogen removal efficiency of constructed wetlands subjected to pulsed loading. Many livestock operations land apply liquid manure to cropland to recycle nutrients and as a soil amendment. Microbial contaminants in manure can move through the soil to the tile drains through preferential pathways. Typically, tile drains receive a pulse of manure contaminants if rainfall occurs soon after a manure application. In our work, tub-scale constructed wetlands which consisted of a combination of surface flow (SF) and subsurface flow (SSF) wetlands were spiked with bacterial (*E. coli)* and viral (bacteriophage P22) indicators during cold and warm weather to evaluate small-scale wetlands as a practical method for remediation of tile drain effluent following manure land application. Indicator organism concentrations in both SF and SSF wetlands were enumerated using culture-based methods. Results showed that constructed wetlands reduced pulse pathogen concentration in the wetland effluent. Seasonal variation in pathogen reduction efficiencies was observed. SSF wetlands were more effective than SF wetlands in both bacterial and viral reduction. Bacterial reduction efficiencies in both SF and SSF wetlands were higher than viral reduction efficiencies. Bacteria were reduced by SF wetlands

at a similar rate in both winter and summer, but bacteria reduction in SSF wetlands was greater in summer than in winter. Viral reduction in both SF and SSF wetlands was higher in summer than in winter.

Impact: Four presentations were made to professional and educator groups. The results of this work has increased their awareness and understanding of the potential for microbiological pollution of drainage effluent following manure land application on artificially drained cropland, and the opportunities and limitations for small-scale wetlands for remediation of contaminated drainage water.

Missouri: submitted by Kelly Nelson

Field research was initiated on claypan and silty clay soils to evaluate the impacts of managed drainage systems for crop and livestock production from 2009 to 2012 and is ongoing. Corn and soybean research has evaluated integrated water management systems from 2001 until present. The impact of corn hybrid selection (2008-2010) and soybean cultivar selection (2007-2008) on crop yields using integrated water management systems was evaluated.

Research evaluated corn (*Zea mays* L.) hybrids (Asgrow785, DKC61-73, DKC63-42, LG2642, and Kruger2114) and water management systems [non-drained, non-irrigated (NDNI); drained, non-irrigated (DNI) with subsurface drain tiles 6.1 and 12.2 m apart; drained plus subirrigated (DSI) with tiles 6.1 and 12.2 m apart; and non-drained, overhead irrigated (NDOHI)] on yields, plant population, and grain quality from 2008 to 2010. Precipitation during this study was 36 to 283 mm above the past decade. Planting date was delayed 18 d in the non-drained control in 2009 and additional delayed planting controls were included this year. Grain yields were similar in the 6.1- and 12.2 m-spaced DNI and DSI systems in 2008 and 2010, but plant population increased 74% and yields were 3.1 Mg ha^{-1} greater with DSI at a 6.1 m spacing compared to 12.2 m in 2009. At a 6.1 m spacing, DNI or DSI increased yield 1.1 to 6.6 Mg ha^{-1} (10 to over 50%) compared to NDNI or NDOHI soil. High yielding hybrids achieved similar yields with DNI, while NDNI DKC63-42 had 1.2 Mg ha^{-1} greater yields compared to DKC61-73. A 6.1 m spacing for DNI claypan soils is recommended for high yielding corn production.

Management of soybean [*Glycine max* (L.) Merr] on claypan soils with drainage (DO) or drainage plus subirrigation (DSI) may depend on correct cultivar selection. Field research in 2007 and 2008 evaluated effect of cultivar (Kruger 382, Morsoy 3636, Asgrow 3602, Pioneer 93M96 and NKS37-N4) and DO or DSI at 20- and 40-ft drain tile spacings on soybean response. Kruger 382 yield increased 7 bu/acre with DSI on a 20-ft spacing compared to DO, but yields were similar between DO and DSI systems for other cultivars. Using DSI and DO, Kruger 382, Morsoy 3636, and Asgrow 3602 increased yields 15 to 46% (7 to 17 bu/acre) compared to the non-drained control. However, Pioneer 93M96 or NKS37-N4 yields were not affected by DO or DSI. Oil concentration of Morsoy 3636 and Asgrow 3602 decreased up to 0.3 percentage points with DO at a 20-ft spacing, but drainage had no effect on oil concentration of Kruger 382, Pioneer 93M96, or NKS37-N4. It was important to match high yielding cultivars with appropriate drainage water management systems.

The Missouri Drainage Workshop was held in February, 2012 with 50 people attending. Contractors were trained on drainage and managed drainage design.

New York: submitted by Larry Geohring

Accomplishment – *Laboratory study relating phosphorus loss from manure and soil macropore size:* Leaching experiments were completed using twenty-four soil columns packed and set up in duplicate with three different sized macropore configurations (i.e., no or matrix flow only, and 1 and 3 mm diameter macropores) and four different phosphorus (P) applications (i.e., none, inorganic P_2O_5, and liquid manure containing either 3.5 or 7 percent solids). Although there was substantial variability in experimental results and few statistical differences of note, this study suggests that the 2 mm diameter macropore threshold may be applicable to P transport through the subsoil. Substantially higher concentrations and loads of soluble reactive P (SRP) were transported through the columns with 3 mm diameter macropores compared to columns with no or 1 mm diameter macropores for both the P_2O_5 and liquid manure at 3.5% solids content treatments. The bulk of the SRP loss occurred most quickly in the effluent breakthrough in the 3 mm diameter macropore columns with the 3.5% solids liquid manure application. The SRP loss from the application of liquid manure containing 7% solids was not statistically different than that with no P application for any of the macropore sizes, which we speculate was the result of macropore sealing from the higher solids content of the manure.

Impact – These results indicate P transport to subsurface drains is most likely to occur in soils containing substantial macroporosity greater than 1 mm in diameter, and where liquid manure with a low solid content or inorganic fertilizers are surface applied. Consequently, producers are being encouraged to take management precautions to disturb (i.e., pre-till or incorporate) P nutrient applications on soils vulnerable to macropore or preferential flow, and to avoid making these applications at least a day or two before a forecasted significant rainfall event.

Accomplishment – *controlled drainage demonstrations and investigations on cooperator farms:* Controlled drainage was demonstrated on two EQIP cooperator private farms where liquid manure is applied to tile drained fields. Monitoring of the sites was done to determine if the controlled versus freely draining drains can reduce nutrient losses, particularly following the time that liquid manure is applied. Preliminary data suggests that P concentration spikes and loads can be reduced somewhat with controlled drainage, especially when a large rain event occurs after a period of soil drying. Data collection and analysis are on-going.

Impact - Outreach efforts in New York consisted of a field day and via extending information on controlled drainage at the annual Northeast Certified Crop Advisors Conference and during training sessions for certified nutrient management planners. Presentations were also made during the CIG Showcase session of the 2011 annual Soil and Water Conservation Society meeting in Washington, DC; and also at the 2011 annual meeting of the American Society of Agricultural and Biological Engineers meeting in Louisville, KY. These outreach activities resulted in greater awareness of the potential water quality impacts of tile drain discharges, so producers and nutrient management planners are now paying more attention to identifying vulnerable tile outlets and adjusting their manure application methods. Drainage contractors, farmers, farm advisors, and soil and water professionals are beginning to learn of the potential water quality benefits of implementing controlled drainage. About 175 people attended the various meetings and training sessions.

South Dakota: submitted by Christopher H. Hay

In response to dramatic increases in drainage activity in South Dakota, research is beginning in South Dakota on the water quality and hydrologic impacts of increased drainage adoption and to evaluate appropriate drainage intensities for the region. Work is beginning to evaluate the use of bioreactors for reducing nitrate losses from drained fields, while other projects are in their infancy.

Extension activities were focused on educating producers and the public on drainage and the impacts of drainage on hydrology and water quality. These activities have included a number of local and regional presentations and events. A series of five drainage design workshops were held in the region in collaboration with University of Minnesota and North Dakota State University Extension. These workshops were targeted at producers, contractors, and others interested in drainage design. The workshops served a total of approximately 250 attendees. A survey was conducted at these workshops to gather information on producer interest in conservation drainage practices in order to develop a more detailed survey to target a larger sample. A Drainage Research Forum was held in Okoboji, IA in November 2011 in collaboration with Iowa State University and University of Minnesota Extension to provide updates on current drainage research activities to approximately 70 attendees representing academia, government agencies, agricultural organizations, and agricultural producers. Other presentations included talks to state legislators, county officials, commodity groups, and NRCS personnel and presentations at farm shows and Extension agronomy meetings and workshops. In response to a need for drain spacing recommendations for South Dakota soils, an online drain spacing calculator was developed and is available for use.

Impact: Participants in the drainage design workshops rated the programs as very useful or useful. Participants indicated that they gained knowledge on drainage system layout, drainage calculations, and drainage design considerations. They also indicated that this knowledge would give them more confidence in designing drainage systems and help them avoid mistakes.

Publications, presentations and related outputs

Adhikari, U., D.M. Reinhold and Timothy Harrigan. 2012. 12th Annual American Ecological Engineering Society Meeting “Nutrient Recovery and Pathogen Reduction in Duckweed Based Constructed Wetlands.” Syracuse, New York. (June 7-9, 2012).

Adhikari, U., T.M. Harrigan, D.M. Reinhold and A. Johnson. 2011. ASABE Annual International Meeting, "Seasonal Variation in Pathogen Removal Efficiency of Treatment Wetlands Subjected to Pulse Loading." Louisville, Kentucky. (August 7-10,2011).

Adhikari, U., T.M. Harrigan, D.M. Reinhold and A.A. Waldhorn. 2012. NCERA217: Drainage Design and Management Practices to Improve Water Quality “Pathogen Removal Efficiency of Constructed Wetlands Subjected to Pulsed Pathogen Loading.” Dundee, Michigan. (April 17-19, 2012).

Adhikari, U., T.M. Harrigan, D.M. Reinhold, A.A. Waldhorn and J.Li. 2011. 8th International Phytotechnology Conference, "Nutrient Recovery and Pathogen Reduction in Duckweed Based Constructed Wetlands." Portland, Orgeon. (September 13-16, 2011).

Christianson, L. and M.J. Helmers. 2011. Woodchip bioreactors for nitrate in agricultural drainage. Iowa State University Extension Publication. PMR 1008. Available at: https://store.extension.iastate.edu/ItemDetail.aspx?ProductID=13691

Christianson, L.*, A. Bhandari, and M.J. Helmers. 2011. Potential Design Methodology for Agricultural Drainage Denitrification Bioreactors. World Environmental and Water Resources Congress (EWRI). Palm Springs, California. 22-26 May 2011.

Christianson, L.*, N. Hoover, A. Bhandari, and M.J. Helmers. 2011. The Potential of Municipal Yard Waste to be Denitrification Bioreactor Fill. American Society of Agricultural and Biological Engineers (ASABE) 2011 Annual International Meeting. Louisville, Kentucky. 7-10 August 2011. Paper No. 1111036.

Christianson, L., A. Bhandari, and M.J. Helmers. In review. A practice-oriented review of woodchip bioreactors for agricultural drainage. Submitted March 2012 to *Applied Engineering in Agriculture.*

Christianson, L., A. Bhandari, M.J. Helmers, K. Kult, T. Sutphin, and R. Wolf. In review. Performance evaluation of four field-scale agricultural drainage denitrification bioreactors in Iowa. Submitted February 2012 to *Trans. ASABE*.

Christianson, L., J. Tyndall, and M.J. Helmers. In review. Financial comparison of seven nitrate reduction strategies for Midwestern agricultural drainage. Submitted April 2012 to *Journal of Soil and Water Conservation.*

Christianson, L., M.J. Helmers, and A. Bhandari. In review. Internal hydraulics diagnosis of a poorly performing agricultural drainage bioreactor. Submitted April 2012 to *Ecological Engineering*.

Davidson, E.A., David, M.B., Galloway, J.N., Goodale, C.L., Haeuber, R., Harrison, J.A., Howarth, R.W., Jaynes, D.B., Lowrance, R.R., Nolan, B.T., Peel, J.L., Pinder, R.W., Porter, E., Snyder, C.S., Townsend, A.R., and Ward, M.H. 2012. Excess nitrogen in the U.S. environment: Trends, risks, and solutions. Issues in Ecology #15. Ecological Society of America, Washington, D.C.

Hay, C., and T.P. Trooien. 2012. Managing high water tables and saline seeps in wheat production. *In* Clay, D.E., C.G. Carlson, and K. Dalsted (eds). iGrow Wheat: Best Management Practices for Wheat Production. South Dakota State University, SDSU Extension, Brookings, SD.

Helmers, M.J., R. Christianson, G. Brenneman, D. Lockett, and C. Pederson. Water table, drainage, and yield response to drainage water management in southeast Iowa. Submitted October 2011 to *Journal of*

Helmers, M.J., X. Xhou, J.L. Baker, S.W. Melvin, and D.W. Lemke. 2012. Nitrogen loss on tile-drained Mollisols as affected by nitrogen application rate under continuous corn and corn-soybean rotation systems. *Canadian Journal of Soil Science* 92: 493-499.

Kaspar, T.C., D.B. Jaynes, T.B. Parkin, T.b. Moorman, and J.W. Singer. 2012. Effectiveness of oat and rye cover crops in reducing nitrate losses in drainage water.: Agricultural Water Management. Online pub.DOI: 10.1016/j.agwat.2012.03.010.

Lawlor, P.A., M.J. Helmers, J.L. Baker, S.W. Melvin, and D.W. Lemke. 2011. Comparison of liquid swine manure and ammonia nitrogen application timing on subsurface drainage water quality in Iowa. *Trans. ASABE* 54(3): 973-981.

Liebman, M., M.J. Helmers, and L. Schulte Moore. 2011. Integrating conservation with biofuel feedstock production. In: M. Schnepf (ed.), *Managing Agricultural Landscapes for Environmental Quality II*. Soil and Water Conservation Society of America, Ankeny, IA.

Malone, R.W., D.W. Meek, L., Ma, L., D.B. Jaynes, B.T. Nolan, and D.L. Karlen. 2011. Quality assurance of weather data for agricultural system model input. *In:* Ahuja, L.R., Ma, L.,(ed.). Methods of Introducing System Models into Agricultural Research. Madison, WI. American Society of Agronomy, Crop Science of America and Soil Science Society of America. p. 283-296.

Nash, P., K. Nelson, and P. Motavalli. 2011. Utilization of Polymer-Coated Urea Fertilizer and Managed Subsurface Drainage Systems to Improve Crop Production and Reduce Environmental Impact on Water Quality. Greenley Center Field Day Report pp. 50-53.

Nelson, K., and C. Meinhardt. 2011. Drainage Water Management and Headline Fungicide Effect on Soybean Yield. Greenley Center Field Day Report pp. 32-33.

Nelson, K., and R. Smoot. 2011. MU Drainage and Subirrigation (MUDS) Research Update. Greenley Center Field Day Report pp. 13-26.

Nelson, K., C. Meinhardt, and R. Smoot. 2011. Yield Response of Soybean Cultivars to Subsurface Drainage and Subirrigation in Northeast Missouri. Greenley Center Field Day Report pp. 30-31.

Nelson, K., C. Meinhardt, and R. Smoot. 2011. Soybean Yield Response to Drainage and Subirrigation of a Claypan Soil in Northeast Missouri. Greenley Center Field Day Report pp. 27-29.

Nelson, K., R. Udawatta, P. Nash, and P. Motavalli. 2011. Managed Drainage for Improved Water Quality. Greenley Center Field Day Report pp. 4-12.

Nelson, K.A., and R.L. Smoot. 2012. Corn hybrid response to water management practices on claypan soil. Online. Int. J. Agron. doi:10.1155/2012/925408. pp. 10

Nelson, K.A., Meinhardt, C. G., and Smoot, R. L. 2012. Soybean cultivar response to subsurface drainage and subirrigation in Northeast Missouri. Online. Crop Management doi:10.1094/CM-2012-0320-03-RS. pp. 9.

Qi, Z., L. Ma, M.J. Helmers, L.R. Ahuja, and R.W. Malone. 2012. Simulating nitrate-nitrogen concentration from a subsurface drainage system in response to nitrogen application rates using RZWQM2. *Journal of Environmental Quality* 41: 289-295. [Short Communication]

Qi, Z., M. J. Helmers, R. Malone, and K. Thorp. 2011. Simulating long-term impacts of winter rye cover crop on hydrologic cycling and nitrogen dynamics for a corn-soybean crop system. *Trans. ASABE* 54(5): 1575-1588.

Qi, Z., M.J. Helmers, R.D. Christianson, and C.H. Pederson. 2011. Nitrate-nitrogen losses through subsurface drainage under various agricultural land covers. *Journal of Environmental Quality* 40: 1578-1585.

Royem, A. Alisa. 2012. Fate and transport of agricultural nutrients in macro-porous soils. M.S. Thesis. Cornell University, Ithaca, NY. 47pp.

Schilling, K., P. Jindal, N. Basu, and M.J. Helmers. 2011. Impact of artificial subsurface drainage on groundwater travel times and baseflow discharge in an agricultural watershed, Iowa (USA). *Hydrological Processes* DOI: 10.1002/hyp.8337.

Singer, J.W., Malone, R.W., Jaynes, D.B., Ma, L. 2011. Cover crop effects on nitrogen load in tile drainage from Walnut Creek, Iowa, using Root Zone Wter Quality Model (RZWQM). Agricultural Water Management. 98(10):1622-1628.

Soil and Water Conservation.

Zhou, X., M.J. Helmers, Z. Qi. Field scale modeling of subsurface tile drainage using MIKE SHE. Submitted December 2011 to *Applied Engineering in Agriculture.*

NCERA 217 Annual Business Meeting Minutes

April 19th, 2012

Cabela's, Dundee, MI

1. The meeting was called to order at 8:10 a.m. by Chair Dr. Xinjua Jia
2. The minutes of the 2011 meeting were read and approved.
3. Election of NCERA 217 Secretary for 2012-2013
    a. Dr. Chris Hay from S. Dakota State University was nominated by Dr. Eileen Kladivko and seconded by Paul Sweeny. The nomination was accepted by Dr. Hay. Dr. Mohammed Youssef was not in attendance but had informed the committee that he would be willing to serve as Secretary if no one else was able to accept the nomination.
    b. Dr. Kladivko called for vote for the election of Dr. Hay and he was elected by unanimous consent of the committee members in attendance.
    c. Dr. Tim Harrigan from Michigan State University will Chair the 2013 meeting with Dr. Hay serving as Secretary and Dr. Xinjua Jia as past Chair.
4. The location for the 2013 meeting was discussed. A suggestion was made by Dr. Kladivko to hold the next meeting in the last week of March to accommodate the need of many researchers to engage in field work in April. Potential sites mentioned were Purdue University, South Dakota State University and N.C. State University. Other sites may be available but many committee members were not in attendance so Dr. Jia offered to poll the full committee by email. We will postpone the decision until we see the results of that poll and will elect a local committee at that time.
5. Dr. Jia conveyed remarks from committee advisor Dr. Kanwar acknowledging the good work of the committee. Dr. Jia noted that the annual committee report for 2012 was due within 60 days of the annual meeting and requested all state reports be submitted by June 20, 2012.
6. Mary Ann Rozum conveyed a message that USDA funding is anticipated to be short in the next years and we should look for funding partners to carry on committee work. USDA anticipates a 5% cut in 2013 and a 19% cut in 2014.
7. ASABE SW-23 is revising the EP-479 engineering standard.
8. The NIFA Partnership Award was discussed; NCERA 217 has been very active and very successful and may be a good candidate for the award. Nominations are required from a Dean or the committee advisor. If we are nominated much of the reporting work has been completed as part of the 5-yr and mid-term reports. Dr. Jia acknowleged the leadership of Dr. Goehring in preparing those reports. Nomination due by June 30.
9. Other business: Pat Dumoulin encouraged members to seek funding for drainage related work from the state and national soybean and corn boards. Kelly Nelson conveyed a message from Dan Jaynes regarding the ASA/CSSA/SSSA meeting in Cincinnati in October. Many presentations given at this meeting would be appropriate.
10. The business meeting concluded at 8:30 am and we began the scheduled Thursday a.m. research reports.

Minutes submitted by Tim Harrigan, April 26, 2012.

AGENDA -- Joint meeting of the
Agricultural Drainage Management Systems Task Force and
North Central Extension and Research Activity 217
(Drainage Design and Management Practices to Improve Water Quality)
Dundee, MI, April 17-19

Tuesday, April 17

Xinhua Jia, Chair of NCERA 217, Moderator

Time	Topic	Speaker(s)
Pre 1 pm	*Registration (Tim Harrigan). Speakers load presentation*	
1 pm	***Welcome***. Overview and goals of meeting, and of ADMS Task Force and NCERA-217; Introductions of all participants	Xinhua Jia; Tim Harrigan; Jane Frankenberger;
1:30	NRCS Ag Water Management Team and related NRCS activities	Paul Sweeney, Doug Toews; Andrew Pursifull
2:00	ARS, Soil Drainage Research Unit station report	Norm Fausey
2:15	Missouri report	Kelly Nelson
2:30	South Dakota State Report	Chris Hay
2:45	**Break**	
3:15	Update on controlled drainage research in NY	Larry Goehring
3:30	Hespler Controlled Drainage Subirrigation Project	R. Sri Ranjan
3:45	Manitoba Drainage Water Management Activities	Bruce Shewfelt
3:55	Watershed Evaluation of Beneficial Management Practices	Mark Sunohara
4:10	New cover crop research in Indiana	Eileen Kladivko
4:25	North Carolina report	Mohammed Youssef
4:40	Discussion – Summarize key points, and identify items for follow-up Thursday morning	All
4:50	*Prepare for tomorrow*	Tim Harrigan
5 pm	Adjourn	

Wednesday, April 18

Morning: Phosphorus in Tile Drainage Mini-Symposium (Jane Frankenberger, Moderator)
Afternoon: Field Trip (Tim Harrigan, Organizer)

Time	Topic	Speaker(s)
8:15	Phosphorus Mini-Symposium: Introduction and goals	Jane Frankenberger
8:30	Significance of Tile Drainage as a Conduit for Phosphorus Transport: an UBWC watershed case study	Kevin King
8:50	A comparison of surface and sub-surface phosphorus losses in the St. Joseph River watershed.	Doug Smith
9:10	Effect of water management on phosphorus transport through surface and sub-surface drainage in corn and soybean rotation	Chin Tan
9:40	Lake Erie: A national treasure threatened by harmful algal blooms. Phosphorus impacts and control efforts.	Steve Davis
10:00	**Break**	
10:30	Comparisons of soil phosphorus loss in tile drainage with surface runoff	Q.T. Zhang

10:50	Short reflections on phosphorus transport mechanisms	Distinguished researchers
11:10	Group discussion – can we reach consensus on most important mechanisms for phosphorus transport to tile drains, and factors influencing transport?	All
noon	Adjourn – Lunch and prepare for field trip	
1 pm	**Board bus for field trip** Stop 1: Livestock Reservoir Wetland Sub-irrigation System—Bakerlad's Dairy, Clayton, MI Stop 2: Two-stage ditch, Hillsdale, MI	Tim Harrigan

Thursday, April 19

Time	Topic	Speaker(s)
8:00	NCERA 217 business meeting – Elect officers, plan next year; review of objectives and annual report requirements	Xinhua Jia
8:30	Wetland research	Tim Harrigan
8:45	North Dakota station report	Xinhua Jia
9:00	North Dakota station report - 2	Roxanne Johnson
9:30	Monitoring tile drains: New electromagnetic sensors	Jane Frankenberger& Kyle Brooks
9:45	Break	
10:00	Synergism in nitrate and phosphate removal in bioreactors and Temporal patterns of nitrate and phosphate export from tile drained watersheds in the Lake Erie basin	Siddhartha Verma
10:15	Moving agricultural drainage management forward: Key research, education, and action steps	Discussion by all
Noon	Adjourn. Safe travels.	

ADMS and NCERA-217 Meeting Participants - April 17-19, 2012		
Name	**Email address**	**Organization**
Phil Algreen	algreen@agridrain.com	Agri Drain Corp
Charlie Schafer	charlie@agridrain.com	Agri Drain Corp.
Chin Tan	chin.tan@agr.gc.ca	Agriculture & Agri-Food Canada
Evan Derdall	evan.derdall@agr.gc.ca	Agriculture & Agri-Food Canada
Bruce Shewfelt	bruce.shewfelt@agr.gc.ca	Agriculture and Agri Food Canada - Agri Environment Services Branch
Mark Sunohara	mark.sunohara@agr.gc.ca	Agriculture and Agri-Food Canada
T.Q. Zhang	Tiequan.zhang@agr.gc.ca	Agriculture and Agri-Food Canada
Patrick Handyside	patrick.handyside@agr.gc.ca	Agriculture and Agri-Food Canada
Larry Geohring	ldg5@cornell.edu	Cornell University
Nathan Utt	nathan@ecosystemservicesexchange.com	Ecosystem Services Exchange
Tom Davenport	Davenport.Thomas@epamail.epa.gov	EPA Region 5
Pat Dumoulin	dumoulin@fvi.net	IL Soybean Association
John Torbert	jtorbertidda@mchsi.com	Iowa Drainage District Association
Tim Harrigan	harriga1@anr.msu.edu	Michigan State University
Natalie Rector	rector@msu.edu	MSU Extension
Masoud Parsinejad	masoudp@msu.edu	MSU, Institute of Water Resources
Mohammed Youssef	mayousse@ncsu.edu	North Carolina State University
Wayne Skaggs	wayne_skaggs@ncsu.edu	North Carolina State University
Xinhua Jia	xinhua.jia@ndsu.edu	North Dakota State University
Jane Frankenberger	frankenb@purdue.edu	Purdue University
Eileen Kladivko	kladivko@purdue.edu	Purdue University
Kyle Brooks	kabrooks@purdue.edu	Purdue University
Chris Hay	christopher.hay@sdstate.edu	South Dakota State University
Carrie Vollmer-Sanders	csanders@tnc.org	The Nature Conservancy
Siddhartha Verma	verma6@illinois.edu	University of Illinois
R. Sri Ranjan	ranjan@cc.umanitoba.ca	University of Manitoba
Kelly Nelson	NelsonKe@missouri.edu	University of Missouri
Kevin King	kevin.king@ars.usda.gov	USDA-ARS
Douglas Smith	douglas.r.smith@ars.usda.gov	USDA-ARS
Norm Fausey	norm.fausey@ars.usda.gov	USDA-ARS, Soil Drainage Research Unit
Paul Sweeney	Paul.sweeney@wdc.usda.com	USDA - NRCS
Tony Bailey	tony.bailey@in.usda.gov	USDA - NRCS
Andrew Pursifull	andrew.pursifull@in.usda.gov	USDA - NRCS
Jerry Walker	jerry.walker@ftw.usda.gov	USDA/NRCS
Anna Bramblett	anna.bramblett@ar.usda.gov	USDA/NRCS
Hamid Farahani	hamid.farahani@gnb.usda.gov	USDA-NRCS
Bill Kuenstler	bill.kuenstler@ftw.usda.gov	USDA-NRCS
Pat Willey	pat.willey@por.usda.gov	USDA-NRCS
Douglas Toews	doug.toews@wdc.usda.gov	USDA-NRCS
Stephen Davis (Mich.)	steve.davis@mi.usda.gov	USDA-NRCS
Steve Davis (Ohio)	steve.davis@oh.usda.gov	USDA-NRCS