Agricultural Drainage Management Systems Task Force

April 2-4, 2008 – Purdue University

Wednesday, April 2

A morning field trip was held jointly with the research committee NCERA-207, called "Geomorphology and Land Use Discovery Using GIS and Tablet PCs", organized by Eileen Kladivko and led by Phillip Owens, Darrell Schulze, and Zamir Libohova. The group visited one of the drainage water management demonstration sites near Reynolds that is part of the Conservation Innovation Grant.

The meeting began at 1:15 pm with a welcome from Sonny Ramaswamy, Associate Dean, Purdue College of Agriculture, and Mike Cox, Indiana State Engineer, NRCS. Mike described Indiana's activities with drainage water management, and said that NRCS is interested in bundling of practices to improve environmental benefits.

Mike Sullivan gave an update of NRCS at the national level, including many recent personnel changes. The Farm Bill is still in progress.

Katie Flahive, EPA Office of Water updated the group on EPA-related activities including the Farm, Ranch, and Rural Communities Advisory Committee and the modeling effort being coordinated by the Corps of Engineer. She said that EPA would like to sponsor a future meeting of the ADMS Task Force. Tom Davenport, EPA Region 5, told the group about his plans to try to encourage the agency to promote drainage management, which generated some discussion.

Jim Fouss gave an update from ARS. He explained the Dr. Mark Walbridge, NPL, could not make it to the meeting due to some recent personnel changes at ARS-NPS, Beltsville. Mark wanted to be here, but with Dr. Asrar leaving a sabbatical leave from his ARS-NPS position, Mark has been selected to serve as the Acting Deputy Administrator for Natural Resources and Sustainable Agricultural Systems research until about mid-May 2008. The DA position will be refilled by ARS when a suitable candidate is recruited and employed.

Charlie Schafer and Leonard Binstock updated the group on ADMC activities. They find that there is more interest in conservation than ever before, and a sense of urgency. Every day drainage systems are being installed that are designed not to be managed, making our work more urgent than ever. We need to look to the future rather than to the past.

Implementation Strategies for Drainage Water Management

1. Illinois NRCS

Don Pitts, Illinois NRCS, told the group about several changes to the 554 conservation practice standard for Illinois.

- Changed wording regarding "water table". Replaced by "outlet elevation".
- Removed description and criteria for installation of the water level control structure, and put it into CPS 587 Structure for Water Control.

- Defined control elevation. Defined as the elevation of the surface at the lowest point of the field impacted by the practice.
- Requested a new purpose of "Interception of drainage water following liquid manure application" (Made the request to the national level. States can't just add a purpose)
- Noted a problem in the definition, because it combines surface and subsurface drainage.
- Required 20 feet of solid pipe plus anti-seep collar, or 20 additional feet of solid pipe. Does not matter where solid pipe is installed as long as it is connected to the water level control structure.

He also shared information about drainage water management plans developed through the EQIP Ground and Surface Water Conservation Project (GSWC)

- 75% cost share on installation of drainage water management structures, but there has to be a plan.
- $30/acre to do a plan. Who can develop? NRCS field office staff, private sector TSP, drainage contractor
- Required certain soil groups. (Drainage "groups" based on drainage class and permeability. If permeability too low, not drained.)
- Additional ranking was 10 extra points for tile map (should have asked for map at the beginning).
- Extra points for flatter slope.

Thirty-five contracts for DWM plans were awarded. Don Pitts and Richard Cooke held training sessions August 2007 and Feb 2008 for contractors on how to develop a drainage water management plan. Preliminary results were 51 planned sub units. Estimated cost for implementation ranged from $32/acre (75 acres controlled with one structure) to $260/acre. The average estimated cost of implementation was $105/acre (Based on installation cost of price of structure x 2). He suggested that where the cost is less than $100/acre they should implement. He noted the following lessons learned:

- Require a tile map.
- Contract to cover only drained area. Not impacted area because the impacted area is not known before-hand.
- Slope (to achieve a economically reasonable plan, average slope should not be greater than 0.5%)

He also noted that the rule changed since last year, and they can no longer pay for planning. (Except CNMP) In Illinois, 20 to 30 contractors have been trained to do drainage water management plans.

He suggested that an important next step is to teach contractors to **design drainage systems with drainage water management in mind.** This would require that laterals be aligned with contour, as opposed to typical systems designed and installed today, in which laterals are perpendicular to contour. But there is generally an additional cost for this design. So, an effort should be initiated to consider public cost-share on this cost differential.

In Illinois there is an estimated 2 to 3 million acres of patterned tile systems that were designed and installed with laterals running down slope. Don Pitts presented a method of retrofitting DWM to these systems by installing collector sub-headers coupled with a hydraulic break. He showed an example of this approach. The cost per impacted acre for the example was comparable to the cost per impacted acre in the approach now used to retrofit DWM, which is only to install water level control structures on existing mains. The advantage to the "collector header" retrofit method was that nearly the entire field would be impacted rather than the typical 1/3 of the field.

He suggested that the obstacle will be to convince NRCS to cost share on the tile for the collect headers and in some cases additional new main. NRCS currently cost shares on tile where there is a clear conservation benefit (e.g. terraces and water ways).

2. ***AgriDrain implementation plans***

Charlie Schafer and Dan Towery commented that there is often a 20-year cycle for other practices to go from concept to widespread use. Reducing nitrate is not a practice that's going to get too many farmers inspired. Enhancing yield during the good years would be much more persuasive. Drainage designs that Don Pitts showed are very new concepts. What we're talking about is changing the paradigm.

Discussion of implementation questions

The group discussed the following questions

1. Should manure management be added to purpose for practice 554? (This would need to be done at the national level.)
    - Norm Fausey stated that Ohio already has about 300 structures implemented for this purpose, and he feels it is appropriate.
    - A question was raised about whether it should be in the nutrient management instead, but it was felt the appropriate place would be the 554 standard.
    - Need more info for design specifications for such a purpose (how long would outlet be raised, etc.).
    - Also need to discuss conditions under which it can be applied (soil type, weather, etc)
    - Although it is known that liquid manure can reach tile lines through preferential flow, this has not been documented in every state.
    - A suggestion was made that the ADMS Task Force state that "*Manure application to drained land should be avoided if possible*" because of the potential contamination due to preferential flow. Lively discussion followed.
    - Action item: ***A committee should look into the effectiveness of drainage water management for reducing impacts of liquid manure application. Contact Bill Boyd, also Michigan people who have dealt with the question.***

2. How do we insure that installed systems are managed to be effective?
    - In Illinois it is clear in the NRCS contract. Don Pitts checked enough that the other people were aware that it was regulated
    - Automatic structures would also address this.

3. What can we do to facilitate new systems being designed and installed *with drainage water management in mind*?
    - Barriers such as the following need to be addressed
        - Farmer are not landowners
        - Changes won't happen until the return is clear to the farmers
        - Average cost is ~$450/acre, drainage water management ready ~$550/acre – additional 20% cost
        - More connections in the drainage water management ready system
    - CSP might provide annual payment (Don says $10/acre/year would be enough)
    - GPS control would make it easier to install
    - Use arguments of uniform - mains on steeper grades can be smaller, also laterals on contours intercept water
    - TSP money to support design of systems with drainage management in mind
    - Need tools (software) that allow contractors to go through several iterations when designing.
    - Quantify monetary value of nutrient reduction

Thursday

Phil Algreen gave an overview of the measurements being done around the region. After initial problems with power for the magnetic flow sensors, monitoring system are working better. Diana Starr has prepared a draft manual on the system. Please contact her if you wish to receive it. Changes to the interface such as making daily and yearly rainfall data available have recently been made. An alarm can be sent to be notified when something happens such as voltage being below a certain value. More sites are being installed, including one in India by Richard Cooke. Configuration is a little different for other countries (outside the U.S.), but it is working well. They have also installed a structure in California with turbidity measurements.

State Updates

- **Ohio:** Norm Fausey showed a map of 9 sites where drainage water management has been implemented around the state. They have made a v-notch weir to measure flow. Since flow is often above the top, the weir needs to be calibrated above the top of the v-notch. They will soon have Lidar coverage for all nine sites. Some farmers are getting EQIP funds for managing their structures.
- **Minnesota**: Craig Schrader presented an update of Minnesota sites.
- **Illinois**: Steve Baker showed several designs of systems.
- **Indiana**: Jane Frankenberger and Nathan Utt described the four Indiana CIG sites and current progress.
- **Louisiana**: Jim Fouss described water management systems being evaluated in Louisiana, including a new project that will involve drainage water management on cropland to produce energy-cane for bio-fuels. The new research is to focus on the development of sustainable production practices for energy-cane biomass while

protecting the soil and water resources from degradation (soil erosion) and pollution (water quality impairment).

- **North Carolina**: Wayne Skaggs reviewed the fact that over 400,000 acres of drainage water management were implemented in the 1980s. But many are no longer being managed as intended. In some cases there have been changes in farm owners or management, and many have not continued the management. The emphasis on management also changed when toxic algae were no longer such a concern. A new CIG project will seek to revitalize the management of the systems, through three activities:
    - Put in a demonstration project to show farmers how it should be managed (open ditch conventional, open ditch controlled, open ditch shallow drainage with a focus on surface drainage within the field (laser leveling, etc.)
    - Another demonstration project(?)
    - An online advisory system using modeling tools to alert farmers as to when they should be making management changes and using DRAINMOD to alert when there is an unusually wet spell so weirs should be adjusted.

Leonard Binstock reminded all CIG producers to work with producers to make sure that hybrids are consistent, and do not require part of field to be a refuge. He also encouraged everyone to look at the ADMC web site, which they developed with help from CTIC. They are looking for articles and photos. They will soon have an animation of drainage water management. He was asked to send an email to the listserver about changes to web site that people should look at.

Yield data analysis to determine the impact of drainage water management *(Presentations and discussion)*

Jess Lowenberg-DeBoer, Purdue Agricultural Economist, explained why spatial statistics are needed to determine yield impacts, and explained the method used at the Indiana sites. He emphasized that if classical statistics are used rather than spatial statistics, you'll get the wrong answer.

Tracy Blackmer, Iowa Soybean Association, emphasized that the most important thing was to agree on what the question is. Therefore, we discussed possible questions that the spatial yield analysis can answer

Discussion: Critical questions to be answered in drainage water management studies:

1. What is the yield impact (compared to free drainage) of drainage water management by elevation above structure?
    - Note: Elevation of structure or control? Berm may be higher than low point
    - Question in the CIG project has been articulated as yield within each 6-inch contour of the structure elevation.
2. What is the bulk or average (whole field) impact?
    - Is there an effect? How big?
    - How often?
    - What economic impact?
    - What percent of field is impacted? What is yield impact in the impacted area?

    - Note: “Whole field” is not a spatial unit, so need to define what is meant.
3. What is the variability within the field?

Some felt that only the whole field impact (#2) can be assessed at many of the sites. It would be helpful to define **best practices for yield data collection**, and what data people need to collect in order to have sufficient information to answer yield questions. Elements of these might be the following:

- Need raw yield data (.yld). Farmers need instructions for output.
- Need good topography data
- Need to know where tiles are
- Good calibration of yield monitor
- Consistency during harvest
    - Same operator
    - Same combine
    - Harvest entire field at same time
    - Reinforce to farmers the importance of uniformity (harvesting, seed variety, tillage, etc)
    - Regular contact with farmer
    - Share instructions with farmer (Also great idea to ride along with farmer if possible)
- Crop scouting and/or aerial imagery for each field, to understand any anomalies.
- Find out dates of field operations.
- Measure water table (preferably in more than one point.)
- Endrows, which are often eliminated in whole field analyses, may be the most impacted part of field if near the structure. A good design would include making sure the field is planted so that the endrows are not near the structure. (The same direction will be used for all other field operations)
- Good to have yield maps prior to installation of drainage water management, so you can see yield patterns before the change. (Q: How many years? A: Ideally, going back to 1992 when yield monitors were commercialized, but in reality whatever you have is helpful.)

Knowing the effect by elevation affects design, but may not be needed to answer the question of how effective the practice is. Size of field is a concern. 5 acres is small, because data in the first 100 feet of combine operation is not reliable.

We agreed to ***develop a list of best practices for yield data collection*** in order to make it possible to answer question #1 in the future.
Also example fields and example layouts would be helpful in advising people.

--*Thursday afternoon*----------

Nitrate Reduction - *Linking drainage management with other practices*

Otto Doering, Purdue Agricultural Economics, described several recent efforts related to nitrate in the Gulf of Mexico in which he has participated including:

- National Academies study on the Mississippi River and the Clean Water Act (http://dels.nas.edu/dels/rpt_briefs/miss_river_cwa_final.pdf). The committee found that EPA has not exercised its coordinating role.
- The EPA Farm, Ranch, and Rural Communities Federal Advisory Committee (http://www.epa.gov/oecaagct/frrcc/index.html). This is a "cosmic exercise" that will have interesting results in a year or so.
- EPA Science Advisory Board (http://yosemite.epa.gov/sab/sabpeople.nsf/WebCommitteesSubcommittees/Integrated%20Nitrogen%20Committee) They are considering pesticide registration, and also the consideration of CO2 production by biofuels plants.

He then discussed the current Farm Bill process in Washington and his always-interesting perspectives. Questions followed.

Linking practices

Barry Fisher, Indiana State Agronomist, NRCS, discussed NRCS vision for bundling practices to achieve conservation goals. He described "Total drainage system management" as a concept we could be seeking.

Nitrate fertilizer rate recommendations

Jim Camberato, Purdue Agronomy Department, presented the new approach to nitrogen rate recommendations that several states in the Midwest are cooperating on. It is based on the concept of Economic Optimum N Rate (EONR). As states complete their rate studies, the amounts are available at http://extension.agron.iastate.edu/soilfertility/nrate.aspx. So far results in the web-based calculator are for Minnesota, Illinois, Iowa, and Wisconsin.

Sylvie Brouder, Purdue Agronomy Department, said that good N management is unlikely to change significantly when drainage water management is implemented. If we were returning water to the crop system (through storage and irrigation of stored water), we could assume N is available to the crop. But since we are not, it is unlikely to be available to the crop at the right time to be used. However, this is not based on field research, but theoretical based on what we know about N availability.

Cover crops and perennials

Eileen Kladivko introduced the Midwest Cover Crops Council. It was formed in 2005 at the Madison meeting of the Great Lakes Regional Water Program, and has three meetings since then. (She noted that some of the strategies were learned from the ADMS Task Force.) Goal is to facilitate adoption of cover crops by 30% of farmers by 2020. "Continuous living cover" is the concept—to always have something growing to take up nutrients and water. The effort is now headquartered at Kellogg Biological Station in Michigan, with a part-time staff person. She noted that cover crops may introduce risk, but also may decrease risk and potentially introduce economic benefits in certain systems as well as improving water quality, soil quality, pest management, and wildlife.

Combining cover crops with drainage systems introduces potential issues. Cover crops reduce nitrate leaching to tiles, if there is sufficient growth. Perennial crops may also reduce water flow. However, many cover crops do not grow well where drainage is

inadequate, so drainage water management with winter control may not mesh well with cover crops. Therefore, she raised the following questions:

- Can we modify drainage water management management (outlet elevation setting) to help cover crops at key times?
- Where should drainage water management, cover crops, and other practices be placed in the landscape? Should there be different approaches for different landscape positions? Which practice would have largest impact in different parts of watershed?
- How do we develop ***systems*** for field or farm?
- How should we link efforts from different groups, to look at systems? i.e., researchers in fert.N, cover crops, drainage water management

Discussion of the potential to combine cover crops with drainage water management:

- Cover crops need moisture, but not excessive, to get established. Can we modify drainage water management to help cover crops at key times (level and timing)?
- Q: How deep are roots? A: They were found to be at up to 20 inches.
- Q: Would it be a problem if the water table limited root depth? A: You wouldn't get the soil quality benefits, although it is unknown if you would get all of the water quality benefits. Annual ryegrass is more forgiving of wet feet than others.
- Water table does not come up to where you set the boards. It takes time.
- It would be best to bring it up progressively, just as you could do for lowering in the spring after planting.
- Plants become dormant between mid-November to mid-December. Could bring water table up after that time.
- Are there other plants that would be more tolerant of water table? Annual ryegrass is more tolerant. Cereal rye is a little more tolerant than other small grains.

Discussion of how different practices could be used differently in the landscape

- Are there guidelines for what practice to put where? Flattest wettest ground better for drainage water management, and is definitely not the best place to start for cover crops. Where there is a little more slope, better for including cover crops.
- Cover crops might also address surface runoff concerns associated with drainage water management.
- Cover crops will convert nitrogen to organic forms, rather than nitrogen gases.

Action Item: Eileen Kladivko and Bill Kuenstler have been involved in both efforts, and are asked to help us think of ways to benefit from both efforts.

Diversion through wetlands

Jim Fouss discussed diversion of small stream flow carrying drainage water from agricultural cropland through wetlands, and potential integration with drainage water management. He uses the term "integrated" and appreciated that Barry Fisher used "bundling", which is excellent although it doesn't convey modifying either one to work better together, which may often be required (this is a researchable topic). He then suggested that perhaps we need to come up with a new term to replace "integrated" which is somewhat an overused word and has lost some of its attention getting ability.

Discussion of potential to combine practices

1. Because it is not possible to test all combinations, modeling could be very helpful. However, no model does all these practices**. *We should talk with modelers about implementing cover crops with improved crop growth models that could look at impacts of excess water.*** (DRAINMOD would need the addition of cover crops; RZWQM needs the impact of excess moisture stress.)
2. ***Field testing in Ohio:*** Norm Fausey will plant cover crops on some of the water management plots.
3. Jim Fouss indicated that cover crops, including perennial cover crops, will be evaluated for energy-cane production (for biofuels) in Louisiana studies.
4. We need to keep up the idea of "***total drainage system management***".

The day ended with a **video honoring Norm Fausey as Scientist of the Year for ARS**. The video is available online at http://www.ars.usda.gov/is/video/vnr/soty2007.htm?pf=1.

Friday

Future meetings

Note: It has already been decided that NCERA-207 Research Committee will meet in Columbus Ohio, March 31-April 3. Therefore the ADMS Task Force **Spring 2009** meeting will be in Columbus Ohio, joint with the research group:

Fall 2008 meeting: EPA offered to sponsor the next meeting. We decided that Chicago would be the best location, in September 2008.
Labor Day week, after Monday, would be OK. **Avoid** the following dates:

- Nonpoint source monitoring conference in Ohio Sept 14-18
- Last week is too close to Agronomy meetings
- Iowa workshop

After the meeting the option was discussed for combining, or "piggy-backing", the Fall ADMS-TF meeting with the Non-Point Source Conference in Columbus, OH; this option is being explored with EPA who has offered to host/sponsor the Fall ADMS Task Force meeting. Watch the ADMS-TF web site for announcements regarding this future meeting.

Topics that could be discussed at Fall meeting

- Katie Flahive suggested several topics for a mini-symposium.
- How to get drainage practices to qualify for 319 funding. Ask Tom Davenport to speak. If EPA is sponsoring, other EPA speakers could participate as well.
- Discuss what needs to be done to promote retrofitting systems (drainage water management, bioreactors, or other choices)
- Discuss what needs to be done to promote designing new drainage systems with drainage water management in mind
- Modification of buffers – Doug Toews could discuss.
- Greenhouse gas emissions, and relation to drainage systems and modifications

- As EPA folks may be attending, could help educate them about drainage practices
- New systems and technologies. (Meeting should keep us up on new technologies.)
    - Ron Schlatter, Darrell Birge, and others including Mike Cook (MI contractor) could talk on technologies using GPS for drainage design and installation.
    - Drainage design software
    - Bioreactors, etc.
- Follow up on Otto Doering's talk: EPA response to National Academies Report on the Mississippi River and the Clean Water Act.
- Get CIG team together after

It was suggested that the draft agenda be distributed out earlier so people can comment and better prepare. It would be a good idea to send out a rough meeting agenda with the meeting notes.

General strategies for the ADMS Task Force (between meetings)

- Plan for transition to 1 meeting/year schedule (see bullet below)
- Consider the use of a Web Cast Meeting for 2nd TF meeting each year
- Discuss other small group meetings to "piggy back" on for meetings
- Develop committees that meet and discuss. Could focus on the "to-do" list.
- NRCS 606 – Revision could include a consideration for water quality an "drainage water management in mind". This will be done before Fall meeting. Pat Willey will keep us informed.
- Drainage design software. Could we contact software firms to develop an option for systems with drainage water management in mind? Contractors are using GPS and would like to see software in which they could enter elevation data to help design the system, including the placement of structures not in the way of the farmer's field operations. Jim Fouss will talk with his contact (e.g., Mike Cook, drainage contractor in MI). Discuss additional ways.

SPARROW model:

Dan Jaynes presented an overview of the SPARROW model, and the new study on sources of nutrients in the Mississippi basin. (See http://water.usgs.gov/nawqa/sparrow/). SPARROW is primarily an allocation model, determining how much of the load comes from what source. The new study allocates more of the load to states like Missouri, and less to Minnesota. The highest nitrogen flux was predicted to come from Illinois, Iowa, and Indiana.

Weaknesses include the following: No seasonal results. Doesn't include best management practices. Forces allocation to a limited number of inputs. Uses global (entire US) fitting of coefficients. Doesn't distinguish surface from subsurface drainage. No soil N mineralization or storage. Uses older water quality data, and particularly older agricultural input data sets. The drainage data is the 1978 agricultural census data.

Drainage data sets

The use of older drainage data in the SPARROW study points out the need for better drainage data. Last information from a census is 1978, which was conducted by asking SCS staff rather than farmers.

Other drainage information comes from the 1992 NRI, and the recent/ongoing detailed survey done at each NRI point for the CEAP program.

The question needs to be carefully developed to get good results. The census values were going up and down with each census, which may be due to the fact that people have different definitions of whether fields are drained, and also that people are asked questions about their entire farm, rather than specific fields.

CEAP Survey: Does this field have subsurface drainage? (It points to a single field)
Could ask what percentage of your farm is drained. Find out 1978 question.
Other interesting information:

- What percent is random-drained? What percent is pattern-drained?
- What percent clay/plastic/concrete? (gets at date of installation)

Next Agricultural Census will be 2012. ***Dan Jaynes will follow up with NASS to find out the best strategy for getting a drainage question into the 2012 Ag Census***. What level should the request come from? Would multiple agencies help? Would non-governmental organizations help?

Effluent application into Subsurface Tiles

We had a brief discussion of the encouragement by at least one company of the application of manure effluent by subirrigation in shallow tiles, such as that described in the last section of http://farmindustrynews.com/farm-equipment/agrem-developed-underground-irrigation-0301/. The concern by several nutrient specialists is that nutrients applied in the subsurface will not be taken up by plants, and will eventually leach to groundwater. Although the tiles are shallow, unless a second set of tiles installed at 3 to 4 feet were in the same field to intercept leaching, there is a good chance that the nitrate would move to groundwater. Steve Baker will call the scientist at Illinois State University who is investigating this, to find out more information.

Interacting with other groups

Jim Fouss suggested that we could learn from the Midwest Cover Crops Council about bringing in many other groups. He will explore some ideas and report back.

The meeting adjourned at 10:40.

Notes compiled by Jane Frankenberger, Purdue University

Participants (sorted by agency/organization)

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