"Adoption and Cost Effectiveness of Practices for Water Quality Protection"

Heartland Regional Water Resources Webcast
September 1, 2009

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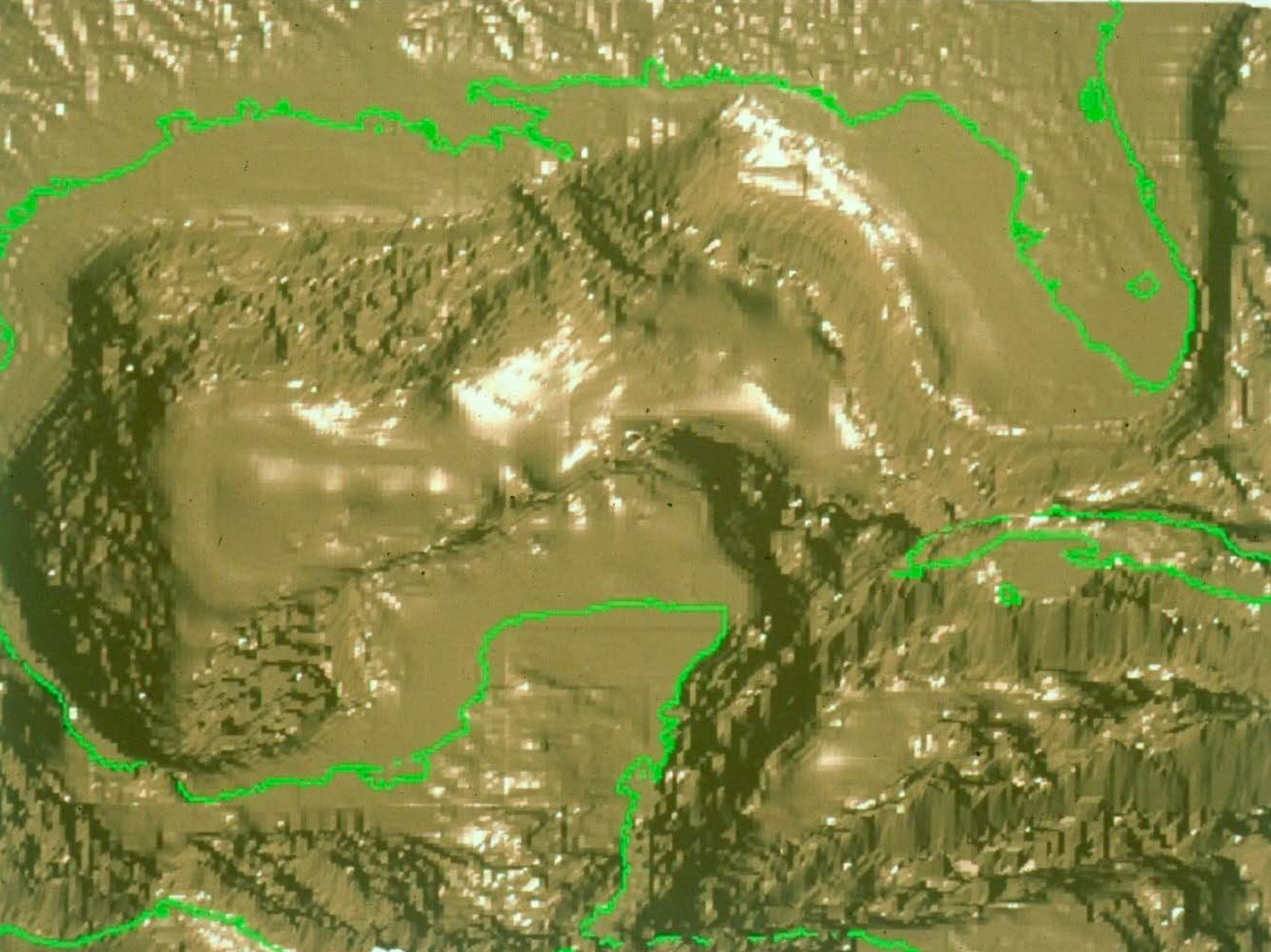
Department of Agricultural and Biosystems Engineering

“Case Study – Iowa’s Cedar River Watershed”

Practices Needed to Reduce Nutrient Loss:

- Nitrate/Nitrogen issues
  - Gulf of Mexico hypoxia area reduction
  - TMDL for drinking water impairment (Cedar River watershed/city of Cedar Rapids)
- Phosphorus issues
  - Gulf of Mexico hypoxia area reduction
  - Pending criteria for local flowing and standing waters



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Des Moines Sunday Register

SUNDAY
March 2, 2003

Experts praise Vilsack's goal to clean up Iowa's lakes and rivers, but warn it's probably unattainable

POLLUTED WATERS

IOWA CAUCUSES

Saddam Hussein

Dean's anti-war stance targets rivals

But the Democratic candidates aren't that far apart on the Iraq

Nutrient loss reduction goals

- Hypoxia area/Gulf of Mexico
  - Reduce N losses 45%
  - Reduce P losses 45%
- TMDL nitrate/Cedar Rapids
  - Maximum concentration 9.5 mg/L
  - Reduce losses 35%
  - Reduce losses 10,000 tons/year (equals 5.5 lb N/acre/year)
  - Load allocation: 92% nonpoint source; 8% point source

FINAL REPORT:

Gulf Hypoxia and Local Water Quality Concerns Workshop

September 26-28, 2005 **Ames, Iowa**

Organized by the UMRSHNC
(Upper Mississippi River Sub-basin Hypoxia Nutrient Committee)

Sponsored by Iowa State University,
the United StatesDepartment of Agriculture (USDA),
and the U.S. Environmental Protection Agency (EPA)

Upper Mississippi River Sub-basin Workshop

- Illinois, Iowa, Minnesota, Missouri, and Wisconsin; plus Indiana and Ohio

- 15 science panels comprised of 75 nutrient/water quality researchers

ISU Agron.-Ag. Eng. Research Center

(8 miles west of Ames)

Cedar River Watershed

- 3,650,000 acres within Iowa above city of Cedar Rapids
- Nitrate losses (2001 – 2004 period)
  - 28,561 tons/year
  - 15.6 lb/acre/year
- 73% row-crop (2,400,000 acres corn/beans; 150,000 acres continuous corn)
- About 2/3 of the row-crop land has tile drainage
- Annual precipitation: about 34 inches
- Stream flow (2001 - 2004 period)
  - Total 8 inches
  - “Base flow” about 65% of total

Potential N Management Practices

- In-field
  - N rate
  - N timing
  - Cover crops
  - Water management

- Off-site
  - Constructed wetlands

Nitrogen Rate

- N rate
  - Starting point critical
  - NASS fertilizer data for 2005 for four northeast Iowa sub-regions is 124 lb N/acre/year on corn
  - IDALS state-wide fertilizer sales data for 2001 – 2005 averaged 137 lb N/acre/year on corn
  - Manure applications (?)
- ISU recommendations
  - For corn following soybeans: 100 – 150 lb N/acre
  - For continuous corn: 150 – 200 lb N/acre

Based on Iowa yield and water quality data; corn at $4.00/bu and N at $0.40/lb

	Corn soybeans	Continuous corn
assumed initial rate (lb N/ac)	150	200
nitrate loss	20.8 lb/ac/yr	24.2 lb/ac/yr
loss reduction with **50 lb/ac** N rate reduction (33 &25%)	25%	20%
nitrate-N loss reduction	10.5 lb/ac* * over two-year rotation	4.8 lb/ac
corn yield reduction	5.3 bu/ac	5.7 bu/ac
cost of N loss reduction	$0.10/lb	$0.57/lb

Based on Iowa yield and water quality data; corn at $4.00/bu and N at $0.40/lb

	Corn soybeans	Continuous corn
assumed initial rate (lb N/ac)	150	200
nitrate loss	20.8 lb/ac/yr	24.2 lb/ac/yr
loss reduction with **100 lb/ac** N rate reduction (67 & 50%)	39%	36%
nitrate-N loss reduction	16.3 lb/ac* *over two-year rotation	8.8 lb/ac
corn yield reduction	20.8 bu/ac	19.7 bu/ac
cost of N loss reduction	$2.66/lb	$4.40/lb

Nitrogen Timing

- Nitrate leaching losses 0-15% less for spring- vs. fall-applied.
- In Iowa, 25 to 33% of N fertilizer applied in fall (mostly ammonia)
- Additional infrastructure needed if all applied in spring might add 5 cents/lb N
- Would equate to about $6.00/lb N saved
- More data needed on side-dressing/split applications

Cover Crops

- Fall cover crops
  - Fall-planted rye or ryegrass can reduce nitrate leaching loss by 50% (USDA Tilth lab data)
- Costs
  - Incentive costs for rye: $30/acre (seed, planting, dealing with the living plants in the spring, possible corn yield reduction)
- For corn-soybeans
  - Rye loss reduction: $3.00/lb N

Water Management

- Drainage water management
  – Modeling predicts a ~50% nitrate loss reduction with installation of drainage water management (USDA Tilth Lab)
- Applicable to about 6.7% of the row crops
- Costs
  – Installation: $1000/structure (for 12 acres on average; 20 year life; 4% interest)
  – Operation: $10/acre/year
- Nitrate reduction costs of $1.56/lb

Constructed Wetlands

- Remove nitrate through denitrification (little long-term effect on P transport)
- In Iowa, 0.5 to 2% wetland area expected to remove average of 50% nitrate input
- Establishment costs of about $250/ac of “treated field” (Iowa CREP program data)
- Assuming 50-yr life and 4% interest, this would be about $1.45/lb N removed

One example scenario to reduce nitrate losses 35% (9,200 tons/non-point source allocation) while retaining row-crop production

Practice	% reduction	Acres* treated	Tons reduced	Cost per lb	Total cost/yr
150 to 100 N rate - CB	25% or 5.2 lb/ac/yr	all or 1.6 M ac	4,160	$0.10	$0.83 M
200 to 150 N rate - CC	20% or 4.8 lb/ac/yr	all or 0.10 M ac	240	$0.57	$0.27 M
Avoid fall application	15% or 2.5 lb/ac/yr	all or 300,000 ac	375	$6.00	$4.50 M
Rye cover crops	50% or 8 lb/ac/yr	10% or 170,000 ac	680	$3.00	$4.08 M
Water mgt.	50% or 8 lb/ac/yr	10% or 167,000 ac	670	$1.56	$2.09 M
Construct. wetlands	50% or 8 lb/ac/yr	45% or 0.76 M ac	3,075	$1.45	$8.92 M
TOTALS		*[*2/3 of 2.55 M crops drained]*	9,200	$1.12	$20.69 M/yr

P loss reduction

- Based on report #3 of the “Integrated Assessment” and also the Iowa state nutrient budget, the average P loss with river flow is about 0.75 lb/ac/yr.
- A 45% reduction of the 1,560 tons of P loss per year would be 702 tons.
- Or the average, total P concentration (that in water plus sediment) would have to be reduced from 0.415 to 0.228 mg/L.

[Note that the draft P criterion for standing waters (i.e. lakes) in Iowa is being proposed at 0.035 mg/L].

Practice: Reducing soil test levels to the optimum level

- The break between “optimum” and “high” soil test P levels (Bray-1) for row-crops is 20 ppm.
- At 20 ppm soil test P level, soluble P in surface runoff is estimated at 0.150 mg/L.
- At 35 ppm, it is 0.225 mg/L.
- With 35% of river flow estimated to be surface runoff, that would be 2.8.”
- Over time, reduced or no P inputs to fields testing “high” would save money and reduce P levels and losses.
- The reduction in P loss associated with reducing the average soil test level from 35 to 20 ppm would meet about 1/7 of that needed for a 45% reduction.

Achieving the remaining P-reduction

- Further conversion to conservation and no tillage (currently 4% no-till).
- Additional contouring (currently 6%).
- Use of vegetated buffer strips.
- Use of water and sediment control basins.
- Use of terraces.

Summary/Concerns

- To reach the Gulf Hypoxia reduction goal of 45% for total nitrogen, of which nitrate is about 2/3, the costs will be significantly higher.
- There is the concern that reducing field P losses, and more importantly reducing P which is actually transported to streams, will not reduce in-stream P concentrations or the amount exported to the Gulf.
- At issue is how much P can be provided by recycling from the soils and sediment already present in the stream, lake, and marine systems.

Summary/Concerns

- Despite what some believe, there are few “win-win” situations, and those associated with rate of nutrient inputs will not get us to currently targeted water quality goals.

- Reaching those goals will come at considerable effort and costs, and therefore, it is imperative to be sure that the practices promoted will secure those goals; and furthermore, that reaching those goals will result in the anticipated environmental benefits.

- Producers and the public, once deceived and/or disappointed, will not readily cooperate or be supportive in the future.

Link to workshop proceedings pdf:

www.UMRSHNC.org

Hard copy available for purchase from:

ASABE

St. Joseph, MI