

## Challenges within the Human Dimensions of Agricultural Nitrogen Management and Water Quality

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### *The Human Dimension of Soil and Water Conservation: Historical and Methodological Perspective*

- Nowak & Korsching 1998, p. 159

“Simply put, a scientific understanding of erosion processes and their application to the development of “technical fixes” does not constitute a solution to soil erosion problems. **All the good intentions of science and technology are meaningless until the farmer actually uses the practices.** The farmer’s adoption or nonadoption of these practices, and the reasons underlying these behaviors, are critical dimensions for a comprehensive understanding of erosion and conservation processes.”



## Outline

- What links social science and denitrification?
- Factors influencing adoption & diffusion of innovations
- Findings from 2 Illinois watersheds on nitrogen runoff management
- Preliminary conclusions

## Socio-Bio-Geo-Chemical & Engineering Science

Hufnagl-Eichiner, Wolf & Drinkwater 2011. Assessing Socio-Ecological Coupling: Agriculture and Hypoxia in the Gulf of Mexico. *Global Environmental Change* 21:530-539.

Kotchen & Young 2007. Meeting the Challenges of the Anthropocene: Towards a Science of Coupled Human-Biophysical Systems. *Global Environmental Change* 17:149-151

“In the absence of a clear understanding of the relevant biophysical and socioeconomic systems, governance systems can generate unforeseen, unintended and undesirable consequences.” (p. 150)



## Literature on Factors Influencing Adoption of Nutrient Management BMPs (Prokopy et al. 2008)

- Capacity
  - Acres (+)
  - Education (+/-)
  - Capital and Income (+, but less sig)
  - Adoption Experience & Land Tenure (-)
  - Information (+)
  - Available Labor (+)
  - Networking (+)
- Attitudes
  - Perceived profitability (+)
  - Environmental awareness (+)
- NOT Significant (but often significant re: other conservation)
  - Age
  - Risk, Heritage, Payments

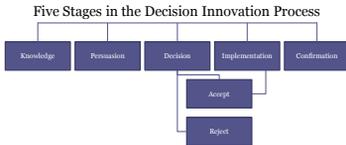
### Overall Findings:

- Inconsistent approaches and variables across studies
- Little synthesis to date



- Program to develop social indicators to assess awareness, attitudes, constraints, capacity, and behaviors that are expected to lead to water quality improvement and protection
- Surveys can be developed from interactive online database and soon, ability to compare findings to other watersheds

## Rogers' Diffusion of Innovation Theory



## Considerations re: Adoption Diffusion

- Assumptions of 100% adoption rarely met
- Accuracy issues in reporting/measurement
- Suitability of innovation for biophysical setting, seasonal & annual climatic variations
- Accuracy of complex environmental and other implication calculations
- Policy & market context
- Assumes one-way flow of information

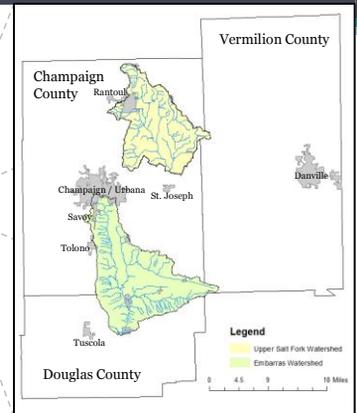


## Nitrogen Management Projects in IL

- Upper Salt Fork & Embarras Watersheds (Near Urbana IL)
  - Dr. Mark David (PI) et al.
- Tile Drainage Modifications to Reduce Nitrate Losses in Agricultural Watersheds
  - Controlled Drainage
  - Bioreactors
  - Wetlands
  - (Nitrogen Application Timing)
- Social Science
  - Factors Influencing Adoption (and Adoption Inclination) of Practices for Water Quality
  - Interviews & Surveys
  - Explore links with biogeochemistry & engineering



## Study Sites



## Perceived Sources of Water Quality Problems: Nitrogen a concern for ~20% of farmers

Possible Sources	Upper Salt Fork Watershed % indicating problem (4-5)	Embarras Watershed % indicating problem (4-5)
Sediment	28.8	29.3
Municipal Discharge	20.0	28.3
Nitrogen	19.0	20.6
Phosphorus	14.1	19.8
Runoff from Lawns (Golf C)	12.6	17.0
Pesticides	9.8	20.4
Manufacturing	8.9	11.3
Septic Systems	7.6	13.3
Livestock Manure	7.6	4.7
Salt	2.6	12.4

Based on 1-5 point scale where 1 = not a problem and 5 = severe problem  
\*Top 3

## Decision Making Factors: Interpretation of "Sustainability"?

Issues for Water Quality Management Decisions	Mean Importance Score out of 5		% Indicating Important or Very Important (4-5)	
	USF	EMB	USF	EMB
Improving or maintaining the appearance and integrity of my farm	4.49	3.99	94.9	75.4
Improving or maintaining the conditions of my farm for future generations of farmers in my family	4.64	4.34	93.6	89.1
Improving or maintaining my relationships with neighboring farmers	4.41	3.99	92.3	79.9
Improving my farm production (and bottom line)	4.45	4.25 4.16	83.3	79.6 75.0
Improving the quality of water downstream	4.14	4.08	78.2	75.9
Promoting conservation of natural resources	4.09	4.09	74.1	78.7

Where 1 = Not at all important and 5 = Very important

### Would farmers change?

Circumstances and Willingness to Modify Farm Operation to Improve Water Quality	Mean Importance Score out of 5		% Indicating Willing or Very Willing (4-5)	
	USF	EMB	USF	EMB
★ If you learned of convincing evidence showing modifications would increase farm productivity	4.04	4.03	81.4	77.2
If financial incentives were provided to cooperating farmers	3.74	3.62	63.2	52.1
If you learned of scientific evidence showing the effectiveness of water management innovations in reducing nutrient loss	3.64	3.67	57.6	51.4
If most neighboring or family farmers adopted water quality improvement management practices	3.53	3.27	55.3	42.6
If recommended by the county Soil and Water Conservation District	3.34	3.22	38.1	35.4
If recommended by the University of Illinois Extension	3.23	2.99	37.8	28.0
If recommended by my county Farm Bureau	3.14	2.83	31.1	21.4
! If federal or state regulations were established governing water quality of agricultural runoff	2.79	2.73	23.7	25.8

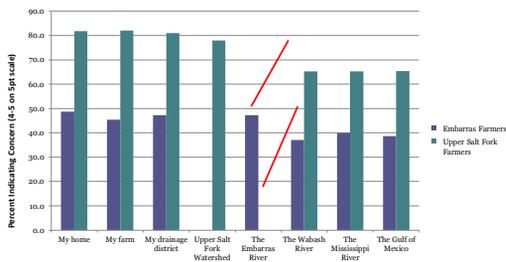
Where 1 = Not at all willing and 5 = Very willing

### Limits to change: \$\$ & Flexibility

How much does each of the following issues limit your ability to implement water quality conservation practices on your farm?	Mean Importance Score out of 5		% Indicating A Lot (4-5)	
	USF	EMB	USF	EMB
★ Personal out-of-pocket expense	3.86	3.62	66.6	58.8
Lack of government funds for cost share	3.73	3.62	59.5	59.2
Possible interference with my flexibility to change land use practices as conditions warrant	3.67	3.48	57.0	53.0
Concerns about reduced yields	3.57	3.27	55.4	49.0
Not having access to the equipment that I need	3.42	3.17	52.1	41.4
Environmental damage caused by the practice	3.30	2.92	46.5	28.4
Requirements or restrictions of government programs	3.33	3.40	45.8	50.0
Lack of available information about a practice	3.10	3.06	36.8	36.7
Not being able to see a demonstration of the practice before I decide	3.11	3.20	36.1	42.2
I do not own the property	2.89	3.22	33.3	48.5
Approval of my neighbors	2.90	2.42	30.0	23.1
No one else I know is implementing the practice	2.66	2.86	19.4	33.3
! Don't want to participate in government programs	2.47	2.53	18.0	22.4

Where 1 = Not at all and 5 = A lot

### Geography of Water Quality Concerns: More concern closer to home



### Different Types of Adopters/Non-Adoptors

- Innovator (Cooperator w/ Installation)
  - "I've always been interested I guess in conservation, I like to do new things. Guess that's why I'm still farming, I'm not done yet."
- Majority
  - Q: "What influences whether or not you adopt a new farming technique?"
  - A: "Bottom line. If it looks like you can make fewer trips over field and you know, save some dollars that way in the long run."
  - A: "I've watched guys do the...ridge till. It seems like that has worked out real well for a lot of guys and we thought about doing that several times."

From Upper Salt Fork Interviews

### Different Types of Adopters/Non-Adoptors

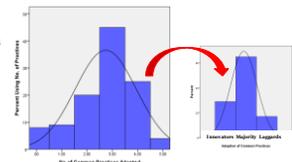
- Laggard:
  - "I was telling you about that tile coming from the neighbors, they wanted to block it off and I says, 'it will never work.' I said, 'I can tell you one thing if you do that on my farm I says somebody better get to running and you better not stop till you get to waters out on the west coast and then you better keep walking on the top of that water 'cuz I'll shoot ya.' That there will never work. I have seen one of the structures put in around here and boy that is a catastrophe. Yeah, total catastrophe."

From Upper Salt Fork Interviews

### Adoption & Adoption Inclination (Embaras)

N=106

- Adoption of Common Practices
  - Nutrient mgmt plan
  - Regular soil tests
  - Rec. fertilization rates
  - Variable rate application
  - Winter cover crops

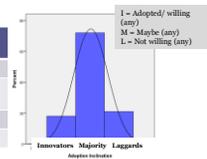


- Adoption Inclination (New)

- 11 Innovators (adopted 1 or 2)

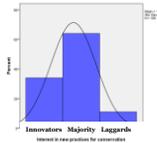
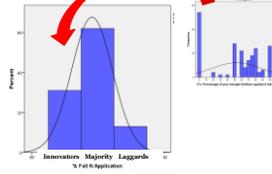
	Drainage H2o Mgmt	Wetlands	Bioreactors
Never heard of	15.2%	18.7%	58.7%
Somewhat familiar	19.6%	34.6%	16.5%
Familiar	58.0%	41.1%	23.9%
Use it	7.1% (8)	5.6% (6)	0.9% (1)

3 DWM + Wetlands; 1 Wetland + Bioreactor



## Adoption & Adoption Inclination (Embarras) N=106

- Fall/Spring N Application
  - 0-49% Fall N (Innovators)
    - Note: mostly 0
  - 50-99% Fall N (Majority)
  - 100% Fall N (Laggards)
- Interest in new practices for conservation
  - No/Low Interest (1)
  - Moderate Interest (2)
  - Very Interested (3)



## Literature vs. Illinois Watershed Findings on Factors Influencing Adoption (or willingness)

### From Literature (Prokopy et al. 2008)

### From Embarras Watershed IL

- Capacity
    - Acres (+)
    - Education (+/-)
    - Capital and Income (+, but less sig)
    - Adoption Experience & Land Tenure (-)
    - Information (+)
    - Available Labor (+)
    - Networking (+)
  - Attitudes
    - Perceived profitability (+)
    - Environmental awareness (+)
  - NOT Significant
    - Age
    - Risk,
    - Heritage, Payments
- Capacity
    - Acres (ns)
    - Education (ns)
    - Capital and Income (+\*\*\*, - spr N)
    - Adoption Experience (n.s.)
    - Land Tenure (+\*)
      - For new practices, maybe= younger
    - Information/Network (+)
      - # of gov/commercial contacts for info
  - Attitudes
    - Perceived profitability (+\*\*\*)
    - Environmental awareness (+)
      - Concern Gulf of Mexico
  - NOT Significant
    - Age (ns)
    - Risk (ns)
    - Heritage (ns), CRP Payments (ns)

## “If you had the ear of policy makers, what would you tell them?” (Embarras)

- Policy makers know nothing about farming, will require impractical things w/ bad consequences
  - “Think more long term. My family has been here since 1850; I don’t want to solve something that will work for two years and be an awful idea for the next hundred. I think sometimes policy makers think about today and not tomorrow.
  - “Don’t cram some far-flung laws down our throats that would really upset our farming practices.”
- Need more time & research, don’t regulate
  - “Need more time to get it right.”
- Don’t blame the farmers
  - “There’s nobody who cares more about the environment than farmers. If there’s some problem that needs to be solved, let’s think positively instead of blaming, blaming.”
- Common Sense
  - “I’d probably just rip their ear off. If guess if I had something I would want to share with them, it is let’s make decisions based on sound science and let’s make it in a common sense approach to the change.”

## Conclusions from Embarras Watershed II

- Farmers would like to have their voices heard
- Low concern about N as source of water quality problem
- Bottom line not only factor considered in decision making, but influential (except re: N application timing)
- “Laggards” less influenced by BOTH farm productivity AND conservation in water quality decision making
- Younger farmers more uncertain about new practices, but haven’t ruled them out (“maybe”)
- Most farmers had not heard of bioreactors; more familiar with drainage water management and wetlands
- Concern about Gulf of Mexico influenced adoption inclination & interest in new practices for conservation, but not adoption of common practices



## What Might Help Overcome Denitrification Challenges?

- More research needed on farmer decision making & attitudes
  - Heterogeneity among farmers
  - Inconsistent findings across studies
  - Context likely matters
- Farmers likely need more info on new practices
  - Efficacy, cost, flexibility, longevity
  - Nutrient management vs. other conservation issues
- Farmer Advisory Boards
  - Diverse representation
  - Found to be helpful in Montana Nutrient Mgmt Project in building trust/ relationships and attracting cooperators
    - (D. Jackson Smith et al.)



## Thank you!

