

Cover Crops and Water Quality

A high-speed photograph of a water droplet falling into a pool of water, creating a series of concentric ripples. The droplet is captured in mid-air, just above the point of impact, with its reflection visible in the water below. The background is a soft, out-of-focus blue.

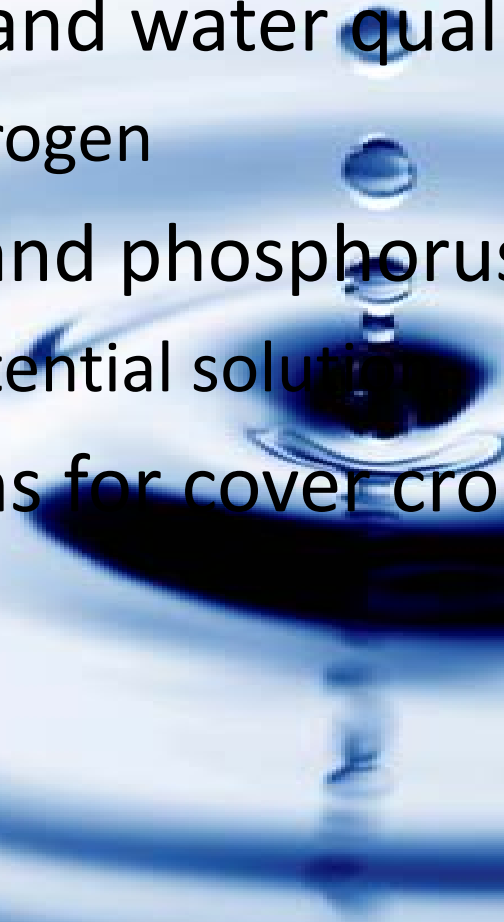
Dean Baas

MICHIGAN STATE
UNIVERSITY
EXTENSION

February 10, 2009

Cover Crops and Water Quality

- Why cover crops and water quality?
- State of cover crop and water quality research
 - Cover crops and nitrogen
- Emerging nitrogen and phosphorus issue
 - Cover crops as a potential solution
- MCCC considerations for cover crop and water quality research



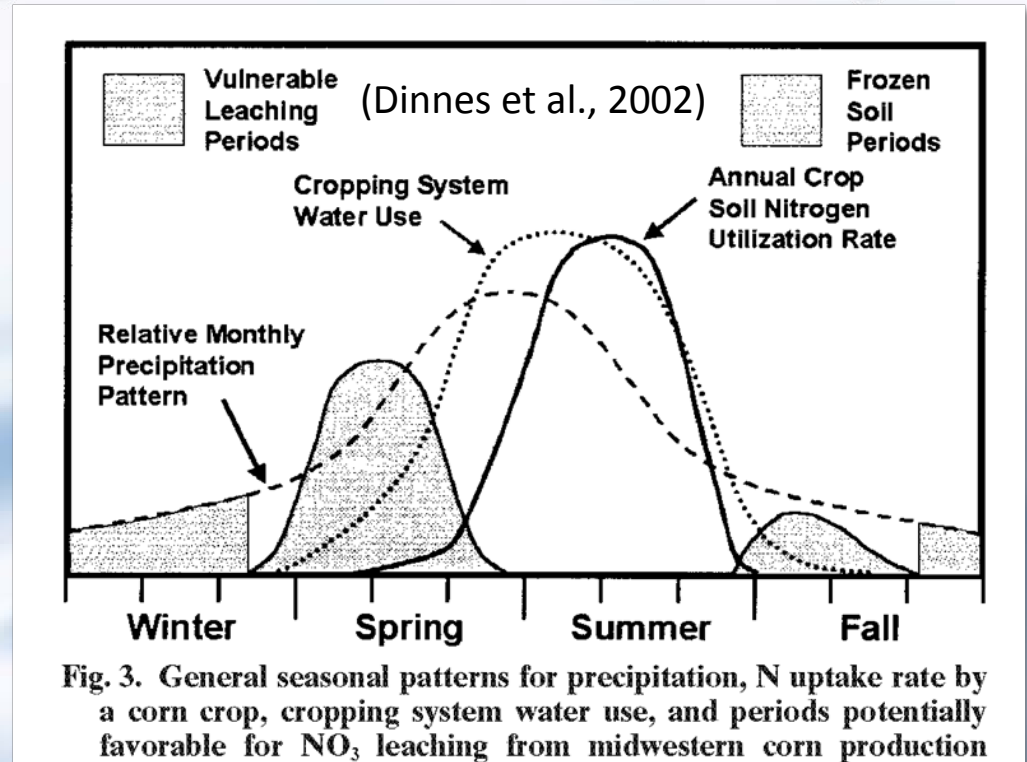
Why Cover Crops and Water Quality?

- Nutrient loading to aquatic ecosystems (eutrophication) is a persistent condition of surface waters and a widespread environmental problem.
- “Eutrophication has become a global problem that is likely to intensify in coming decades because of increases in human population, demand for food, land conversion, fertilizer use and nitrogen deposition (Carpenter, 2005).”
- Agricultural nutrients are lost to ground and surface waters by:
 - Leaching
 - Runoff

Carpenter, S.R., 2005. Eutrophication of Aquatic Ecosystems: Bistability and Soil Phosphorus. Proceedings of the National Academy of Sciences of the United States of America, 102(29): 10002-10005.

Why Cover Crops and Water Quality?











- Nutrients lost to water are nutrients lost for productivity
- Cover crops reduce nutrient losses by:
 - Mimicking natural ecosystems
 - Accumulating inorganic nutrients between growing seasons
 - Holding them in organic form preventing leaching
 - Subsequently releasing to the next crop as residue decomposes
 - Protecting against soil erosion



Dinnes, D.L., Karlen, D.L., Jaynes, D.B., Kaspar, T.C., Hatfield, J.L., Colvin, T.S. and Cambardella, C.A., 2002. Nitrogen management strategies to reduce nitrate leaching in tile-drained midwestern soils. *Agronomy Journal*, 94(1): 153-171.











Cover Crop & Water Quality Research

- Nitrogen
- Search of ISI Web of Science®
 - Topic=("cover crops" AND nitrogen)
 - 666 papers since 1978

Field: Subject Area	Record Count	% of 666	Bar Chart
AGRONOMY	237	35.5856 %	
SOIL SCIENCE	237	35.5856 %	
AGRICULTURE, MULTIDISCIPLINARY	88	13.2132 %	
PLANT SCIENCES	88	13.2132 %	
HORTICULTURE	77	11.5616 %	
ECOLOGY	52	7.8078 %	
ENVIRONMENTAL SCIENCES	48	7.2072 %	
WATER RESOURCES	29	4.3544 %	
CHEMISTRY, ANALYTICAL	24	3.6036 %	
FOOD SCIENCE & TECHNOLOGY	13	1.9520 %	
Field: Subject Area	Record Count	% of 666	Bar Chart
(22 Subject Area value(s) outside display options.)			

Cover Crop & Water Quality Research

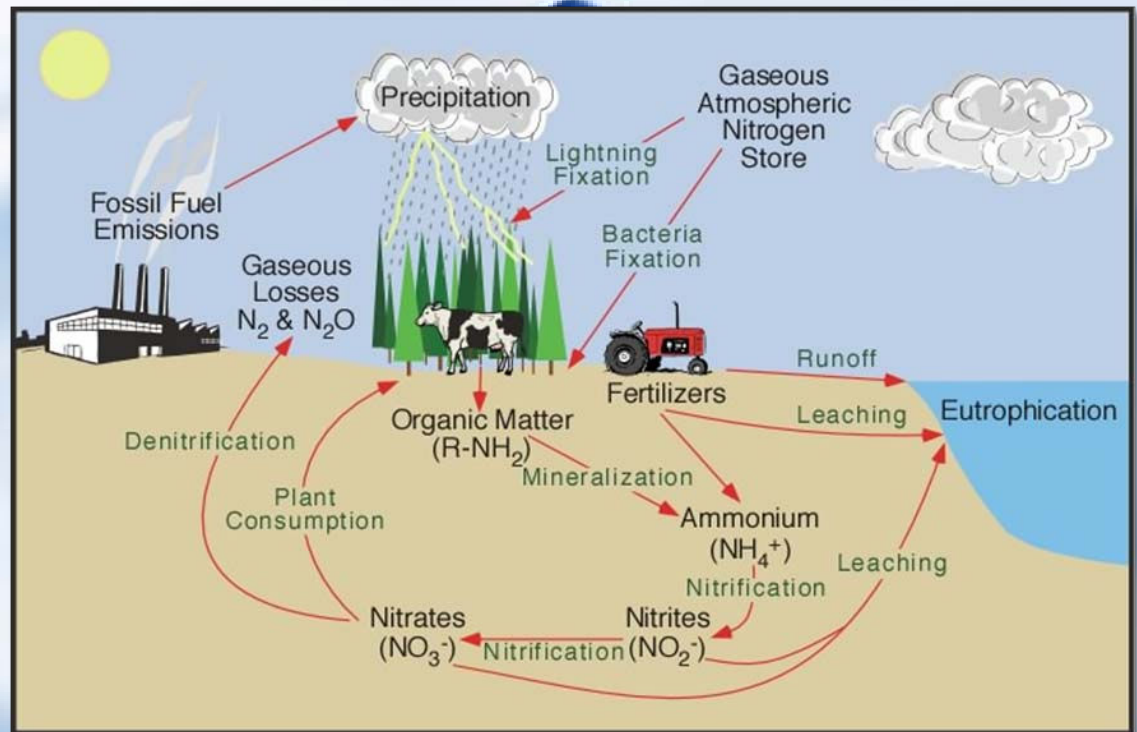
- Nitrogen and water quality
- Search of ISI Web of Science®
 - Topic=("cover crops" AND nitrogen AND "water quality")
 - 32 papers since 1994 (first published)

Field: Subject Area	Record Count	% of 32	Bar Chart
SOIL SCIENCE	15	46.8750 %	
AGRONOMY	10	31.2500 %	
ECOLOGY	8	25.0000 %	
WATER RESOURCES	6	18.7500 %	
ENVIRONMENTAL SCIENCES	5	15.6250 %	
PLANT SCIENCES	5	15.6250 %	
CHEMISTRY, ANALYTICAL	4	12.5000 %	
AGRICULTURAL ENGINEERING	2	6.2500 %	
HORTICULTURE	2	6.2500 %	
AGRICULTURE, DAIRY & ANIMAL SCIENCE	1	3.1250 %	
Field: Subject Area	Record Count	% of 32	Bar Chart

(3 Subject Area value(s) outside display options.)

Cover Crops & Water Quality Research

- Many of the cover crop nitrogen studies quantify N capture, recycling and credits
- Few studies measure and quantify actual N loss to surface and ground water



<http://www.physicalgeography.net/fundamentals/9s.html>

Emerging P and N Issue

- In general, BMPs other than cover crops have been encouraged and cost shared to reduce nutrient losses by reducing sediment loss, such as:
 - Conservation tillage
 - Nutrient management
 - Vegetative filter strips
- Recent information has emerged indicating this may not be as effective as originally thought

Emerging N and P Issue

Fwd: Dissolved Phosphorus Issue

Janelle Hohm [hohmj@michigan.gov]

You forwarded this message on 10/23/2008 9:46 PM.

Sent: Thu 10/23/2008 10:52 AM

To: baasdean@msu.edu

Dean-

Do you know of any studies on this issue? I know that dissolved phosphorus is in issue in the Battle Creek River, but I don't remember no till being the presumed cause.

Thanks!
Janelle

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>>> Robert Day 10/21/2008 10:36 AM >>>

FYI, EPA is hearing concerns regarding conservation tillage practices. Apparently, at least one study found a correlation between conservation tillage and increased loads of dissolved reactive soluble phosphorus (DSRP) to the Great Lakes. Region 5 NPS staff are skeptical and would like the states to let them know if we have any studies that show this link. Please let me know if you are aware of any studies covering this issue.

Michigan) have program plans that specifically identify DSRP as a cause of impairment and none of the program plans target actions to deal specifically with DSRP. Therefore, "stand alone activities focusing on just DSRP are ineligible for section 319 funding." On the other hand, nutrient or sediment load reduction activities that are not "focusing on just DSRP" and are included in approved watershed management plans can be eligible for 319 funding.

I don't see this changing our approach regarding nutrient load reduction activities. However, please let me know if you have questions.

Bob

Emerging P and N Issue

- Nomini Creek watershed study in VA (Inamdar et al., 2001)
- BMP's cost shared implemented over 12 yr period:
 - Strip cropping
 - Conservation tillage
 - Nutrient management
 - IPM
 - Vegetative filter strips
 - Grade stabilization and drop structures

Cover crops not included
in BMPs

Emerging N and P Issue

- Nitrogen pre- and post-BMPs

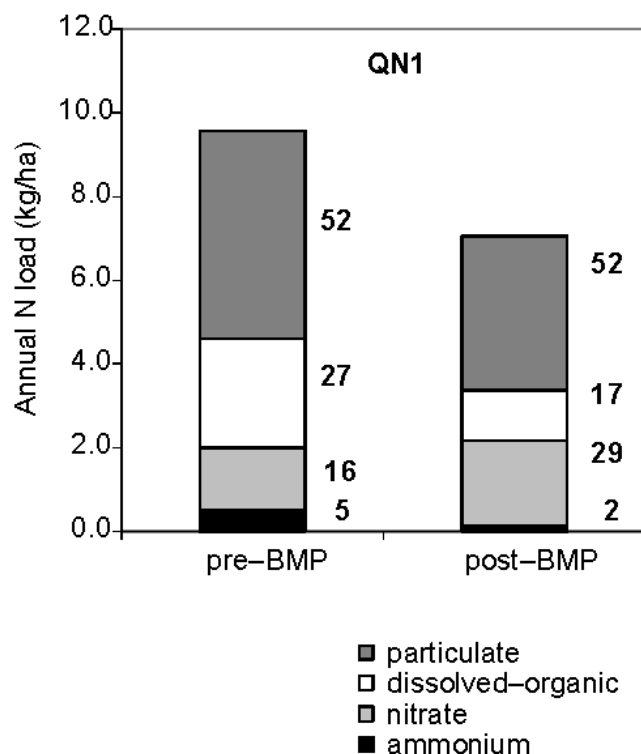


Figure 2. Proportions of various N forms comprising pre- and post-BMP total-N loads for QN1 (percent values listed next to the bars).

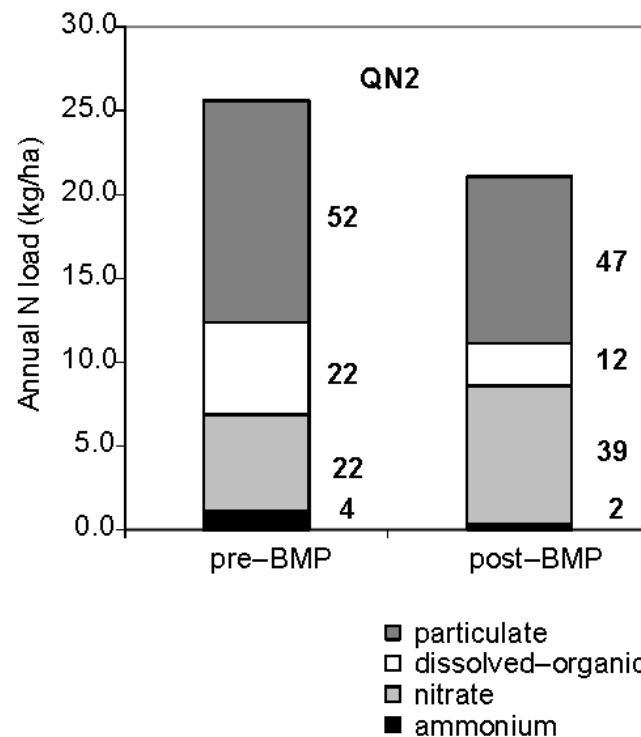


Figure 3. Proportions of various N forms comprising pre- and post-BMP total-N loads for QN2 (percent values listed next to the bars).

Inamdar, S.P., Mostaghimi, S., McClellan, P.W. and Brannan, K.M., 2001. BMP impacts on sediment and nutrient yields from an agricultural watershed in the coastal plain region. Transactions of the Asae, 44(5): 1191-1200.

Emerging N and P Issue

- Phosphorus pre- and post-BMPs

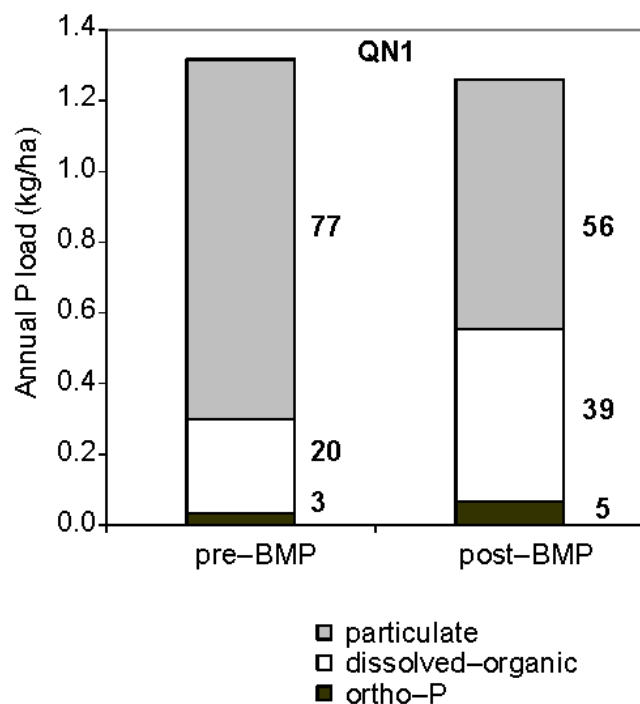


Figure 4. Proportions of various P forms comprising pre- and post-BMP total-P loads for QN1 (percent values listed next to the bars).

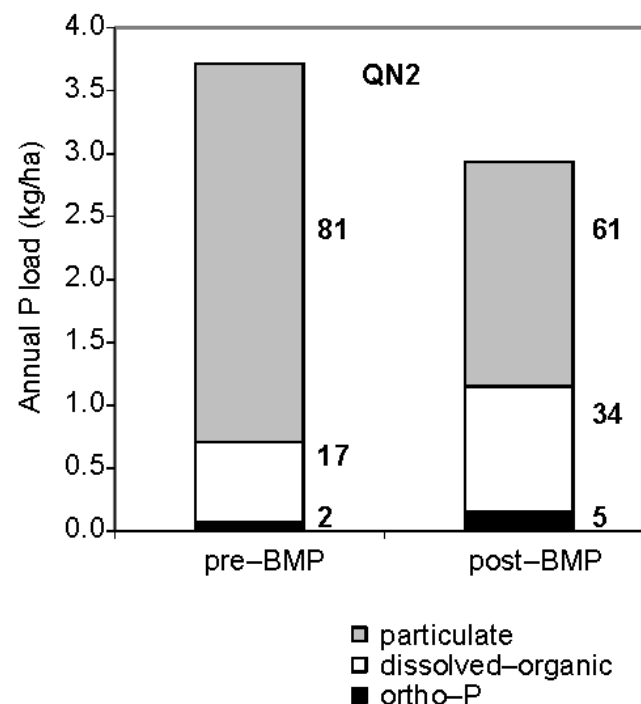


Figure 5. Proportions of various P forms comprising pre- and post-BMP total-P loads for QN2 (percent values listed next to the bars).

Inamdar, S.P., Mostaghimi, S., McClellan, P.W. and Brannan, K.M., 2001. BMP impacts on sediment and nutrient yields from an agricultural watershed in the coastal plain region. Transactions of the Asae, 44(5): 1191-1200.

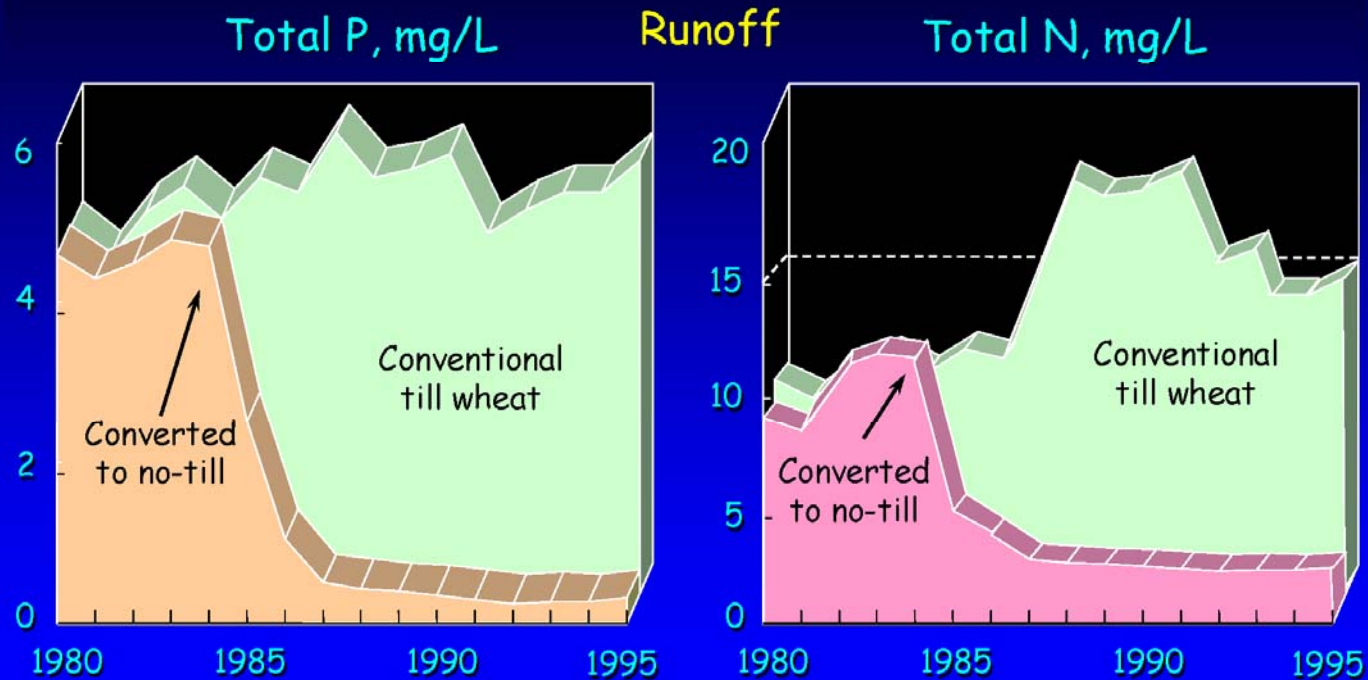
Emerging N & P Issue

- Presentation on the web by Andrew Sharpley, University of Arkansas and Peter Richards, Heidelberg College at <http://www.northwyke.bbsrc.ac.uk/IWAMwebsite/Bath%20files/Day%202/Keynotes/Andrew%20Sharpley.pdf>
- Data from El Reno, OK and the Maumee and Sandusky Rivers in OH.

Emerging N & P Issue

Conservation tillage - N & P tradeoffs

No-till reduced erosion from wheat 95%

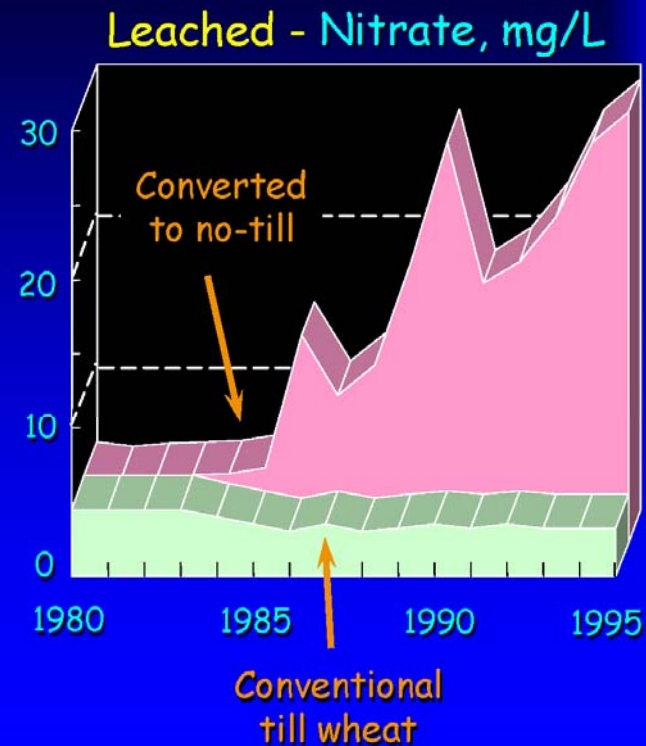
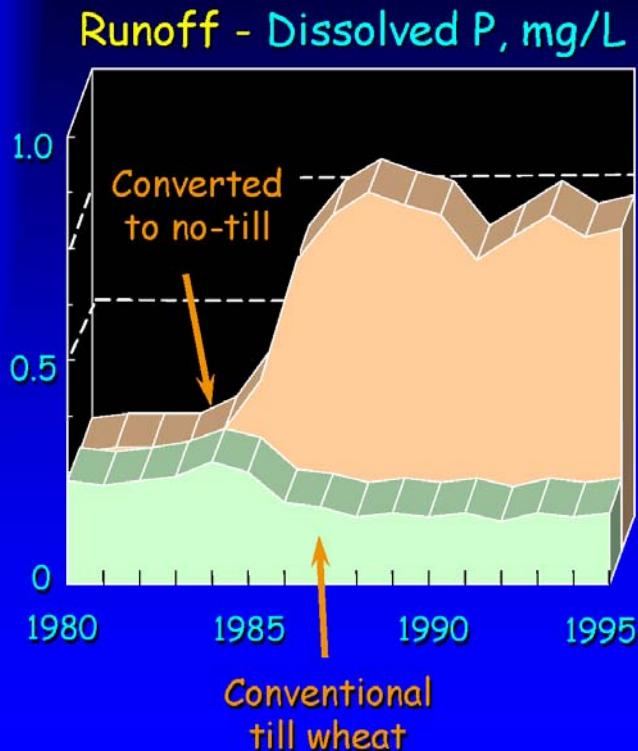


El Reno, OK

Emerging N & P Issue

Conservation tillage - N & P tradeoffs

Infiltration increased 33%



Emerging N & P Issue

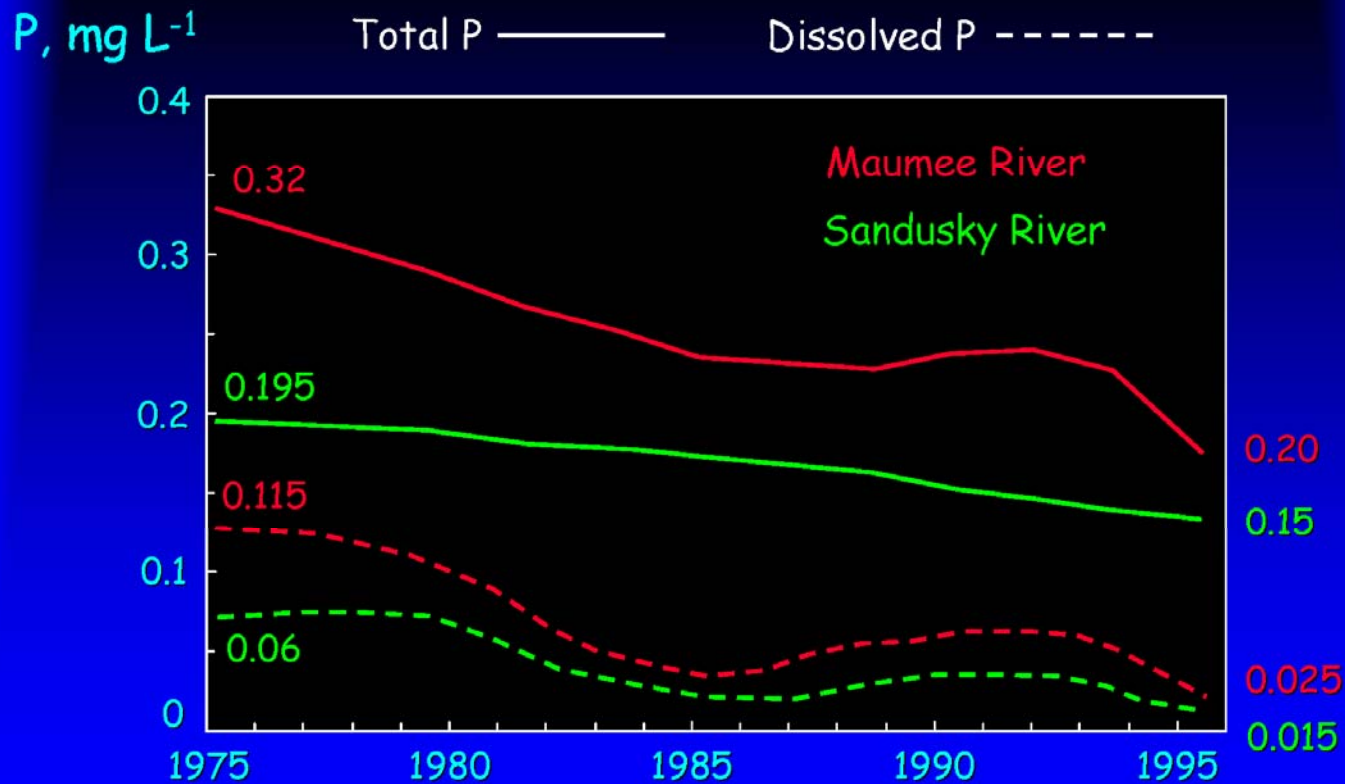
BMPs implemented between 1975 & 1995

Maumee and Sandusky River Watersheds, northeastern Ohio

- ✓ Conservation tillage
 - Soybeans & corn - increased from 0 to 50%
- ✓ Conservation Reserve Program
 - Land taken out of production - 5% of land retired
- ✓ Nutrient management plan implementation
 - Decreased nutrient applications
 - Fertilizer P use decreased 30%
 - 25% less manure applied

Emerging N & P Issue

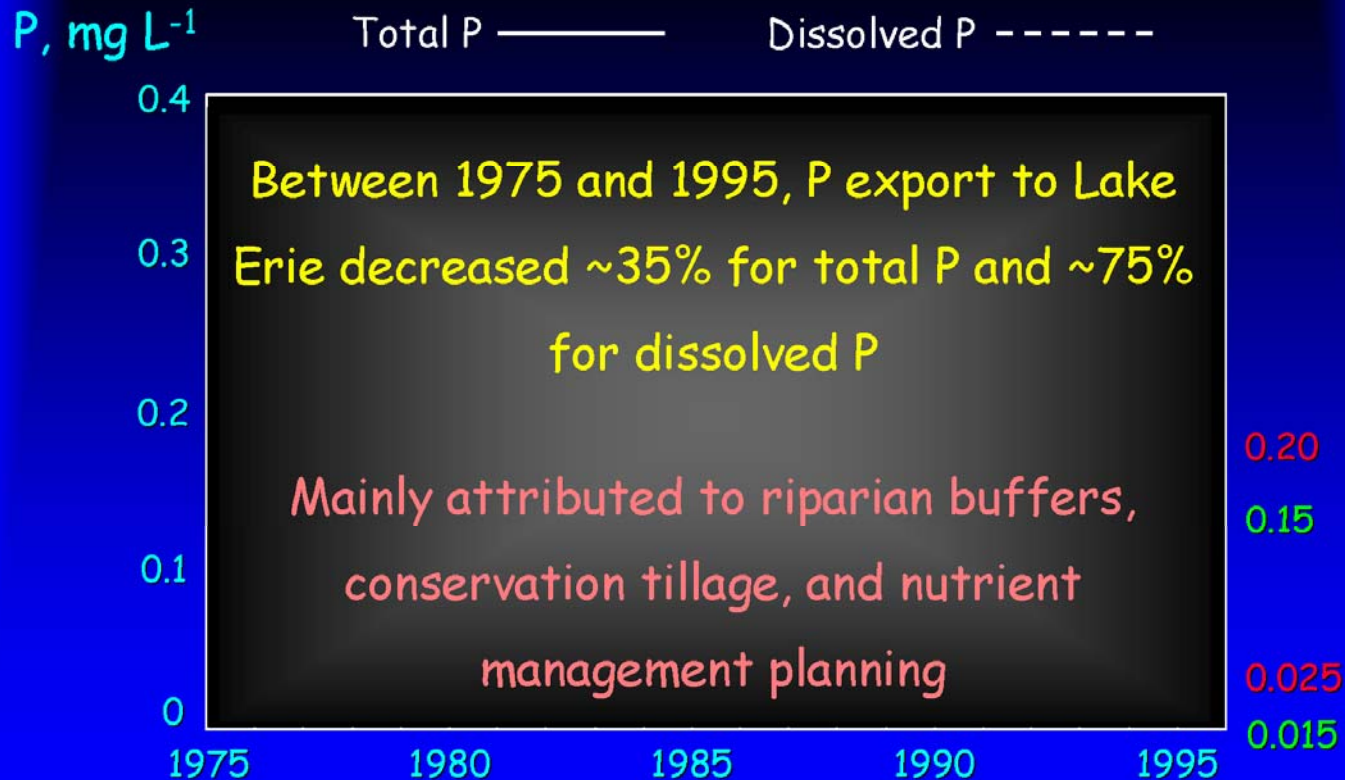
P trends in major rivers



Richards & Baker, JEQ 2002

Emerging N & P Issue

P trends in major rivers

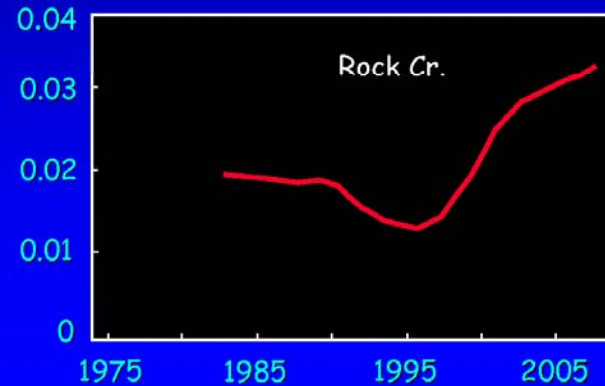
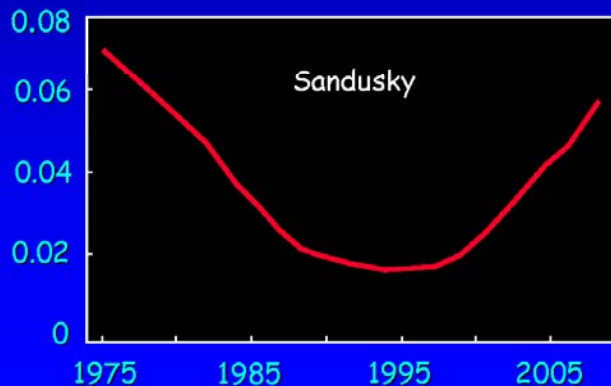
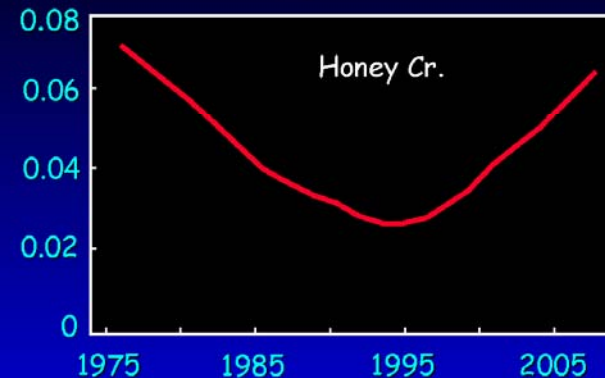
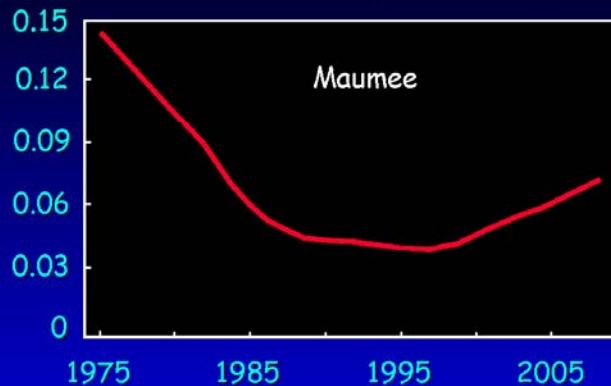


Richards & Baker, JEQ 2002

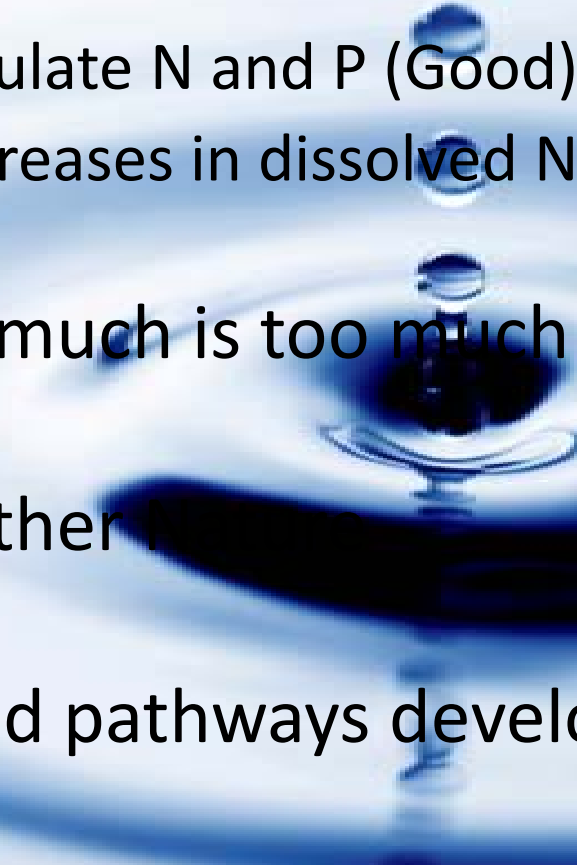
Emerging N & P Issue

Trends in dissolved P

Daily average concentration, mg L⁻¹

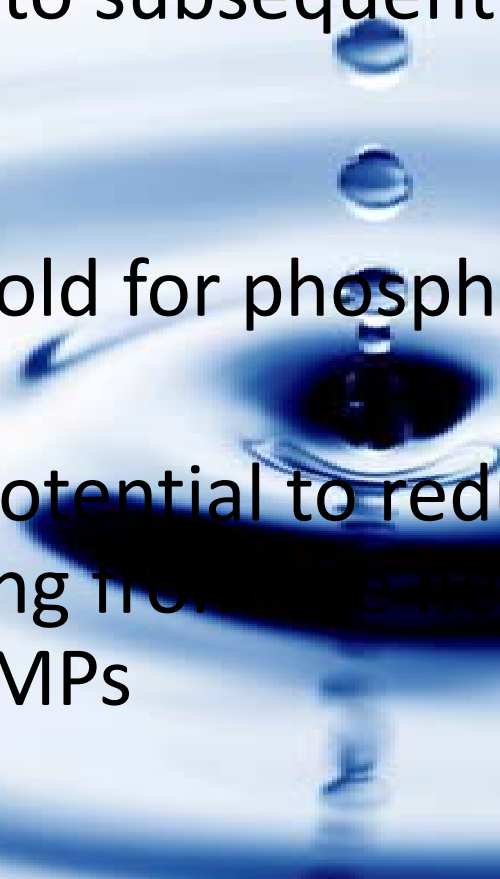


Emerging N and P Issue

- The emerging issue is that the most common conservation practices while:
 - Controlling particulate N and P (Good)
 - Are leading to increases in dissolved N and P (Bad)
 - Bottom line: Too much is too much
 - You can't fool Mother Nature
 - New processes and pathways develop
- 
- A background image showing a water droplet falling into a pool of water, creating concentric ripples. The image is in shades of blue and white, with the droplet captured mid-fall, creating a small splash and ripples on the surface below.











Cover Crops as a Solution

- Cover crops have been shown to capture, recycle and supply to subsequent crops excess nitrogen
- The same should hold for phosphorus
- Cover crops have potential to reduce the loss of nutrients resulting from the new pathways created by other BMPs



Cover Crops and Water Quality











- Phosphorus
- Search of ISI Web of Science®
 - Topic=("cover crops" AND phosphorus)
 - 116 papers since 1978

Field: Subject Area	Record Count	% of 116	Bar Chart
SOIL SCIENCE	46	39.6552 %	
AGRONOMY	36	31.0345 %	
PLANT SCIENCES	21	18.1034 %	
AGRICULTURE, MULTIDISCIPLINARY	19	16.3793 %	
ENVIRONMENTAL SCIENCES	12	10.3448 %	
ECOLOGY	10	8.6207 %	
HORTICULTURE	10	8.6207 %	
WATER RESOURCES	8	6.8966 %	
CHEMISTRY, ANALYTICAL	5	4.3103 %	
AGRICULTURE, DAIRY & ANIMAL SCIENCE	3	2.5862 %	
Field: Subject Area	Record Count	% of 116	Bar Chart

(8 Subject Area value(s) outside display options.)

Cover Crops and Water Quality

- Phosphorus and Water Quality
- Search of ISI Web of Science®
 - Topic=("cover crops" AND phosphorus AND "water quality")
 - 14 papers since 1999 (first published)

Field: Subject Area	Record Count	% of 14	Bar Chart
ECOLOGY	6	42.8571 %	
SOIL SCIENCE	6	42.8571 %	
WATER RESOURCES	5	35.7143 %	
ENVIRONMENTAL SCIENCES	3	21.4286 %	
AGRICULTURE, DAIRY & ANIMAL SCIENCE	1	7.1429 %	
AGRICULTURE, MULTIDISCIPLINARY	1	7.1429 %	
AGRONOMY	1	7.1429 %	
HORTICULTURE	1	7.1429 %	
LIMNOLOGY	1	7.1429 %	
MARINE & FRESHWATER BIOLOGY	1	7.1429 %	
Field: Subject Area	Record Count	% of 14	Bar Chart

(1 Subject Area value(s) outside display options.)

MCCC Considerations for Cover Crop and Water Quality Research

- Continue and increase research into cover crops and water quality
- Expand research to include phosphorus as well as nitrogen
- Include dissolved and particulate fractions

