

## Comparative Losses of Nutrients and Sediment in Surface Runoff from Watersheds in Conservation Tillage and Reduced-Input Management Practices



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Runoff from Reduced-Input Watershed 127



H-Flume and Coshocton Wheel Sampler

## Introduction & Objective

- Conservation tillage can help control soil loss, but nutrients are often detected at high concentrations in surface runoff, particularly in the first few events after application.
- In particular, concern has been raised that no-till row crop production leads to nutrient stratification that contributes to excessive loadings to lakes and streams resulting in harmful algal blooms.



Algal Bloom  
Western Lake Erie Basin  
9 October 2011

Credit: NASA Aqua Satellite

- Tillage and extended (3-4 yr) rotations combined with reduced mineral fertilizer applications have been proposed as methods to reduce nutrient losses in surface runoff compared to typical 2-yr corn-soybean rotations.
- Our objective was to determine if long-term no-till increases nutrient losses in surface runoff, relative to other tillage practices. We also investigated whether replacing some of the mineral fertilizer with manure and red clover in a disked tillage treatment as a part of an extended, 3-yr, rotation can reduce nutrient losses without increasing soil loss to unacceptable levels.

## Materials & Methods

- Surface runoff from seven watersheds in Coshocton, Ohio (2 No-Till, 2 Chisel-Tilled in a 2-yr Corn-Soybean rotation and 3 Disked Reduced-Input watersheds in a 3-yr Corn-Soybean-Wheat/Red Clover rotation) was monitored and sampled for 16 crop years (1990-2005). One watershed within each tillage treatment was planted to each crop each year.

### Tillage Treatments and Watershed Characteristics

Watershed	Tillage	Area (ha)	Average Slope (%)	Maximum Length (m)	Dominant Soil Series <sup>†</sup>
WS 109	Chisel	0.68	13	110	Rayne silt loam
WS 123	Chisel	0.55	7	107	Keene silt loam
WS 113	No-till	0.59	11	118	Coshocton silt loam
WS 118	No-till	0.79	10	132	Coshocton silt loam
WS 111	Disked/Reduced-Input	0.45	6	143	Keene silt loam
WS 115	Disked/Reduced-Input	0.65	7	119	Coshocton silt loam
WS 127	Disked/Reduced-Input	0.67	9	104	Coshocton silt loam

<sup>†</sup> Rayne - Fine-loamy, mixed, active, mesic Typic Hapludult  
Keene - Fine-silty, mixed, superactive, mesic Aquic Hapludalf  
Coshocton - Fine-loamy, mixed, active, mesic Aquatic Hapludalf

- The watersheds were fertilized at the recommend rates based on soil tests and moderate yield goals. No-till and chiseled watersheds received broadcast applications of ammonium nitrate shortly after planting in corn years. The red clover along with beef cattle manure was disked into the reduced-input watersheds prior to corn planting. In some years these watersheds also received starter fertilizer at planting in addition to sidedress applications of ammonium nitrate.
- Herbicides were used to control weeds and the disked watersheds were cultivated once in June and once in July for additional weed control in corn and soybean crop years.
- Runoff volumes were measured using H flumes and flow-proportional, composite, samples were obtained using Coshocton Wheels and analyzed for sediment, NO<sub>3</sub>-N, NH<sub>4</sub>-N, Organic N, Total N, PO<sub>4</sub>-P, Total Dissolved P, Total P, and K.

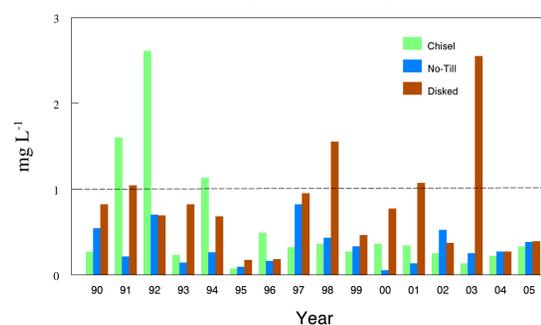
## Results

- Within tillage treatments, the average yearly volume of runoff and number of events were similar among crops. The disked watersheds had the highest average runoff volume, about 37% more than the chisel and no-till watersheds, whereas the no-till had the most events.
- Nutrient losses were generally highest in the corn years for all tillage treatments (Greatest average losses within tillage treatments highlighted in red below).
- Losses of NH<sub>4</sub>-N were small relative to NO<sub>3</sub>-N, but organic N losses exceeded NO<sub>3</sub>-N losses in most crop years. Mineral N losses were similar among tillage treatments.
- Average Total Dissolved P losses were similar to PO<sub>4</sub>-P losses, indicating that most of the Dissolved P losses were in this form. Average losses of all forms of P were greatest from disked reduced-input watersheds, probably due to manure application.
- During row crop years, average soil loss was greatest for the disked watersheds (1667 kg/ha), intermediate for the chisel (1073 kg/ha), and lowest for the no-till (807 kg/ha).

### 16-Year Average Runoff, Nutrient, and Sediment Losses by Tillage and Crop

Crop	Runoff		NO <sub>3</sub> -N	NH <sub>4</sub> -N	Organic N	K	PO <sub>4</sub> -P	Total Dissolved P	Total P	Sediment
	# of Events	mm								
	kg ha <sup>-1</sup> year <sup>-1</sup>									
	<b>Chisel</b>									
Corn	23	95	9.0	0.8	4.3	9.8	0.13	0.23	1.24	1609
Soybean	19	93	2.0	0.5	5.5	6.2	0.12	0.19	0.44	537
	<b>No-Till</b>									
Corn	50	109	5.8	0.8	10.1	14.1	0.29	0.34	0.86	719
Soybean	48	106	1.6	0.3	4.7	9.6	0.21	0.30	0.73	894
	<b>Disked Reduced-Input</b>									
Corn	33	130	6.6	0.5	9.5	26.7	0.74	1.34	2.33	734
Soybean	38	139	3.8	0.3	11.3	15.0	0.27	0.35	1.35	2600
Wheat	37	144	1.9	0.3	2.1	14.4	0.58	0.84	1.34	198

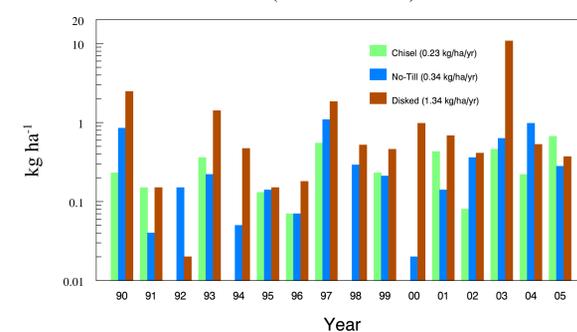
Annual Flow-Weighted Dissolved P Concentration (Corn 1990-2005)



- The disked watersheds had the greatest Dissolved P losses in 13 out of 16 corn years.
- The no-till watersheds had the greatest Dissolved P losses in 1992 and 2004, whereas a chiseled watershed had the greatest loss in 2005.

- The disked watersheds had the highest Dissolved P concentrations in 11 out of 16 corn years.
- 2002 was the only year that a no-till watershed had the highest Dissolved P concentration.

Annual Dissolved P Losses (Corn 1990-2005)



## Conclusions

- In the watersheds investigated nutrient losses as a result of long-term no-till were not elevated compared to chisel tilled where stratification of nutrients should have been less pronounced.
- The combination of disking, reduced mineral fertilizer input, and an extended 3-yr rotation resulted in greater average soil loss in the row crop years. Additionally, losses of P in all forms were greater than the other treatments, probably due to manure application.