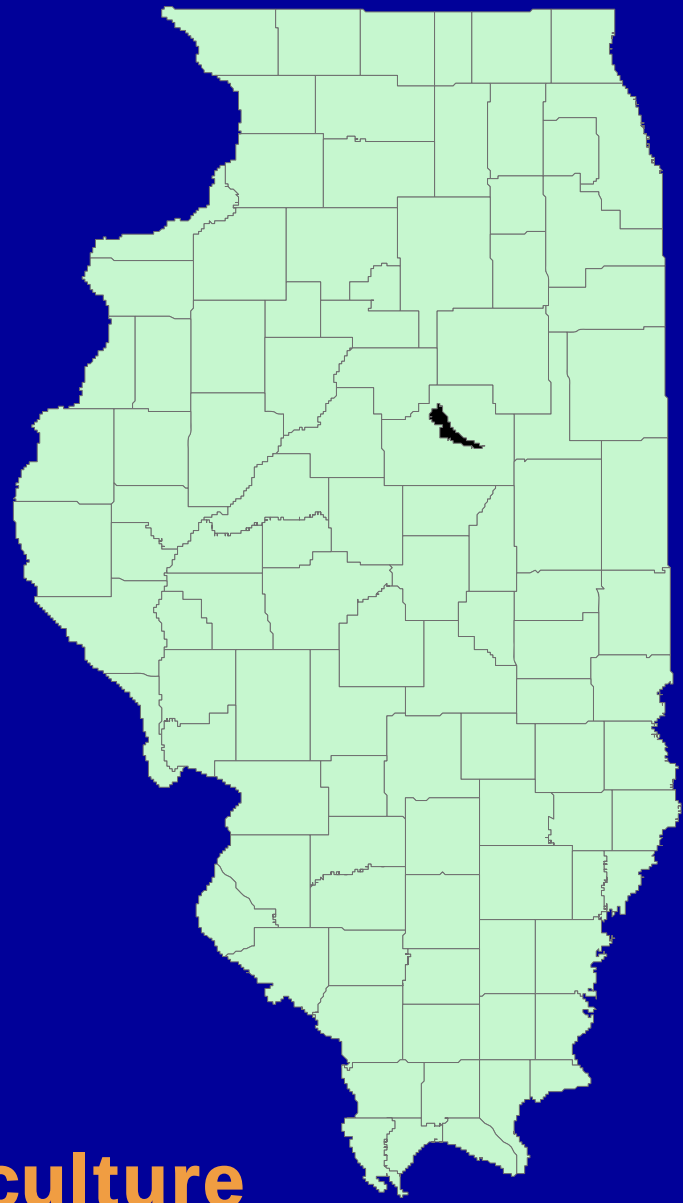
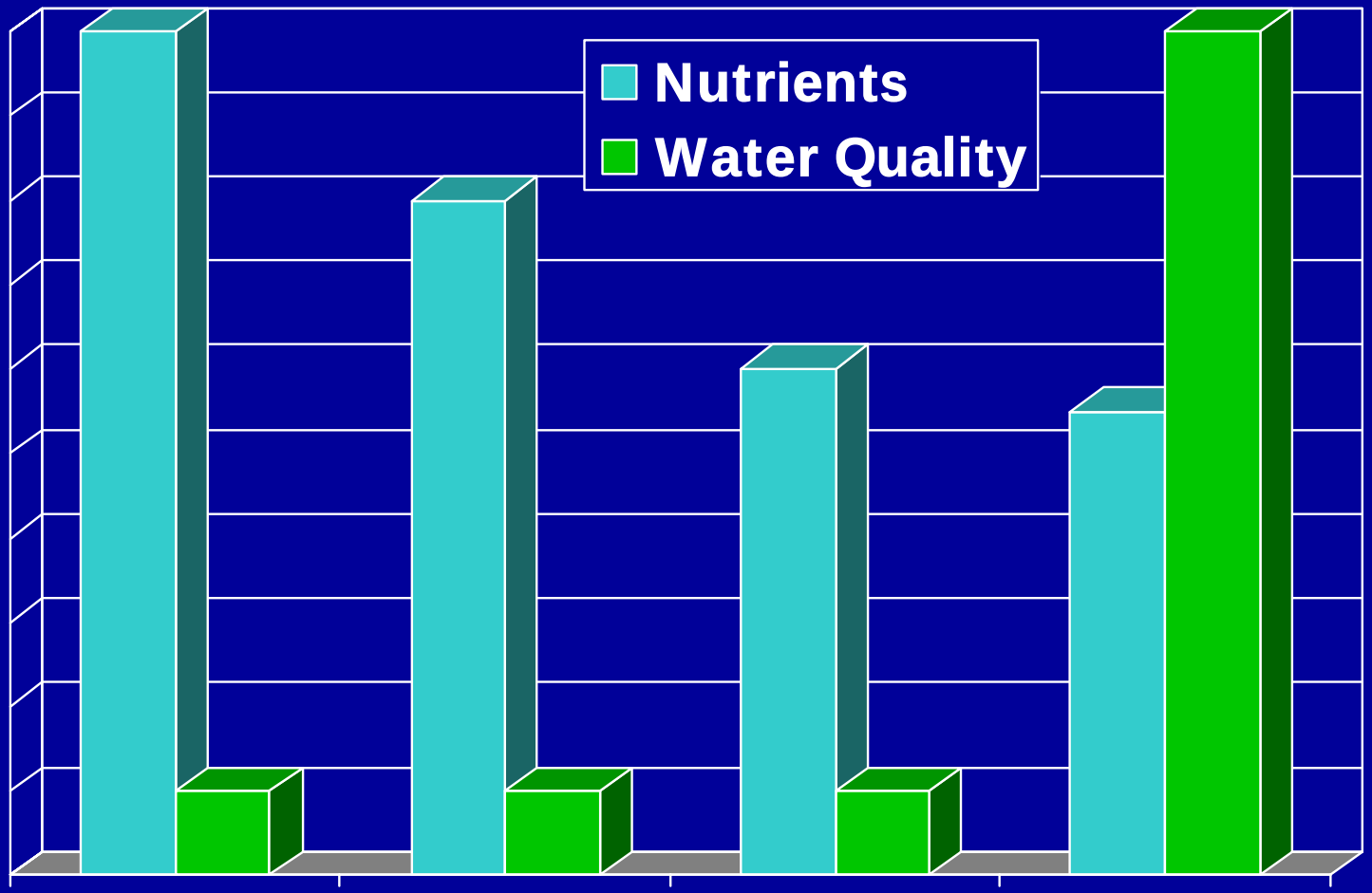
Alternatives and Costs of Reducing Agricultural Nutrient Losses to Surface Water



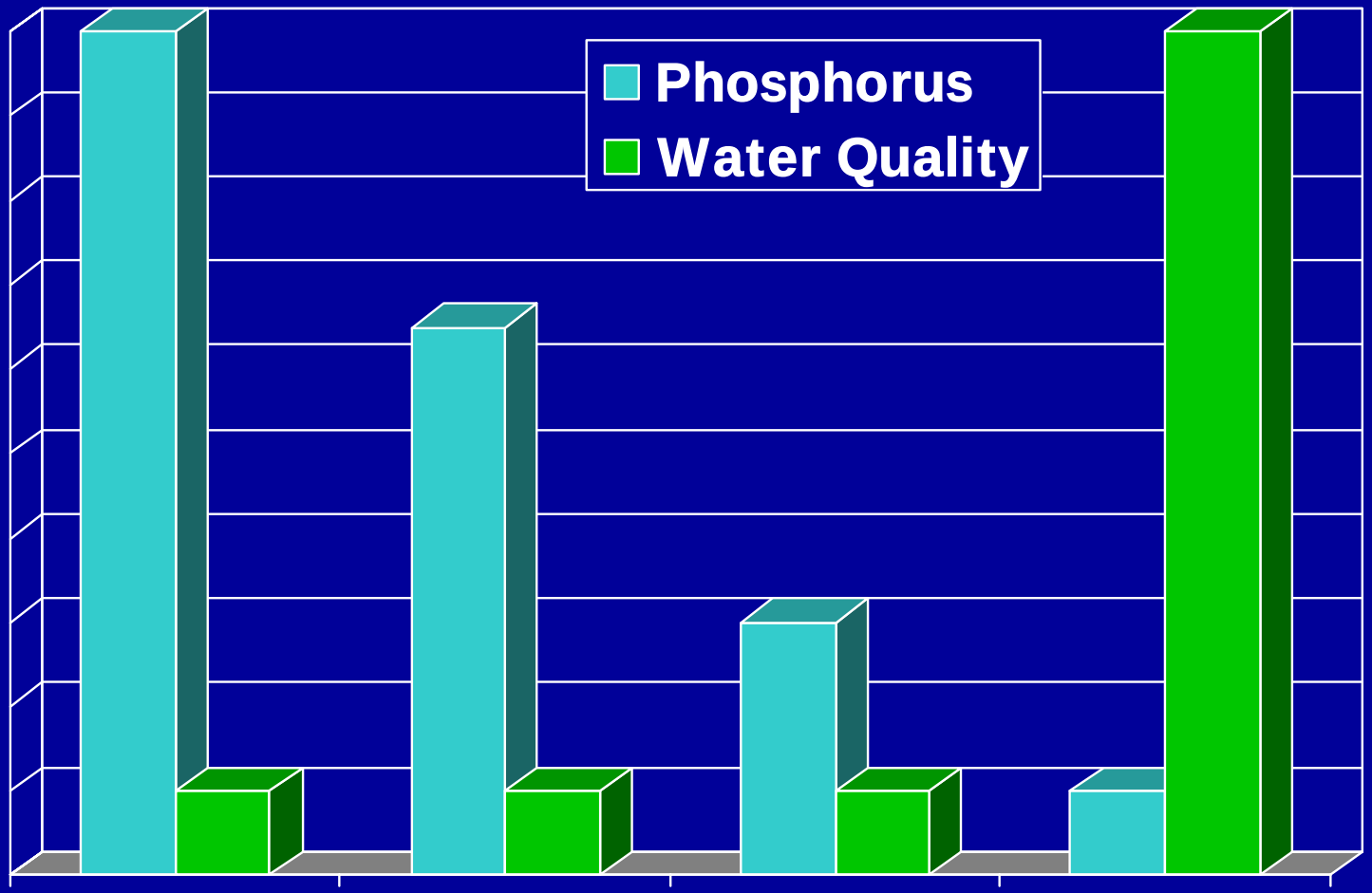
Dennis McKenna

Illinois Department of Agriculture

Water quality response to reductions in nutrients is not linear-- Hypoxia



Water quality response to reductions in nutrients is not linear – Phosphorus TMDL



Lake Bloomington Watershed

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Baseline conditions

44,764 acres
93% cropland
Low erosion rates
More than 50% tile-drained
Well-buffered

Nutrient Management Practices

- 77% fall apply N, nearly all use a nitrification inhibitor
- N rates at University recommendations
- P surface -applied, recent 21% reductions in rates to U of I recommendations

Water Quality

- **Estimated Lake Bloomington Loading**
  - **Total P loading – 14,100 lbs P yr-1 (0.31 lb/ac)**
  - **Total N loading – 917,000 lbs N yr-1 (21 lb/ac)**

- **Reductions Scenarios**
  - **Nitrate-N reduction of 30% , also 50%**
  - **Total P reduction of 45%, also 90%**

TMDL calls for 48% reduction in N and 89.1% reduction in P

Nitrogen reduction practices (tile drainage)

Practice	% reduction
nitrification inhibitors	10
spring vs. fall fertilization	20
recommended rate vs. above	0
no-till vs. conventional	0
cover crops	25
water table management	40
shallow or wide tiles	25
conversion to CRP	95
conversion to perennial crops	80
constructed wetlands (20:1)	50
bioreactors	No data

Phosphorus reduction practices

Practice	% reduction	
	Tiled	Runoff
recommended rate vs. above		5
inject phosphorus fertilizer		20
cover crops	5	25
shallow or wide tiles	+	-
conversion to CRP	50	75
conversion to perennial crops	50	95
WASCOBs		75
sedimentation basin		95
riparian buffers		50
constructed wetlands (20:1)		20

Practice	Cost
Fall to spring fertilizer N	$25/ac
Recommended P rate vs. above	$12/ac/4 yrs
Inject P fertilizer	$14/ac/2yrs
Wetlands	$6,000/ac + $300/ac rent
Drainage mgt	$250/ac
Sediment basin (250 ac)	$3.3 million
Cover Crops	$50/ac
CRP/perennials	$300/ac/yr

To achieve a 30% reduction in TN

Practice	Plan 1 (acres)	Plan 2 (acres)	Plan 3 (acres)
Fall to spring fertilizer	32,134	32,134	32,134
Wetlands		4,003	
Drainage mgt		4,171	
Sediment basin	40,718		
Cover crops		7,304	29,213
Total Cost/lb/yr	$1.97	$3.73	$7.86

50% reduction TN

	Non-targeted		Targeted	
Practice	Area	Annual cost/lb	Area	Annual cost/lb
CRP	6,919	$15.60		
Fall to spring fertilizer	26,805	$3.59	32,134	$2.85
Cover Crops	19,027	$15.79	23,228	$13.06
Wetlands	4,003	$4.03	4,003	$2.16
Drainage mgt	4,171	$3.17	4,171	$1.80
Sediment basin	40,718	$1.42	40,718	$1.26
Total		$8.59		$4.67

To achieve a 45% reduction in TP

Practice	Area (ac)	Reduction lbs/yr	Total cost 30 years	Annual cost/lb
No P fertilizer > 70	17,945	282	$1,663,950	$193.01
Inject P	21,409	1,323	$4,548,600	$114.62
Sediment basin	40,718	5,344	$4,523,500	$28.22
Grand Total		6,949	$10,706,050	$51.36

To meet TMDL for phosphorus

	Acres	Total P reduction	%TP	30-year cost	Annual cost/lb
Perennial crops	41,731	12,491	88.5	$379,980,000	$1,013.99
Sediment basin	40,718 served	692	4.9	$4,523,500	$217.82
Grand total		13,183	93.4	$384,503,500	$972.18

Also achieves 79.8% reduction in TN

Dual nutrient scenarios

	Percent reductions		Total cost (30 years)	Annual cost per acre
	TN	TP		
Targeted N	50%	52%	$70,509,163	$56.32
Non-targeted	50%	52%	$117,671,310	$93.99
TMDL	79%	93%	$384,503,500	$307.13

Conclusions

- In a flat, tile-drained watershed with low erosion and P loss, but high N loss:
  - the per-lb costs for P reductions are very high
  - nitrate reduction costs are substantially lower, but some practices (spring application and DWM) may not be options in other areas
  - estimating costs is difficult with rapidly escalating land prices and uncertainties about valuing risk costs to producers


10 million acres of tile-drained cropland in Illinois x $56 to $94/acre = $560 million to $940 million per year
Mark David, UIUC

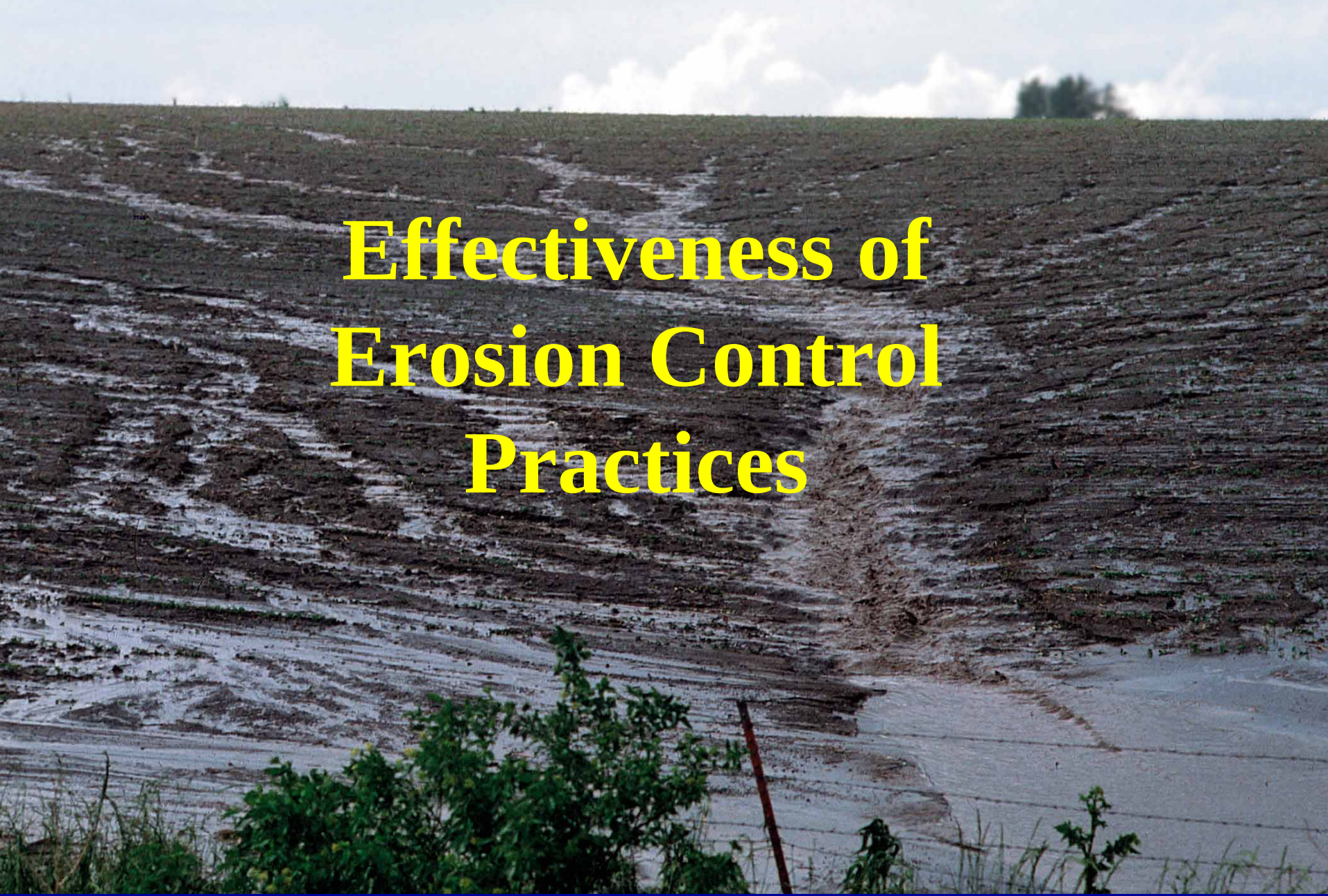

Photo by USDA NRCS

Baseline Conditions

- Average erosion rate in 2003 was 4.0 t/ac/yr
  - 35% less than in 1982
- 85.8% of fields < T value
- 33.1% of all cropland no-till, including 51% of soybeans

Erosion control effectiveness

Practice	Erosion/ sediment	P losses in soil	P losses in water	Total P losses
Moldboard	7.5	11.4	0.1	11.5
Typical tillage	3.9	6.3	0.2	6.5
No-Till	0.5	1.2	0.4	1.6
Contour	2.0	2.4	0.3	2.7
Strip-cropping	1.5	1.8	.0.3	2.1
Terrace	1.2	1.5	0.2	1.7
WASCOB	0.2	0.5	0.3	0.8

Cost effectiveness compared to typical tillage system

Practice	Cost	Life span	Annual cost-lb P	Annual cost - 20% SDR
No-Till	$20	2	$2.04	$10.20
Contour	$10	5	$0.53	$2.65
Strip-cropping	$25	5	$1.14	$5.70
Terrace	$550	20	$5.73	$28.65
WASCOB	$600	10	$10.53	$52.65

Cost effectiveness

- Costs per acre do not change greatly for many practices
- Current nutrient loss/erosion rate
- Sediment delivery ratio
- If producers adopt changes in management practice, costs rapidly approach $0

Challenges

- 24,000,000 acres of cropland
- Federal policies
- Funding
- Competing water quality goals
- Competing demands for natural resource enhancement – soil quality, wildlife habitat, carbon sequestration, etc.

No magic bullets

Practice	Erosion/ runoff	Phosphorus	Nitrate
No till	↓	↓ ↑	↑ ↔
Drainage management	↑	↑	↓
Tile drainage	↓	↓	↑
Cellulosic crops	↓	↓	↓

Implementation

- Important to do the “right thing”, equally important to not do the “wrong thing”
- Combination of management strategies
  - Improved fertility management
  - Off-field nutrient removal practices
  - Potentially cropping system changes
- Right practice in right area vs. first-come, first-served
- Variable payment rates?

Reasons for optimism

- 35% in soil erosion 1982 – 1997
  - Due to targeted programs, e.g. CRP and new technologies