Rationale for Combining In-field and Edge of Field Practices in the Nutrient Loss Reduction Strategy

Gregory McIsaac, PhD
Associate Professor Emeritus, U of IL at Urbana Champaign
Research Scientist
Agricultural Watershed Institute

Nutrient Loss Reduction Strategy combined scenarios

Name	Combined practices and scenarios	Nitrate-N reduction (percent)	Total P reduction (percent)	Cost of reduction ($/lb)	Annualized costs (million $/yr)
NP3	MRTN, spring-only N application, bioreactors on 30 percent of acres, no P fertilizer on 12.5 million acres above STP maintenance, reduced till on 1.8 million conventionally tilled acres eroding >T, cover crops on 87.5 percent of corn/soybean acres, buffers on all applicable lands, perennial crops on 1.6 million acres >T and 0.9 million additional acres	45	45	**	827

How did we develop this and other scenarios?

Statewide average estimated %N reduction and costs of practices per lb of N reduction.

Practice/scenario	Nitrate-N reduction per acre (percent)	Nitrate-N reduced (million lb)	Nitrate-N reduction from baseline (percent)	Cost ($/lb removed)
Reducing N rate from background to MRTN on 10 percent of acres	10	2.3	0.6	-4.25
Nitrification inhibitor with all fall-applied fertilizer on tile-drained corn acres	10	4.3	1	2.33
Split application of 50 percent fall and 50 percent spring on tile-drained corn acres	7.5-10	13	3.1	6.22
Spring-only application on tile-drained corn acres	15-20	26	6.4	3.17
Split application of 40 percent fall, 10 percent pre-plant, and 50 percent side dress	15-20	26	6.4	
Cover crops on all corn/soybean tile-drained acres	30	84	20.5	3.21
Cover crops on all corn/soybean non-tiled acres	30	33	7.9	11.02
Bioreactors on 50 percent of tile-drained land	25	35	8.5	2.21
Wetlands on 35 percent of tile-drained land	50	49	11.9	4.05
Buffers on all applicable crop land (reduction only for water that interacts with active area)	90	36	8.7	1.63
Perennial/energy crops equal to pasture/hay acreage from 1987	90	10	2.6	9.34
Perennial/energy crops on 10 percent of tile-drained land	90	25	6.1	3.18
Point source reduction to 10 mg/L		14	3.4	3.3

Actual performance and costs will vary by site and region

Combining two practices on a single field

	Nitrate-N reduction per acre (percent)
Spring-only application on tile-drained corn acres	15-20
Bioreactors on 50 percent of tile-drained land	25

The % reductions are not additive

Example: annual average loss of 33 lb N/ac

Switch to spring only N reduces the loss by 20% to 26.4 lb N/ac (note that 26.4 is 80% of 33)

Adding a bioreactor reduces the 26.4 lb N/ac by 25% to 19.8 lb N/ac

19.8 is a 40% reduction from 33 lb N/ac

The % reductions are not additive, but the fraction of remaining N loss is multiplicative:

[(1-0.20) x (1-0.25)] = 0.60 or 60% N loss remaining

100% - 60% = 40% N loss reduction

We attempted to combine least cost N and P reduction practices

Table 3.14. Example statewide results for total phosphorus reductions by practice/scenario with shading to represent in-field, edge-of-field, land use changes, and point source practices or scenarios.

Practice/scenario	Total P reduction per acre (percent)	Total P reduced (million lb)	Total P reduction from baseline (percent)	Cost ($/lb removed)
1.8 million acres of conventional till eroding >T converted to reduced, mulch, or no-till	50	1.8	5	-16.6
P rate reduction on fields with soil test P above the recommended maintenance level	7	1.9	5	-48.75
Cover crops on all corn/soybean tile-drained acres	30	4.8	12.8	130.4
Cover crops on 1.6 million acres eroding >T currently in reduced, mulch, or no-till	50	1.9	5	24.5
Wetlands on 25 percent of tile-drained land	0	0	0	
Buffers on all applicable crop land	25-50	4.8	12.9	11.97
Perennial/energy crops equal to pasture/hay acreage in 1987	90	0.9	2.5	102.3
Perennial/energy crops on 1.6 million acres >T currently in reduced, mulch, or no-till	90	3.5	9	40.4
Perennial/energy crops on 10 percent of tile-drained land	50	0.3	0.8	250.07
Point source reduction to 1 mg/L (majors only)		8.3	22.1	13.71

Nutrient Loss Reduction Strategy combined scenarios

Table 3.17. Example statewide nitrate-nitrogen and total phosphorus scenarios.

Name	Combined practices and scenarios	Nitrate-N reduction (percent)	Total P reduction (percent)	Cost of reduction ($/lb)	Annualized costs (million $/yr)
NP1	MRTN, spring-only N application, bioreactors on 50 percent of acres, wetlands on 35 percent of acres, no P fertilizer on 12.5 million acres above STP maintenance, reduced till on 1.8 million conventionally tilled acres eroding >T, buffers on all applicable lands, point source to 1 mg total P/L and 10 mg nitrate-N/L	35	45	**	438
NP4	MRTN, spring-only N application, bioreactors on 53 percent of acres, no P fertilizer on 12.5 million acres above STP maintenance, reduced till on 1.8 million conventionally tilled acres eroding >T, buffers on 80 percent of all applicable land	20	20	**	76

Nutrient Loss Reduction Strategy combined scenarios

Name	Combined practices and scenarios	Nitrate-N reduction (percent)	Total P reduction (percent)	Cost of reduction ($/lb)	Annualized costs (million $/yr)
NP3	MRTN, spring-only N application, bioreactors on 30 percent of acres, no P fertilizer on 12.5 million acres above STP maintenance, reduced till on 1.8 million conventionally tilled acres eroding >T, cover crops on 87.5 percent of corn/soybean acres, buffers on all applicable lands, perennial crops on 1.6 million acres >T and 0.9 million additional acres	45	45	**	827

Different practices have different strengths and weaknesses

- Cover crops may not perform well in a dry fall due to limited germination and establishment
- Spring application of N may not perform well in a summer drought
- Bioreactors and wetlands don’t perform well wet and high flow situations.
- Combining approaches that perform well in low flow and high flow conditions provides a more robust approach to nutrient loss reduction

Value of in-field and edge of field practices

Estimated statewide cost was lowest using a combination of in-field and edge of field practices

Diversified approach provides flexibility in implementation

Diversified approach is likely to have more consistent performance

Remember that reduction percentages of practices applied to an individual field are not additive!

Thank you!