Minnesota Watershed Nitrogen Reduction Planning Tool

Research shows how a simple management strategy can decrease nitrogen contaminants in perennial grasses, while also providing additional ecosystem services.

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Abstract

Using the nitrogen reduction planning model involves three steps. The first step is to select a watershed, enter hypothetical adoption rates for each BMP, and compare the effectiveness and cost of the individual BMPs. The second step is to compare suites of the BMPs that would attain any given reduction in the N load at minimum cost. The third step is to "drill down" to the details and assumptions behind the models of effectiveness and costs of any particular BMP and make any adjustments to reflect your particular situation.

Why Develop a Nitrogen Reduction Planning Tool?

A watershed-level nitrogen reduction planning tool (Excel spreadsheet) compares the effectiveness and cost of nine different "best management practices" (BMPs), alone and in combination, for reducing N loads leaving a Minnesota watershed. The Minnesota Pollution Control Agency is developing a new set of standards for nitrate nitrogen in surface waters based on aquatic life toxicity. The tool was developed to assist the agency and local resource managers to better understand the feasibility and cost of various "best management practices" to reduce N loading from Minnesota cropland.

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What Did we Do

The BMPs are:

- Reducing corn N fertilizer rates to extension recommended rates,
- Changing fertilizer application timing, seeding cover crops, installing tile line bioreactors or controlled drainage,
- Planting riparian buffers, or
- Converting some corn and soybean acres to a perennial crop.

The spreadsheet does its analysis for a watershed that the user selects. However, the N loadings and crop economic calculations are done first by agroecoregion before aggregating the results into the watershed of interest. Agroecoregions are units having relatively homogeneous climate, soil and landscapes, and land use/land cover. The spreadsheet includes area data for the fifteen high-N HUC8 watersheds that make up roughly the southern half of the state, along with the state as a whole. When the user

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selects a watershed for analysis, formulas retrieve results as an area-weighted average of the agroecoregions making up that watershed. Each of the fifteen HUC8 watersheds includes between four and nine agroecoregions.

The N loadings from each agroecoregion are calculated in three categories: drainage tile discharges, leaching from cropland, and runoff. Nitrogen loading amounts modeled are "edge-of-field" measures that do not account for denitrification losses that occur beyond the edge of field as groundwater travels towards and is discharged to streams. The BMPs consider only loading from cropland, but loading from forests and impervious urban and suburban land is also included in the totals.

What We Have Learned

The EPA's Science Advisory Board has said that a 45% reduction in both N and P is needed in the Mississippi River to reduce the size of the Gulf of Mexico hypoxic zone. This tool suggests that the BMPs considered are not likely to achieve much more than half that reduction even at high adoption rates. Reducing N fertilizer rates on corn down to extension-recommended levels and shifting from fall to spring or sidedressed applications tend to be among the cheaper BMPs to adopt, but the results vary across watersheds and weather scenarios. Various other factors such as crop and fertilizer prices also affect the results, hence the need for a computer tool.

Future Plans

The tool and results of a larger project will be reviewed during the first half of 2013. The tool may then play a role in implementation of the new N state standards in the state.

For More Information

- **CenUSA Bioenergy Resources** CenUSA Project Resources - Research-based information on the opportunities and challenges in developing a sustainable system for the thermochemical production of biofuels from perennial grasses grown on land marginal for row crop production is available at www.cenusa.iastate.edu
- Davenport, M. A. & B. Olson. 2012. Nitrogen Use and Determinants of Best Management Practices: A Study of Rush River and Elm Creek Agricultural Producers Final Report, submitted to the Minnesota Pollution Control Agency as part of a comprehensive report on nitrogen in Minnesota Surface Waters. Department of Forest Resources, University of Minnesota, St. Paul, Minnesota,
- Fabrizzi, K. & D. Mulla. 2012. Effectiveness of Best Management Practices for Reductions in Nitrate Losses to Surface Waters In Midwestern U.S. Agriculture. Report submitted to the Minnesota Pollution Control Agency as part of a comprehensive report on nitrogen in Minnesota Surface Waters.

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- Lazarus, W. F., et al. Watershed Nitrogen Reduction Planning Tool (NBMP.xlsm) for Comparing the Economics of Practices to Reduce Watershed Nitrogen Loads. December 11, 2012. Mulla, D. J., et al. 2012. Nonpoint Source Nitrogen Loading, Sources and Pathways for Minnesota Surface Waters. Report submitted to the Minnesota Pollution Control Agency as part of a comprehensive report on nitrogen in Minnesota Surface Waters. Department of Soil, Water & Climate, University of Minnesota.

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