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Minnesota Crop Production Retailers Association Trade Show

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"Big Picture" Trends in Nitrogen Fertilizer Use, Water Quality, and Response Strategies

MN Crop Production Retailers/CPM
December 11, 2014

Bruce Montgomery
MN Department of Agriculture
Today’s Discussion Will Touch Upon the Following:

• “Big Picture” Overview of Nitrogen Fertilizer Use and Practices in Minnesota;

• Why is Nitrate in Groundwater so Challenging to Characterize and How Severe is it?;

• The State’s Response Strategy and the Proposed Nitrogen Fertilizer Rules;
State waters tainted with nitrogen

WATER FROM A1

Toxic levels of nitrogen found in state waters

A fourth of southern Minnesota's lakes and rivers are too tainted to use as drinking water, report says.

By Josephine Marcotty

In southern Minnesota, nitrogen contamination of the state's lakes and rivers is so severe that 27 percent of the state's lakes and rivers could not be used as drinking water, according to a new report from the Minnesota Pollution Control Agency (MPCA). The report found that nitrogen contamination is most prevalent in the state's southern and central regions.

Nitrogen contamination is caused by the slowdown in the growth of aquatic ecosystems. In a report, the MPCA identified nitrogen sources and their impact on water quality. The report found that nitrogen contamination in the state's lakes and rivers is so severe that 27 percent of the state's lakes and rivers could not be used as drinking water.

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Why Is This Such a Complex Problem?
One Huge Challenge is the Sheer Size:
There are Over 4 Million Acres of Cropland Overlying Vulnerable Groundwater Supplies

Statewide Analysis: 19% of Minnesota’s Cropland Overlies Highly Sensitive Groundwater Resources
With phosphorus, soil erosion, and most other contaminants, 90%+ comes from <10% of the land area. Targeting strategies are key.

Nitrogen is a very different “animal”. Crop selection and implementation of practices that cover a majority of the acres will be required.
Trends in Acres of “Leaky” Crop Rotations
1986-2012

Cumulative Acres of Corn, Soybeans, Edible Beans, and Potatoes

Acreages of Leaky Crops (Millions)
Trends in Planted Corn (Grain) Acres in MN from 1986-2014

Data Source: National Ag Statistics-MN Dept of Ag
Commercial Nitrogen Fertilizer Sales Trends in Minnesota: 1989-2013
Data Source: MDA, TVA, and AAPFCO

Sales Since 1989
Relationship between Grain Corn Production, Acreage, and N Fertilizer Inputs 1992-2013

Bushels Produced

Planted Acres

N Fertilizer Inputs (estimated for corn)

Corn Acres (X10000)
Est. Tons of N Fertilizer on Corn (X1,000)
Bu. Produced (Millions)
Nitrogen Fertilizer Use Efficiency Trends

Statewide “NUE” on Corn Using the N Balance Method

Ratio of Bushels Produced per Lb N Fertilizer Input

1.4
1.2
1.0
0.8
0.6
0.4

Relationship of N Use Efficiency and Groundwater Nitrate Levels (Nebraska)

\[ y = 1.8242x - 3517.2 \quad R^2 = 0.4484 \]
\[ y = 0.3668x - 591.26 \quad R^2 = 0.0464 \]
\[ y = -0.2369x + 495.89 \quad R^2 = 0.8657 \]

N Fertilizer Applied
\[ y = 0.3668x - 591.26 \quad R^2 = 0.0464 \]

N Removed in Grain
\[ y = 1.8242x - 3517.2 \quad R^2 = 0.4484 \]

Groundwater Nitrate-N (mg/L)

Data from Dr. Richard Ferguson, University of Nebraska
A Quick Overview of Where Minnesota Producers are at in Terms of BMP Adoption

Survey of Nitrogen Fertilizer Use on Corn in Minnesota

Peter Bierman\textsuperscript{1}, Carl Rosen\textsuperscript{1}, Rod Venterea\textsuperscript{1,2}, John Lamb\textsuperscript{1}

\textsuperscript{1}University of Minnesota – Department of Soil, Water, and Climate
\textsuperscript{2}United States Department of Agriculture – Agricultural Research Service
Regional BMP Analysis for the Northwest Minnesota

Rates on Corn: 131 lb/A (the most conservative of the five regions);

Timing on Corn: Dominated by spring applications (89%);

Other Crops: High Level of N Management on Sugar Beets

Groundwater Concerns: Localized along the beach ridges;

Site Specific Issues: Atmospheric N losses under sheet water conditions and flooding;

Future subsurface tile drainage?
Regional BMP Analysis for East Central and Localized Coarse Textured Soils

Rates on Corn: Highly variable depending on irrigation or dryland;

Timing on Corn and Potatoes: Split applications common; N management very high

Other Crops: Edible Beans requires high level of management

Groundwater Concerns: Very high especially in areas where specialty crops are grown; BMPs may not be enough

Site Specific Issues:
Crop failure due to excessive water stress

High density of feedlots/manure resources in Stearns and other localized areas
Regional BMP Analysis for Southwest and West Central

Rates on Corn: 139 lb/A

Timing on Corn: 46% Fall applied.

Other Crops: Excellent N management on sugar beets

Groundwater Concerns: Sensitive alluvial channels for rural water systems. Lack of water quantity an issue.

Site Specific Issues: Manure management (mainly hog) and proper crediting remains a significant issue.

Additional crediting for soybean N credits needed
Regional BMP Analysis for South Central

Rates on Corn: 146 lb/A (Highest of the five regions)

Timing on Corn: 40% Fall applied. Roughly half of those acres used a nitrification inhibitor

Groundwater Concerns: Localized where coarse-textured soils are found.

Site Specific Issues: Manure management (mainly hog) and proper crediting remains a significant issue.

Additional crediting for soybean N credits needed

Fall application of Urea--minimal
Regional BMP Analysis for South East

Rates on Corn; 140 lb/Acre

Timing on Corn: Highly dominated by spring or split applications

Groundwater Concerns: Extremely fragile area and well construction costs are very high

Site Specific Issues: Manure management and proper crediting remains a significant issue. High amount of dairy consolidation.

Continued loss of alfalfa acres

Fall application of MAP/DAP
Statewide N Timing Assessment by N BMP Regions

“Brick Notation” denotes a probable environmental issue

% Nitrogen Applied by Season

NW | WC/SW | Sands | SC | SE

Interpretation:
5% of the N applied on the Sands, 5% in the Southeast Karst and 21% of the N applied in the South Central Regions may be inappropriate for these locations

Original Data Source: Bierman et al, 2011
NASS Corn Grower N Survey-2010

Statewide N Fertilizer Rates on Non-Manured Corn
(Represents 17% of the fields surveyed)

Corn

Acceptable Range 120 to 165
(0.10 Value Ratio)

143 Lbs/A

Bierman et al., 2011
NASS Corn Grower N Survey-2010
Statewide N Fertilizer Rates on Non-Manured Corn
(75% of the fields surveyed followed beans)

Acceptable Range 90 to 125 (0.10 Value Ratio)

Bierman et al., 2011
Statewide N Rate Assessment on Corn Following Soybeans: Average Rate 140 lb/A

“Brick Notation” denotes a probable environmental issue

N Fertilizer Rate Distribution for Corn Following Soybeans

1,119 Fields--2009 NASS/MDA/UM Report

<table>
<thead>
<tr>
<th>Nitrogen Fertilizer Pounds per Acre</th>
<th>Percent of Farm Fields</th>
<th>Est. 1 to 2 lb/A Loss over BMP Rate</th>
<th>Est. &gt;3 lb/A Loss over BMP Rate</th>
</tr>
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<tbody>
<tr>
<td>Less than 109</td>
<td>9%</td>
<td>9%</td>
<td>9%</td>
</tr>
<tr>
<td>110 to 124 (UM Recs)</td>
<td>15%</td>
<td>33%</td>
<td>25%</td>
</tr>
<tr>
<td>125 to 139</td>
<td>18%</td>
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<tr>
<td>140 to 154</td>
<td>33%</td>
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<tr>
<td>Over 155</td>
<td>25%</td>
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Original Data Source: Bierman et al, 2011  N Loss Interpolation by MDA Staff
Nitrapyrin Sales: 1996-2012
Data Source: MDA

Trends in N-Serve and Instinct Use on Corn
(Acres Treated Based on 1/2 Pound of AI Per Acre, Label Rate)
Nitrate-Nitrogen in Minnesota Groundwater
MN's Best Statewide Estimate: 94-95% of the Private Drinking Water Wells are Safe for Human Consumption In Terms of Nitrate-Nitrogen Concentrations
TARGETED TOWNSHIP TESTING

A RAPID, HIGH DENSITY APPROACH FOR THE ASSESSMENT OF NITRATE IN MINNESOTA PRIVATE WELLS
Nitrogen Fertilizer Management Plan (NFMP)

The NFMP is the state’s blueprint for minimizing groundwater impacts from the use of nitrogen fertilizer.
The NFMP is Intended to Assist Both Public Drinking Water and Private Homeowners
NFMP Review Process and Timelines

1. The NFMP went through an extensive review process with the assistance of numerous organizations and agencies (2011-2013)
3. MDA released its response to comments in June, 2014
4. NFMP to be finalized in Fall, 2014 Winter 2014-15
Source Water Protection Areas (SWPA)
(Highest Priority)

Blue dots show locations for 27 community PWS (groundwater) systems currently monitored quarterly for exceeding 5 mg/L nitrate.
Many tools and approaches in the revised NFMP were developed from successes learned from a small number of Source Water Protection Areas (public water suppliers).

MDA and Our Local Partners have a 20+ Year History Working with Farmers and Communities
The “Ten Minute” Version of the NFMP

<table>
<thead>
<tr>
<th>Nitrate Levels</th>
<th>Voluntary</th>
<th>Acceptable</th>
<th>Not Acceptable</th>
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<td>BMP Adoption</td>
<td>Acceptable</td>
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## Revised NFMP: Clear Definition of Prevention & Mitigation Levels for Localized Responses

<table>
<thead>
<tr>
<th>Prevention</th>
<th>Level One</th>
<th>Level Two</th>
<th>Level Three</th>
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<td>Regulatory Status</td>
<td></td>
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Some Key Overarching Principles
Primary Goal of the NFMP:

“.......is to involve the agricultural community in problem solving at the local level. We all need to work together to respond to and address localized concerns about unsafe levels of nitrate in groundwater.”

Commissioner of Agriculture, Dave Fredrickson
Key NFMP Principles:
Local Involvement is Critical at ALL Levels

- Local Advisory Team including local government and SWCDs;
- Participation of local farmers, their dealers and crop advisors; and
- Site specific strategies are needed
Key NFMP Principles:

The NFMP......Highly Dependent on Voluntary BMPs

If farmers adopt the recommended practices, it is unlikely additional regulations on nitrogen fertilizers will be required
Key NFMP Principles:
The NFMP also recognizes however that fertilizer management BMPs may not be enough in highly sensitive areas!

There is a growing amount of research that suggests that if we are truly going to protect groundwater in sensitive areas, we may have to go far beyond traditional BMPs (4-R’s, etc);

Actions may require the conversion of row crops to perennials, CRP, permanent cover cropping systems, or pasture
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<tr>
<td>% Number of Private Wells</td>
<td>5% or More Above 10 mg/L OR 10% or More Above 7 mg/L</td>
<td>10% or More Above 10 mg/L</td>
<td>15% or More Above 10 mg/L</td>
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Criteria within the “Mitigation” Process for Private Wells (Township Scale)
Private Well Mitigation Criteria for Level 1

- Elevated conditions confirmed after eliminating wells of questionable construction;
- Greater than 5% of the wells exceed the 10 mg/L nitrate-N standard (or 10%>7 mg/L);
- Private wells resampled on a regular basis;
- Begin documenting nitrogen management practices and potential opportunities for improvement.
Private Well Mitigation Criteria for Level 2

- >10% of wells (after eliminating un-useable wells) exceed 10 mg/L nitrate-N standard;
- MDA evaluates nitrogen management practices;
- Remains classified as a Level 2 if BMPs are either already adopted OR adopted within the required time period;
- All sites start out in Levels 1 or 2;
Cliff’s Notes Edition

Private Well Mitigation Criteria for Level 3

• 10% of wells (after eliminating un-useable wells) exceed 10 mg/L nitrate-N standard;

• Determined that the BMPs are not adopted;

• Regulations/restrictions applied as needed.
Private Well Mitigation Criteria for Level 4

• 15% of wells (after eliminating un-useable wells) exceed 10 mg/L nitrate-N standard;

• Determined that the BMPs are not adopted;

• Increased restrictions.
Private wells within 230-280 townships may be at risk;

MDA and local partners will be assessing 80-100 townships over the next two years;

If funding continues to be available, ALL identified townships will be tested in six years (70,000 households)

Note: There are 2,775 Townships in Minnesota
Long Term Goal: Offer Testing Services to All Townships at Risk

As of November, 2014
58 Townships Tested

- Townships at Risk based upon 1) Vulnerable geology; 2) Row crop production; 3) History of high nitrate concentrations
Initial Private Well Nitrate-N Testing Results

Next Step: Site Visits to Determine Which Wells Should be Eliminated Due to Construction or Point Sources

Initial Results from the 22 Townships

- In 18 townships, 10% or more of the wells tested had nitrate-N $\geq 10$ mg/L
- In 3 townships, 5% or more had nitrate-N $\geq 10$ mg/L
- In one township, < 5% of the wells were over 10 mg/L
In a Nutshell, the Revised NFMP must consider water quality and BMP adoption.

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Recent Developments with the NFMP?

- Proposed Restrictions on Fall Applications;
- Localized Restrictions Resulting from Advanced Stages of the NFMP
- Preliminary Findings of the Township Testing Program
Proposed Rules Restricting Timing of Nitrogen Fertilizer Applications

The MDA will begin the process for developing rules for new regulations following the completion of the final NFMP. The rule development process will include additional opportunities for public comment. These rules will include two parts.

**Part One**—Proposed rules will restrict the fall application and application to frozen ground of nitrogen fertilizer in areas that are vulnerable to groundwater contamination.
Proposed Rules Restricting Timing of Fertilizer Application

Where?
In areas with vulnerable groundwater.
Restrictions vary by N BMP Region
Rules Restricting Timing of Fertilizer Application (See Handout)

This proposed rule will ONLY apply in areas of the state with vulnerable groundwater. Vulnerable areas will be officially defined through the rulemaking process. The map below provides an example of areas of the state where the proposed rule may apply. Areas in pink are considered the most vulnerable to groundwater contamination.

**Vulnerable Aquifers and Nitrogen BMP Regions**

**Statewide**
- In vulnerable areas, restrict fall and winter application of any fertilizer containing nitrate-nitrogen, such as 28% or 32% UAN solutions.
- In vulnerable areas with sandy soils, restrict fall and winter applications of any type of nitrogen fertilizer.

**South Central**
- In vulnerable areas, restrict fall and winter application of urea and ammonia without a nitrogen inhibitor.

**Southeastern**
- In vulnerable areas, restrict fall and winter application of any type of nitrogen fertilizer.
EXAMPLE:
Rule Restrictions in South Central Region

What Would Be Restricted?
No fall applications without the use of a nitrification inhibitor in areas with vulnerable groundwater:
Statewide N Timing Assessment by N BMP Regions

"Brick Notation" denotes a probable environmental issue

Interpretation:
5% of the N applied on the Sands, 5% in the Southeast Karst and 21% of the N applied in the South Central Regions may be inappropriate for these locations.

Original Data Source: Bierman et al, 2011
If LOCAL Regulations are needed, they will be applied through the use of a Commissioner’s Order.

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Second Part of the Proposed Rules

Part Two—The process for moving to regulations, as outlined in the draft NFMP, will be placed into rule.

• Based on regional and site specific conditions and considering input from the local advisory team, the rules will be applied to an area with elevated nitrate through the use of a Commissioner’s Order as outlined in the Groundwater Protection Act.
Take Home Messages—Voluntary Aspects

• We believe that the Plan is a logical and flexible approach for dealing with a very complex system;
• The revised Plan is built upon the knowledge gained from the 20 years of experience working with farmers and communities;
• The Plan is heavily dependent upon education and local problem solving; and
• Township Testing will be the “launching pad” for the NFMP characterizing current nitrate conditions in private wells across 230-280 townships.