

Proceedings of the 2nd Annual Nitrogen: Minnesota's' Grand Challenge & Compelling Opportunity Conference



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Nitrate in Our Drinking Water---

What 10,000 Wells Are Telling Us

NITROGEN: MN's Grand Challenge and Compelling
Opportunity Conference

February 23, 2016
Rochester, Minnesota

Bruce Montgomery
MN Department of Agriculture

Huge holiday
savings
inside

StarTribune

Sunday

DECEMBER 23, 2012

December 23, 2012

21°/12°
Snow won't melt
Cold and a bit dreary, B12

How Serious of a Problem is it?

Where has Agriculture Made
Advancements?

What are Some of the Remaining
Challenges?

Debbie Carlson filled a bottle of water on one of her properties near Red Wing to bring back to her Hastings home for drinking and cooking. She has high nitrate levels in her well water at home.

RENÉE JONES SCHNEIDER • reneejones@startribune.com

WATER FROM A1

N ow, through an emerging state-wide strategy, the Minnesota Department of Agriculture is devising a range of first, includ-

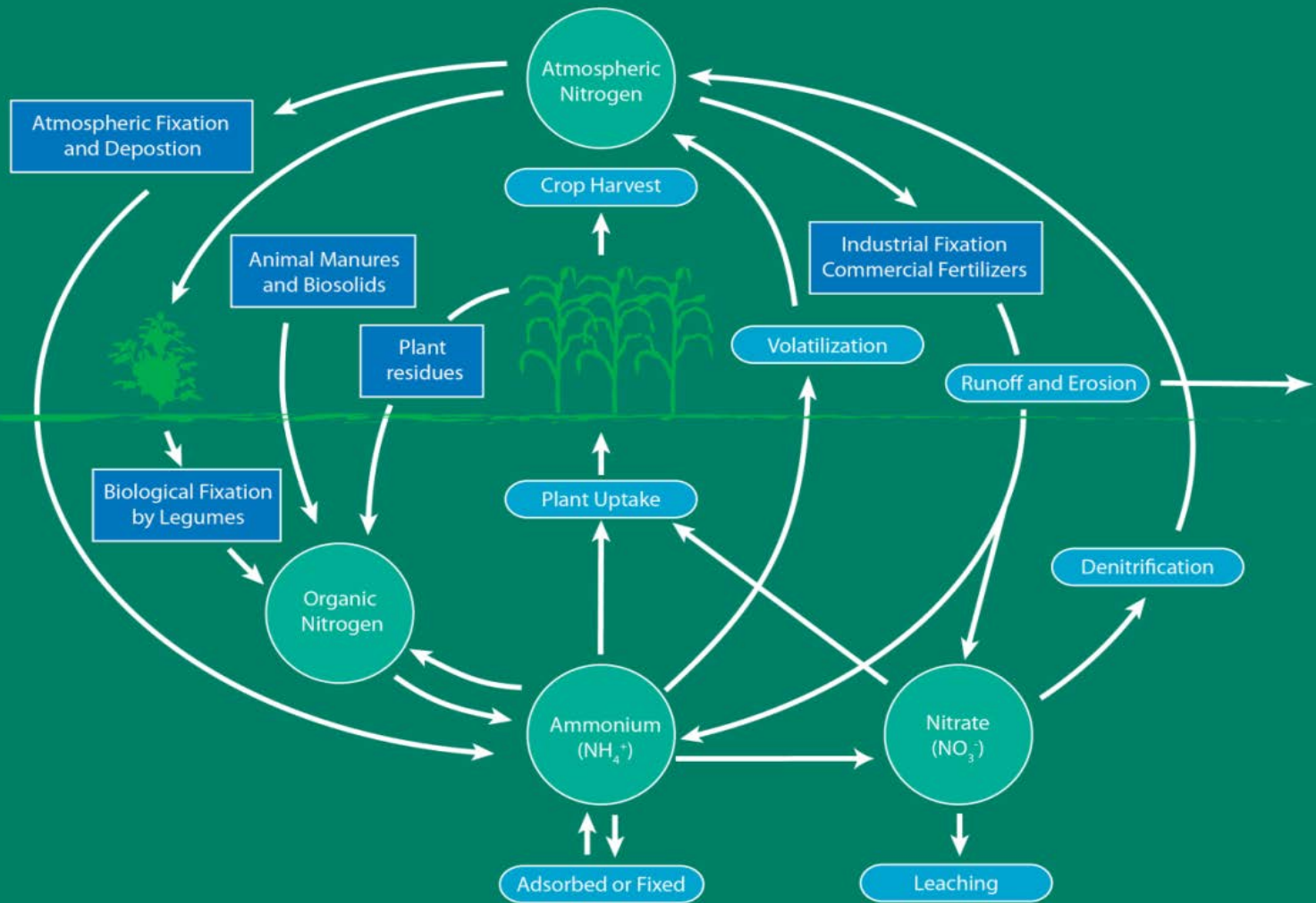
PAYING A PRICE FOR FERTILIZER AT FAUCET

"It's a pain," she said. "I don't know what I'm going to do."

Regulation?

Minnesota came up with its

The Nitrogen Cycle is a Highly Complex Set of Chemical and Biological Processes





Mythbusters

Driving with your tailgate down increases gas mileage....

“TRUE or FALSE”??



Driving with your tailgate down increases your gas mileage?

Correct Answer---FALSE (BUSTED)

Sorry, You're Incorrect

☒ A. True

The correct answer is:

B. False

go. But when MythBusters Jamie Hyneman and Adam Savage drove identical trucks under the same conditions across the desert — one with the tailgate up and the other with it down — Jamie's tailgate-closed pickup outlasted Adam's by more than 30 miles.

Closing the tailgate actually improves fuel efficiency because it creates a type of airflow called a separated bubble within the bed of the truck. As wind rushes over the moving truck, that bubble of slow-moving air deflects it over the raised tailgate. By guiding surrounding air over and across the truck bed, that vortex effect prevents added drag.



*Crop Selection and their Historic Acreages Help Explain
Nitrate Trends in Groundwater....
“TRUE or FALSE”??*

MYTHBUSTERS

Crops with Low N Loss Leaching Potential



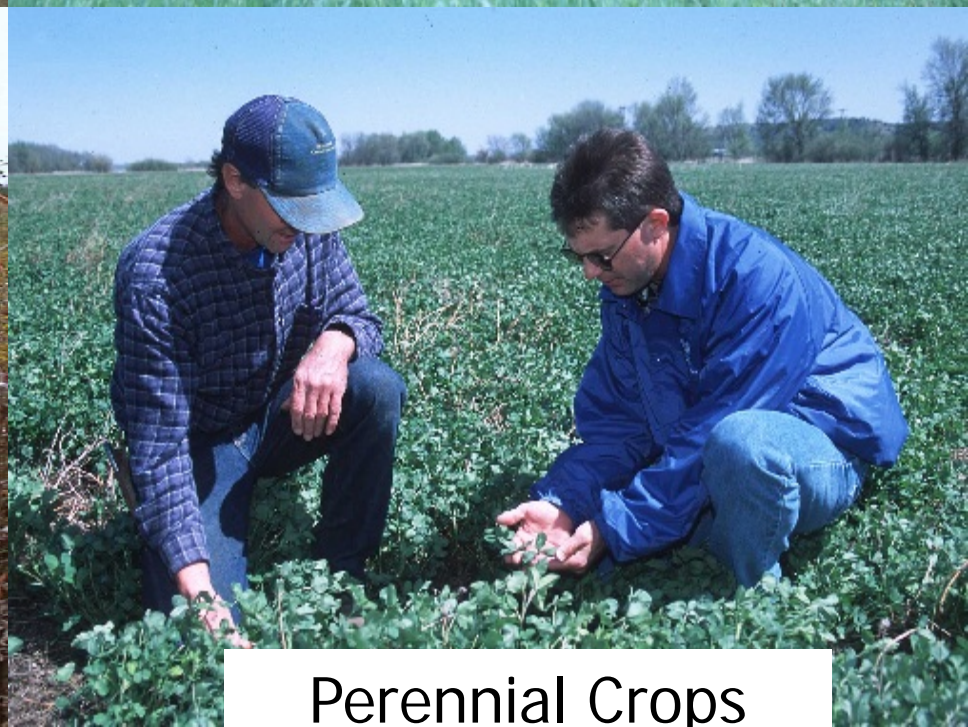
Alfalfa and Clover



Vegetated Pasture



Native Prairie/CRP
Plantings



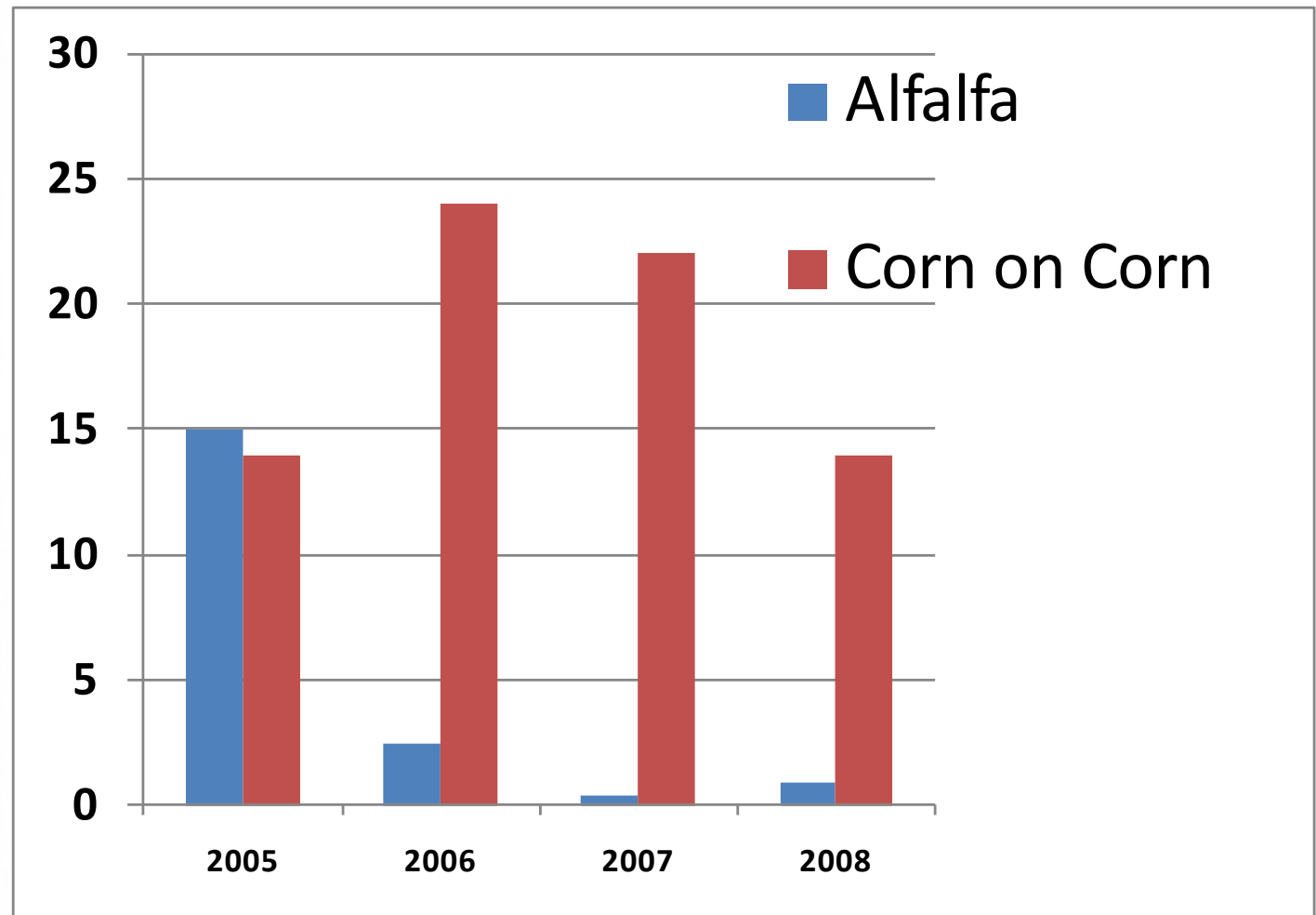
Perennial Crops

Alfalfa, Clovers, Orchard Grass, and Other Perennials Are Excellent Nitrogen Scavengers



Annual Nitrogen Losses Under Corn vs. Alfalfa Red Top Farm Demonstration Site

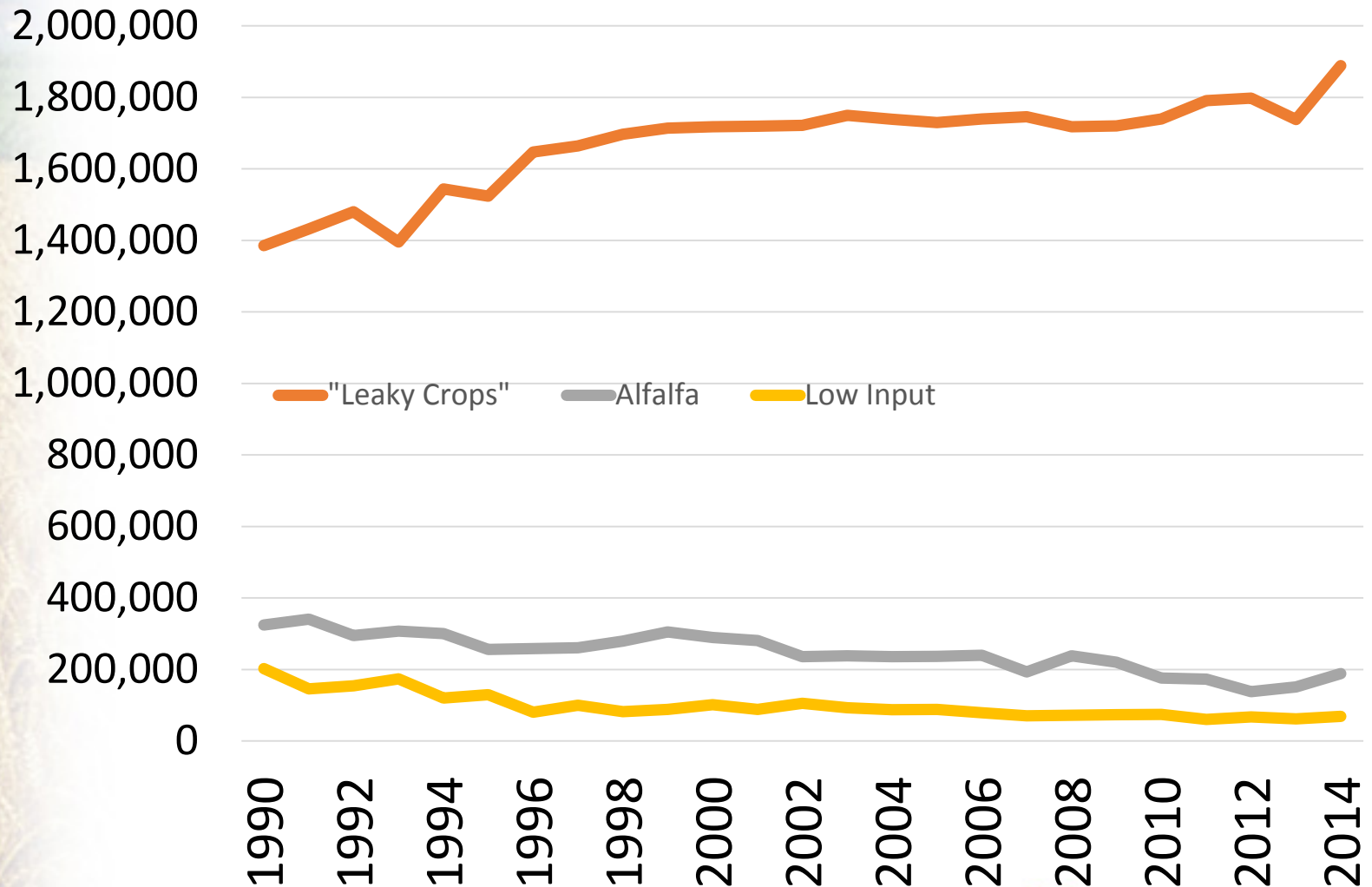
Annual N Losses lb/A



South East MN's Cropping Trends

1990-2014

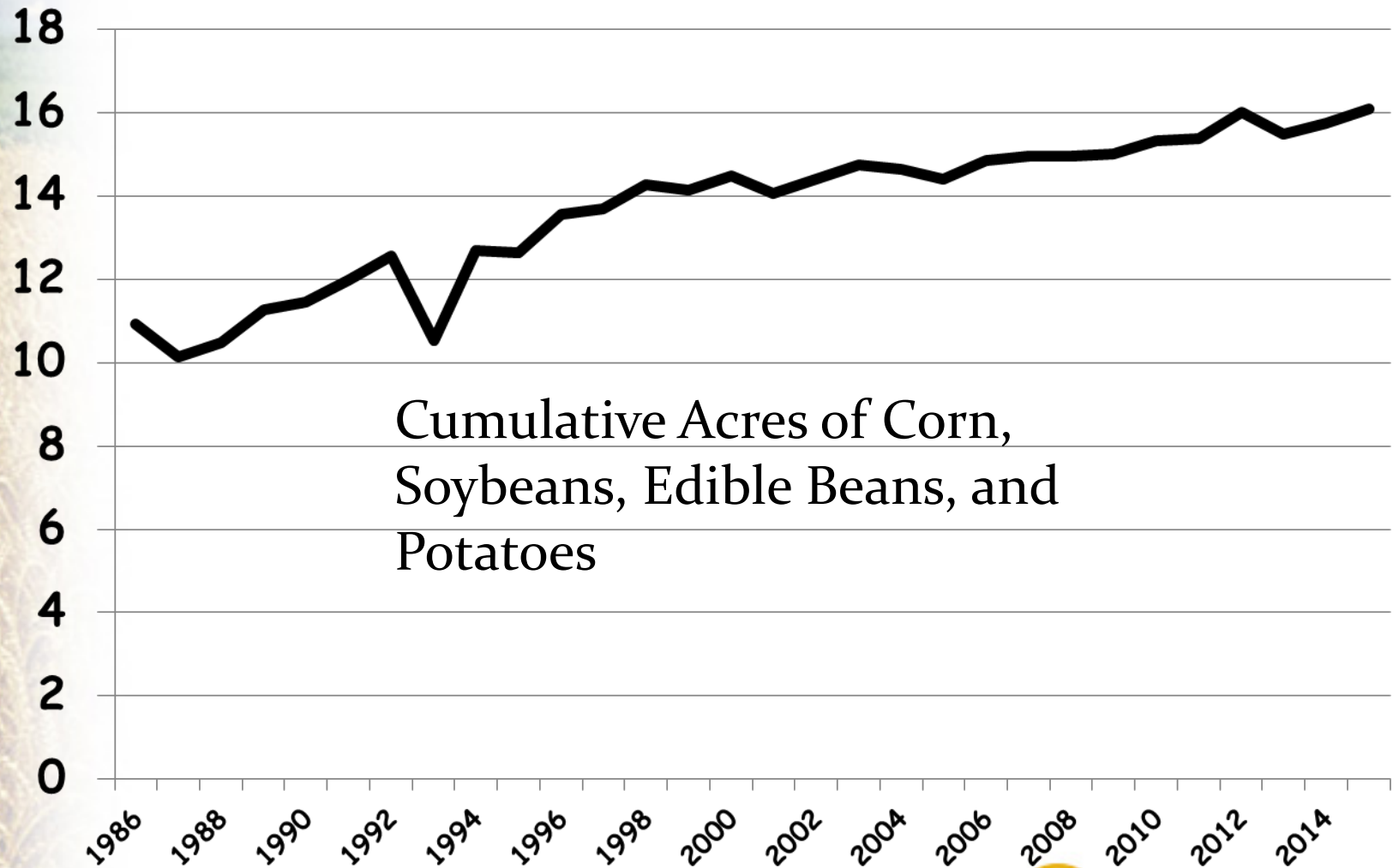
Cropland Acres



Trends in “Leaky” Crop Acreage in Minnesota

1986-2015

Acreages of Leaky Crops (Millions)



*Crop Selection and their Historic Acreages Help Explain
Nitrate Trends in Groundwater....
“TRUE or FALSE”??*

Plausible



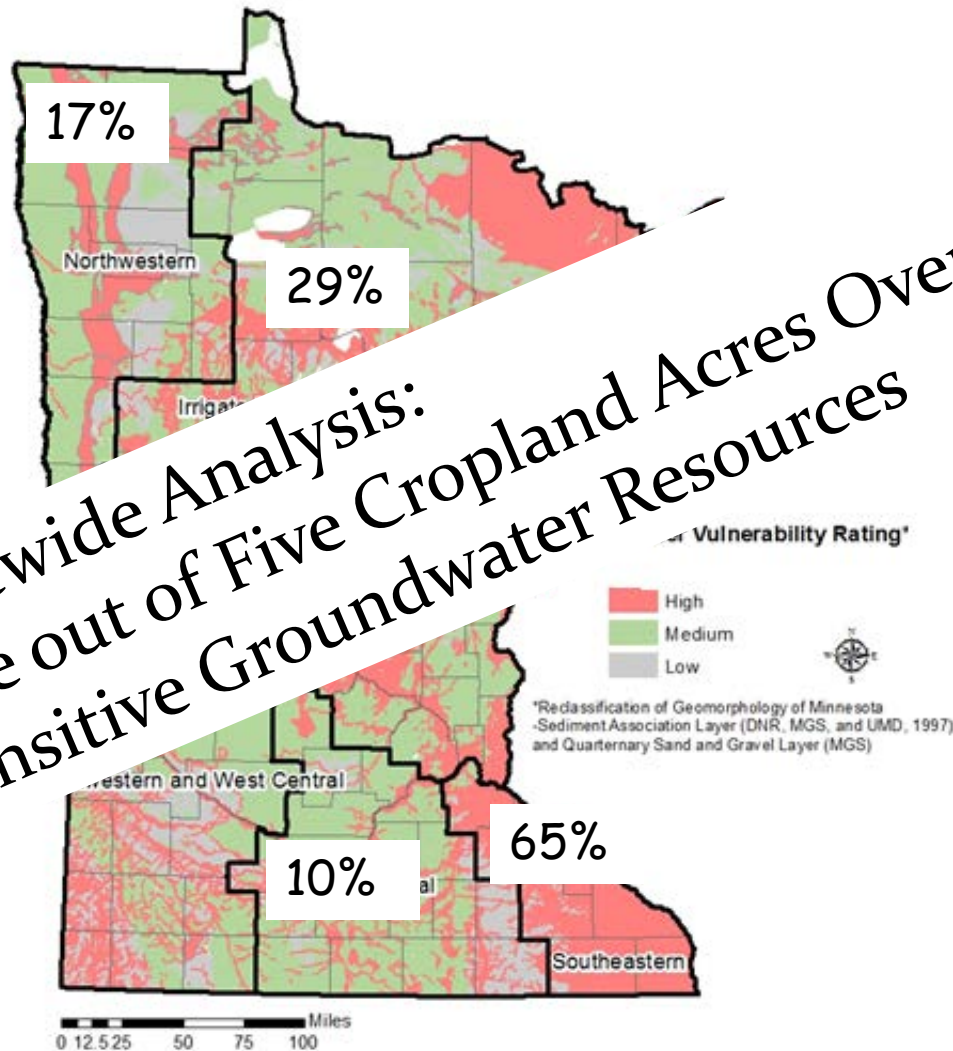
*We Should Only Be Concerned About Only A Very Small
Percentage of Our Farmland Potentially Impacting
Groundwater Supplies?*

“TRUE or FALSE”??

MYTHBUSTERS

One Huge Challenge is the Sheer Size:
Minnesota Has Over 4 Million Acres of Cropland
Overlying Vulnerable Groundwater Supplies

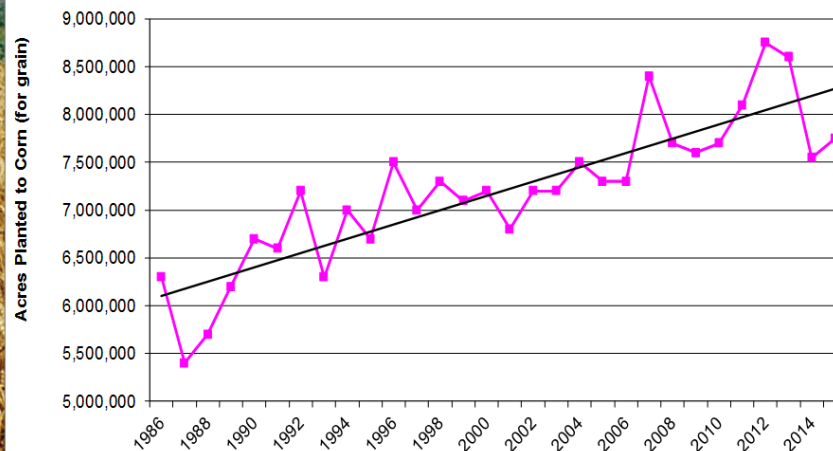
Statewide Analysis:
One out of Five Cropland Acres Overlies Highly
Sensitive Groundwater Resources



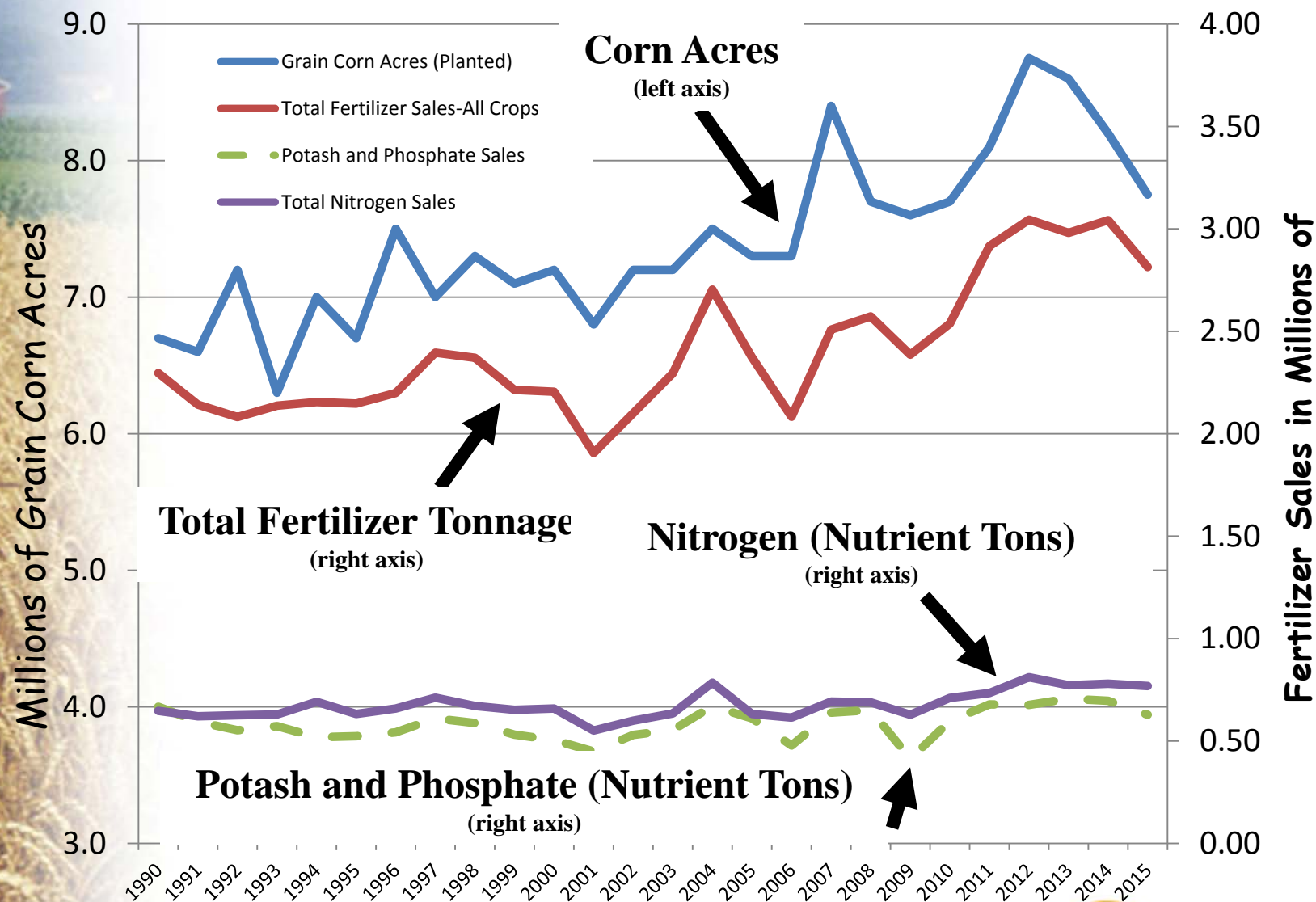
*Nitrogen fertilizer sales have sky-rocketed to support the record corn production....
“TRUE or FALSE”??*

Trends in Planted Corn (Grain) Acres in MN from 1986-2015

Data Source: National Ag Statistics-MN Dept of Ag

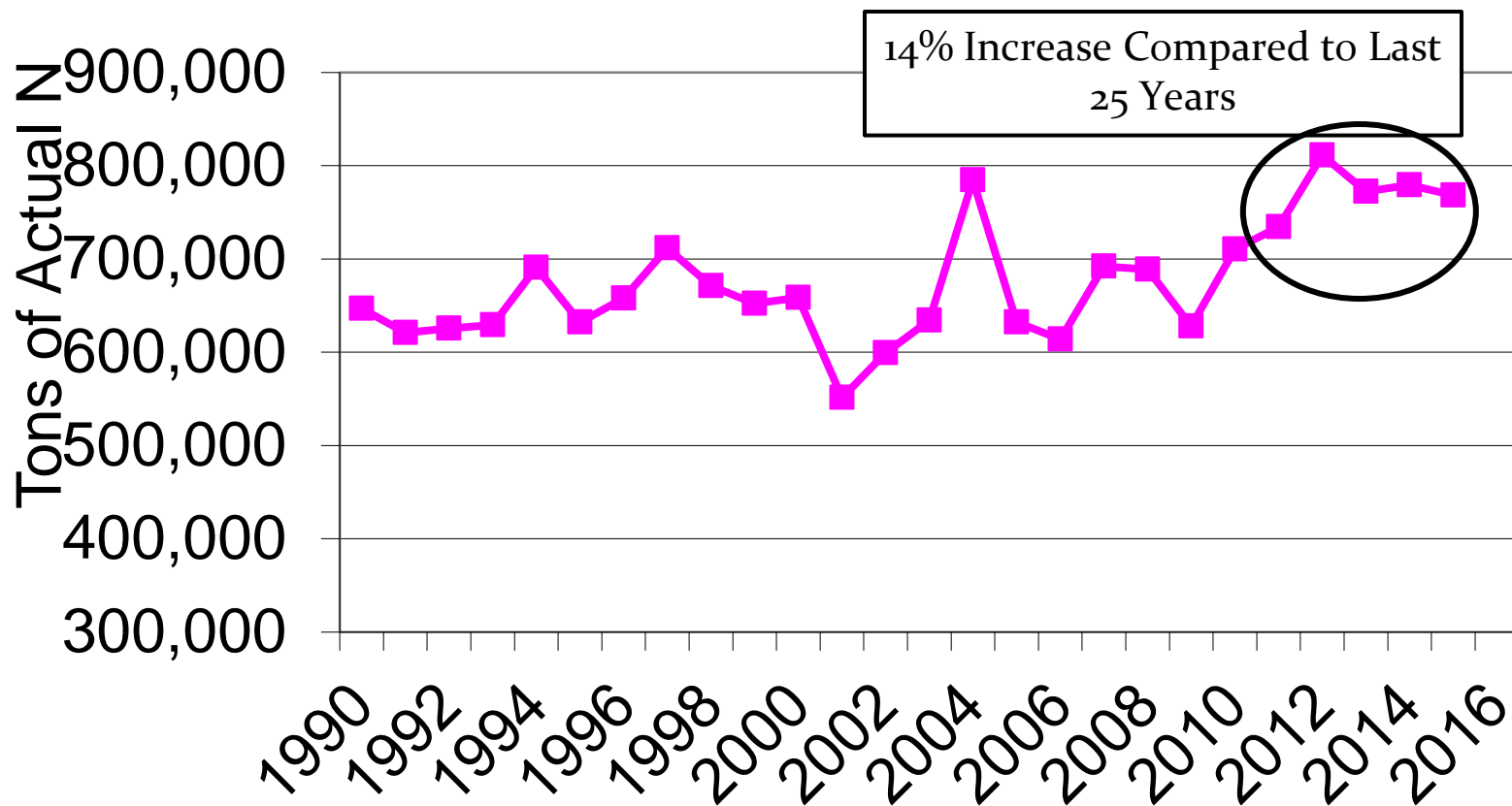


Trends in Minnesota's Corn Acreage and Fertilizer Sales: 1990-2015



Commercial Nitrogen Fertilizer Sales Trends in Minnesota: 1990-2015

Data Source: MDA, TVA, and AAPFCO



Sales Since 1990

Decade Averages 1990-1999: 653,817

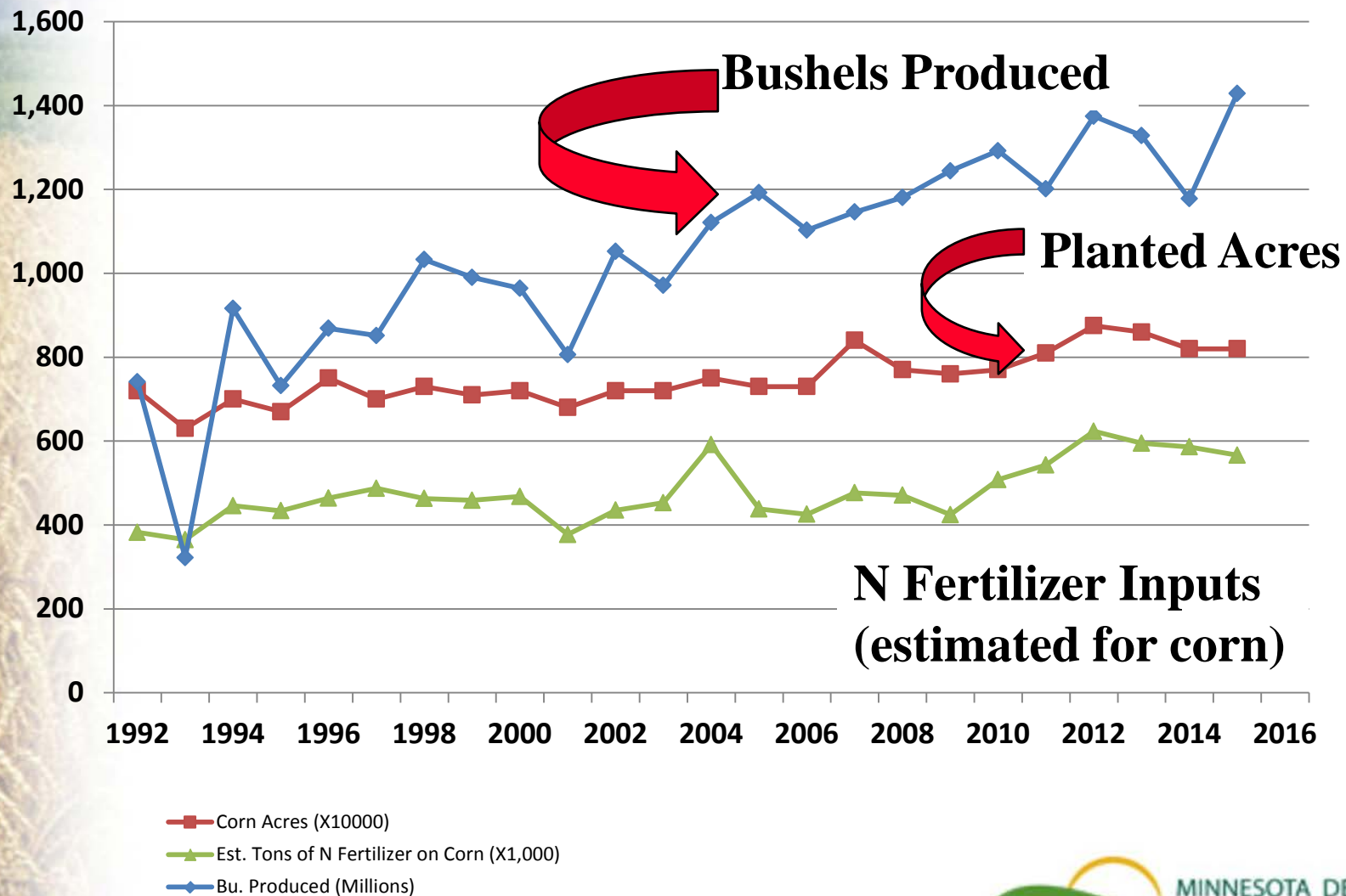
2000-2009: 648,274

2010-

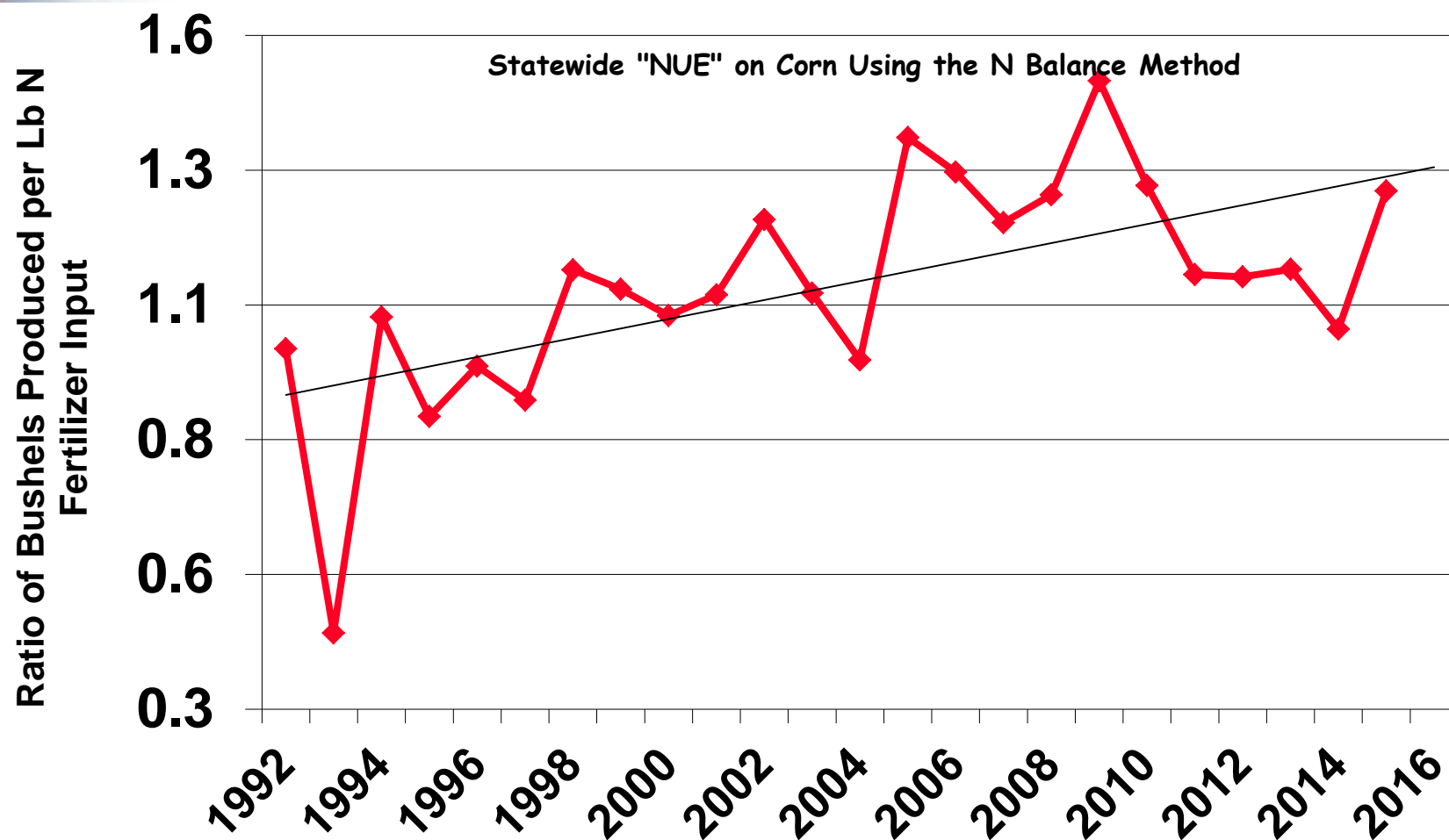
2015: 762,573

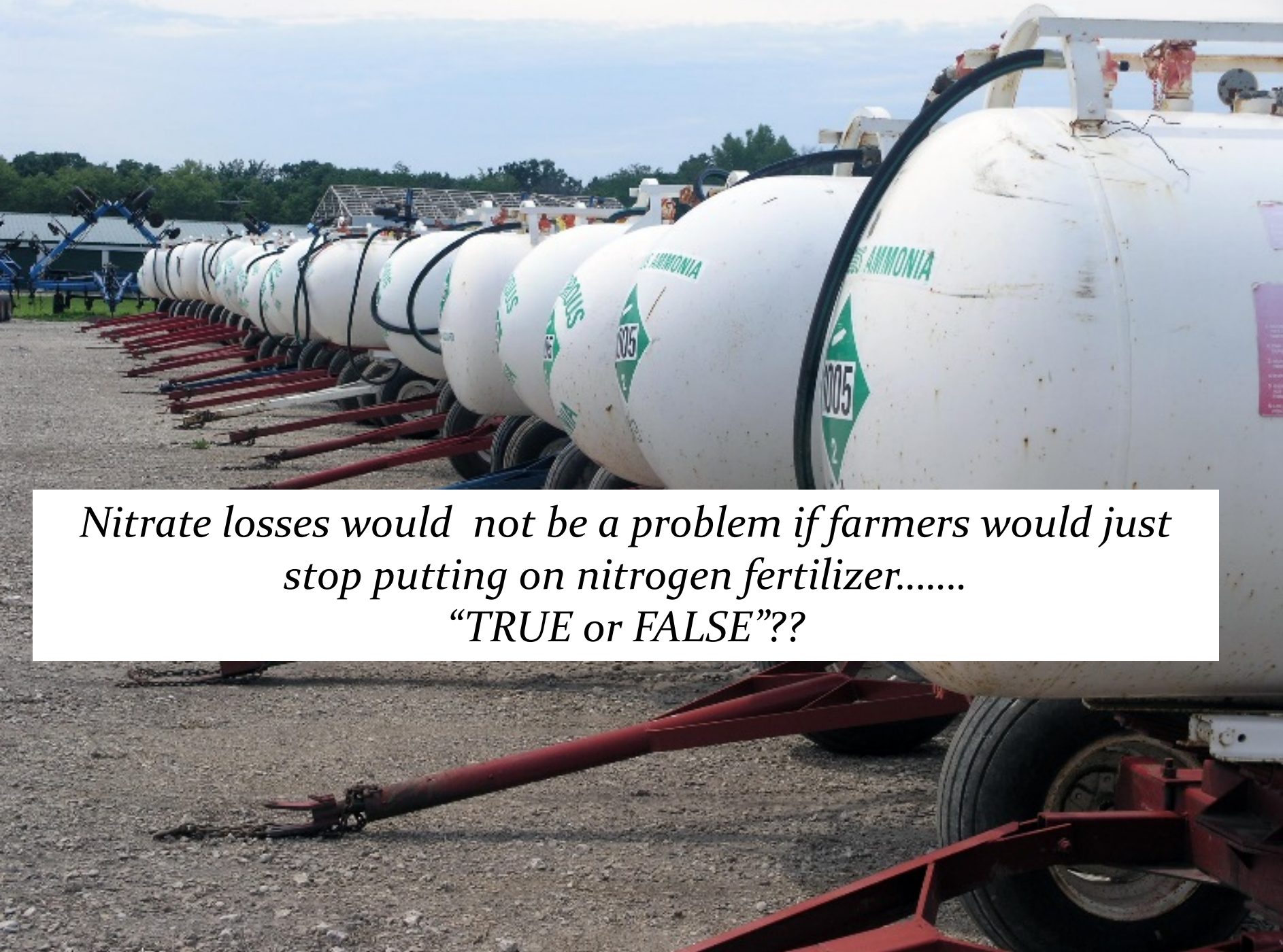
(Updated 2-6-2016)

Relationship Between Production and N Fertilizer Inputs on MN Corn (1992-2015)

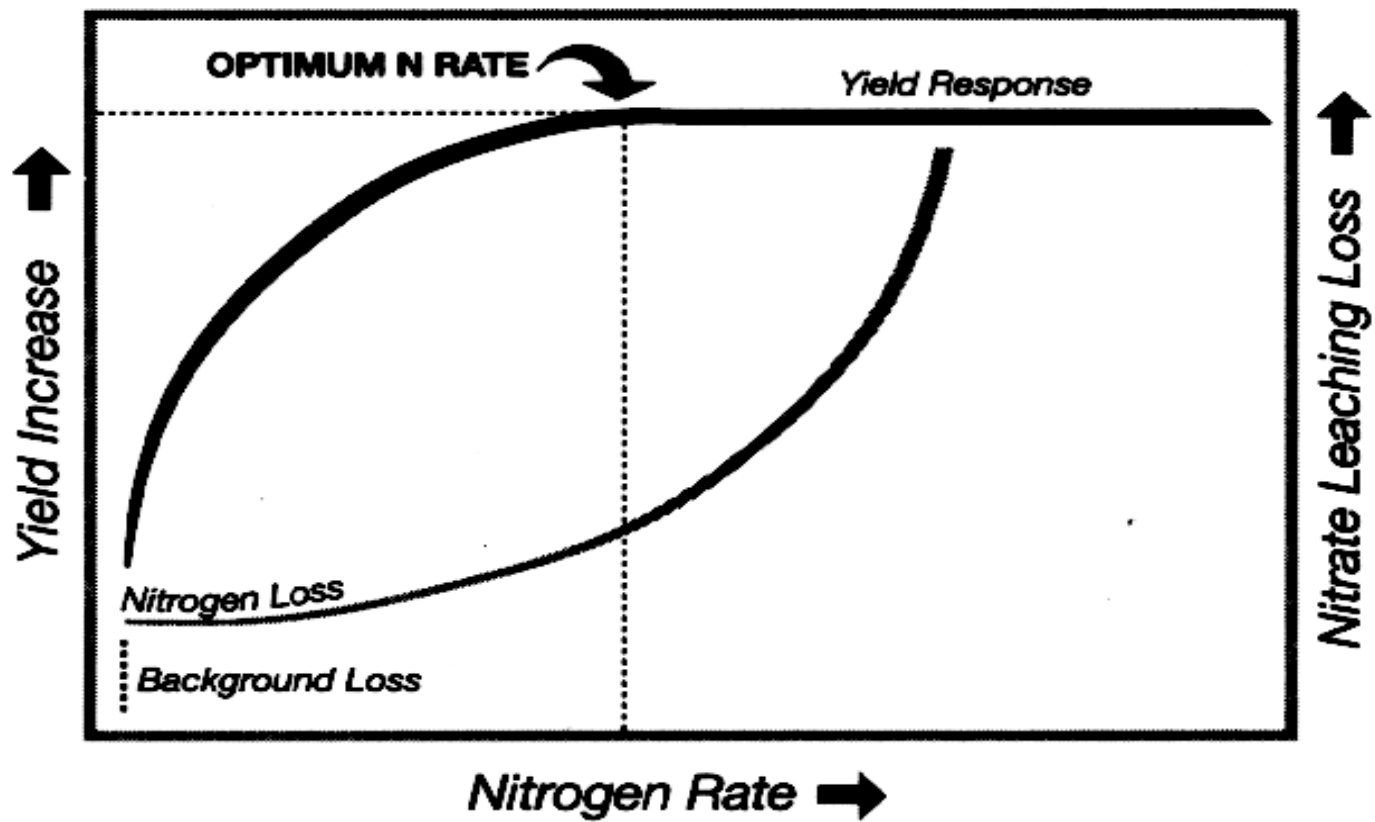


"Nitrogen Use Efficiency" for Minnesota Corn Production 1992 to 2015





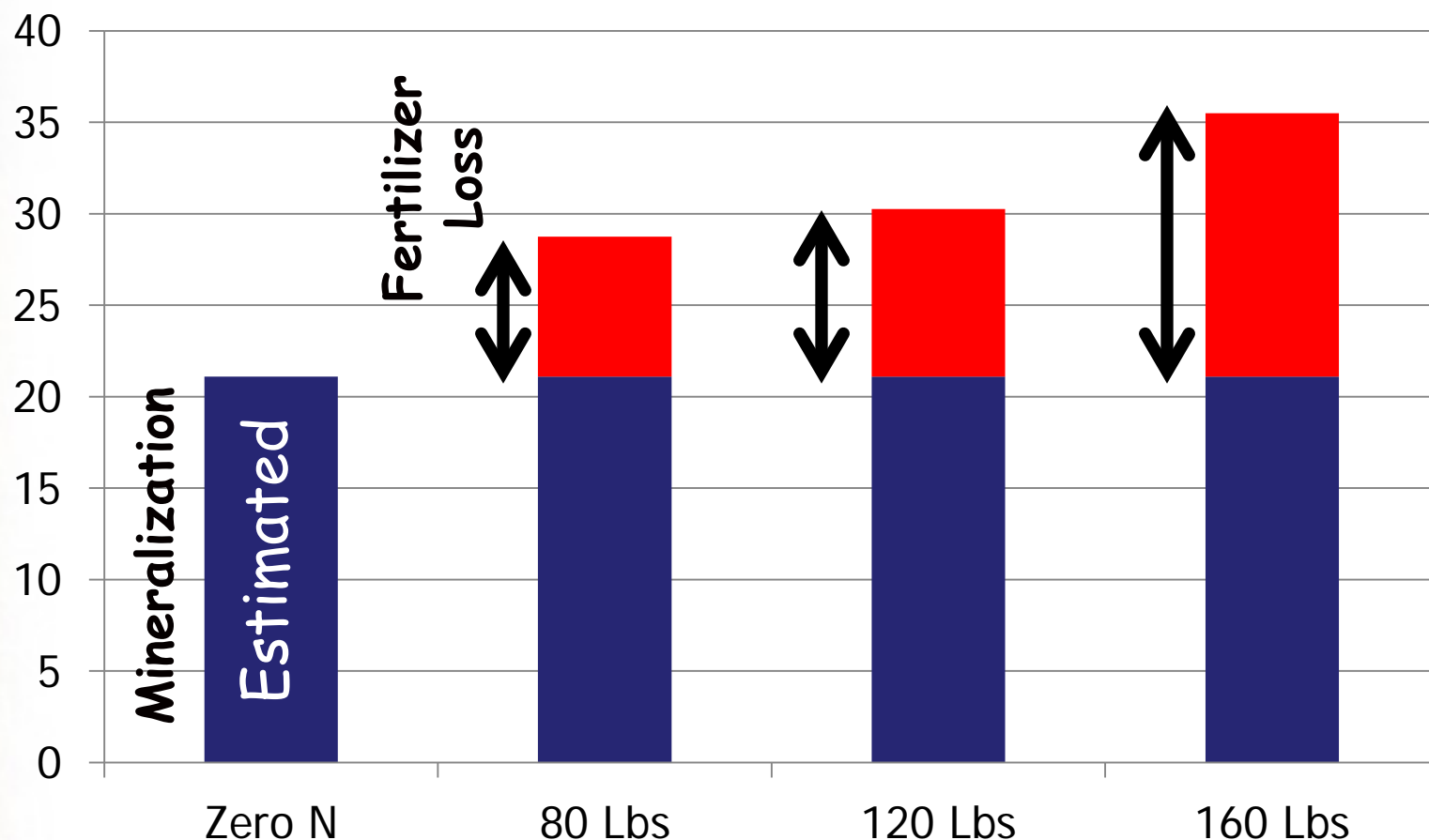
*Nitrate losses would not be a problem if farmers would just stop putting on nitrogen fertilizer.....
“TRUE or FALSE”??*



Partitioning Nitrate-N Losses from Mineralization and Fertilizer Applications

(SROC Waseca, 2000-2003 Wetter than normal years)

Nitrate-N Loss in Lb/A/Year



Data Source: Randall and Vetch, SROC

Estimated Check using 10 ml/L, 9.3 inches of drainage which is one inch higher due to poorer water use efficiency)

*Nitrate losses would not be a problem if farmers stopped putting on nitrogen fertilizer.....
“TRUE or FALSE”??*

False. There will always be some losses under row crop production. However, using recommended rates that optimize yields can significantly reduce unnecessary nitrate loading to our water resources



Nitrates in Drainage Water in Minnesota

Brad Carlson, Extension Educator, University of Minnesota Extension

Jeff Vetsch, Assistant Scientist, University of Minnesota SROC

Gyles Randall, Soil Scientist and Professor Emeritus, University of Minnesota SROC

UNIVERSITY OF MINNESOTA
EXTENSION

AGRICULTURAL DRAINAGE

Nitrates in Drainage Water in Minnesota

Brad Carlson, Extension Educator, University of Minnesota Extension
Jeff Vetsch, Assistant Scientist, University of Minnesota SROC
Gyles Randall, Soil Scientist and Professor Emeritus, University of Minnesota SROC

THE SITUATION

Nitrogen (N) is the single largest component of the atmosphere, and is an important building block for all living organisms. It is found in many different forms in the soil depending on the Nitrogen Cycle (Understanding Nitrogen in Soils, O'Leary et al., 1994). It is taken up by crops in greater quantities than any other added nutrient. Grass crops, such as corn and wheat, require the addition of N-based fertilizers to maximize productivity. Legume crops, such as soybeans and alfalfa, do not require additional N inputs because they have the ability to fix N from the atmosphere in their root systems. Overall, N sourced by crops for plant growth comes from fertilizer, soil organic matter, atmospheric deposition, animal manure, and fixation (for legumes only).

Losses of nitrate, a mobile form of N, to water systems have been a concern for many years because of human health issues. Ingestion of nitrate by mammals, especially human infants < 6 months old, interferes with the blood's ability to carry oxygen. Thus, a standard of 10 parts per million (ppm) of nitrate-N has been established for drinking water by the USEPA (<http://water.epa.gov/dwrl/contaminants/ha/haformation/nitrate.cfm>).

For decades, the primary focus has been on ground water because of its connection with drinking water. Less attention has been given to nitrate levels in surface water because of decreased dependence on surface water for drinking. This is also because phosphorus is typically a limiting nutrient in surface waters in meaning that excess nitrate does

not usually lead to increased plant and algae growth (considered significant surface water quality problems). For decades, there has been no established contaminant standard for nitrate-N in class 2 (aquatic life and recreation) waters in Minnesota (A Minnesota Farmer's Guide to Federal and State Clean Water Law, Carlson et al., 2012). Standards are currently under development, though, and are being phased in over the next few years.



Artificial drainage is not the only source of nitrate to surface waters, but it is the most easily seen, and measured, and therefore under more scrutiny than other transport mechanisms.

Recently, Hypoxia in the Gulf of Mexico has led to increased scrutiny on nitrate contributions to surface waters from agricultural systems (Gulf Hypoxia Action Plan, USEPA, 2008). Subsurface agricultural drainage or "tile drainage" has been the primary focus of the scrutiny. Tile drainage is a highly visible pathway of water transporting nitrate from the landscape to surface waters. Other pathways of water movement from the landscape, such as leaching, shallow groundwater flow, and

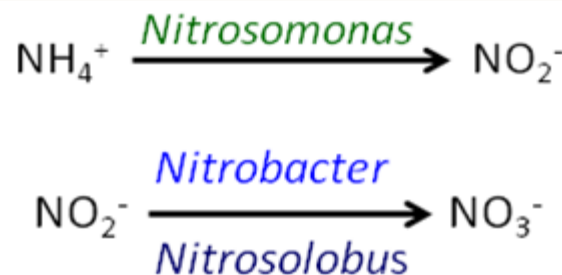
New Products Intended to Help Producers Increase Fertilizer Efficiencies Have Flooded the Market in Recent Years

“TRUE or FALSE”??



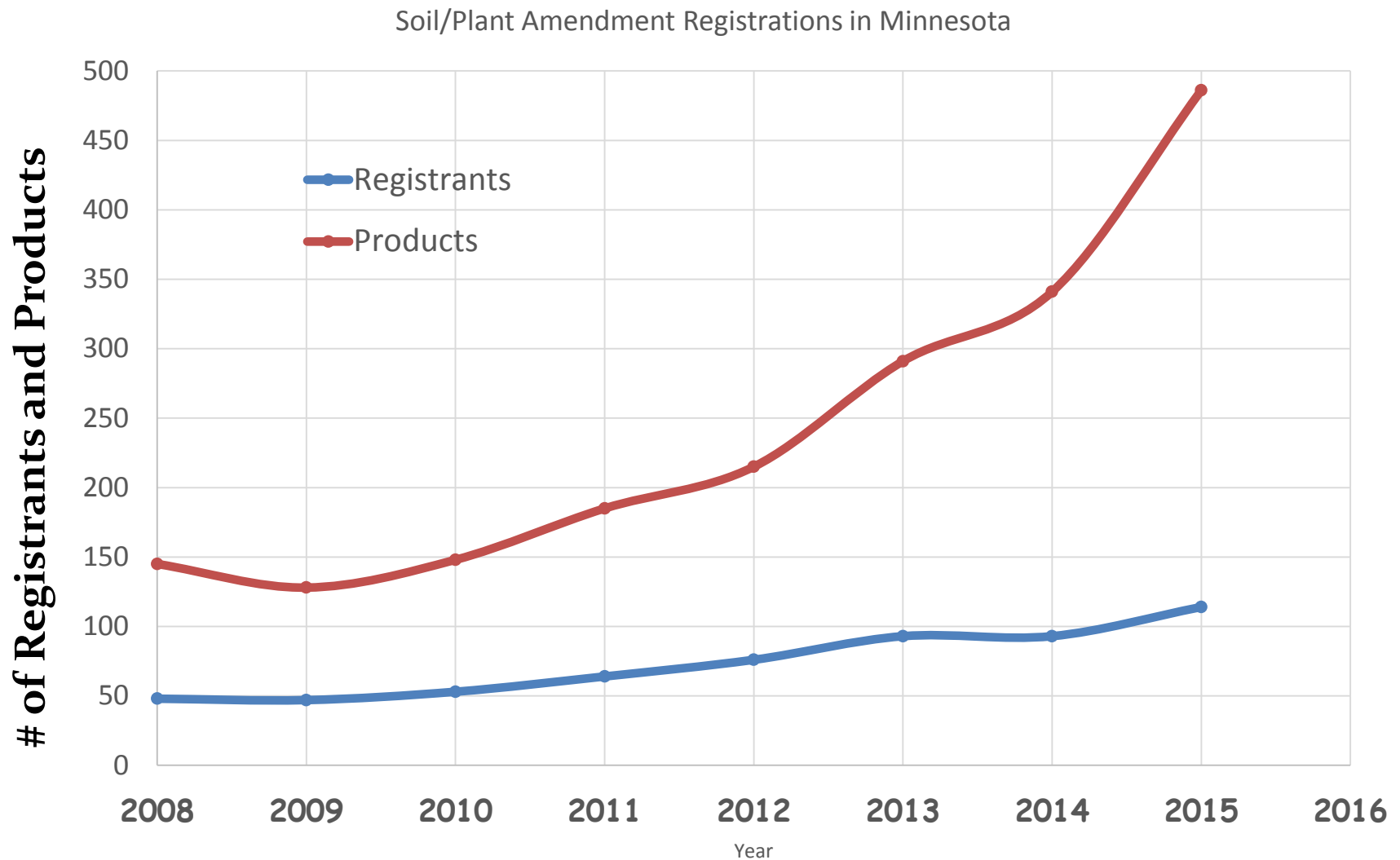
AVAIL® Phosphorus Fertilizer Enhancer

AGROTAIN®



Soil and Plant Amendment Registration Trends 2008-2015

Data Source: MDA

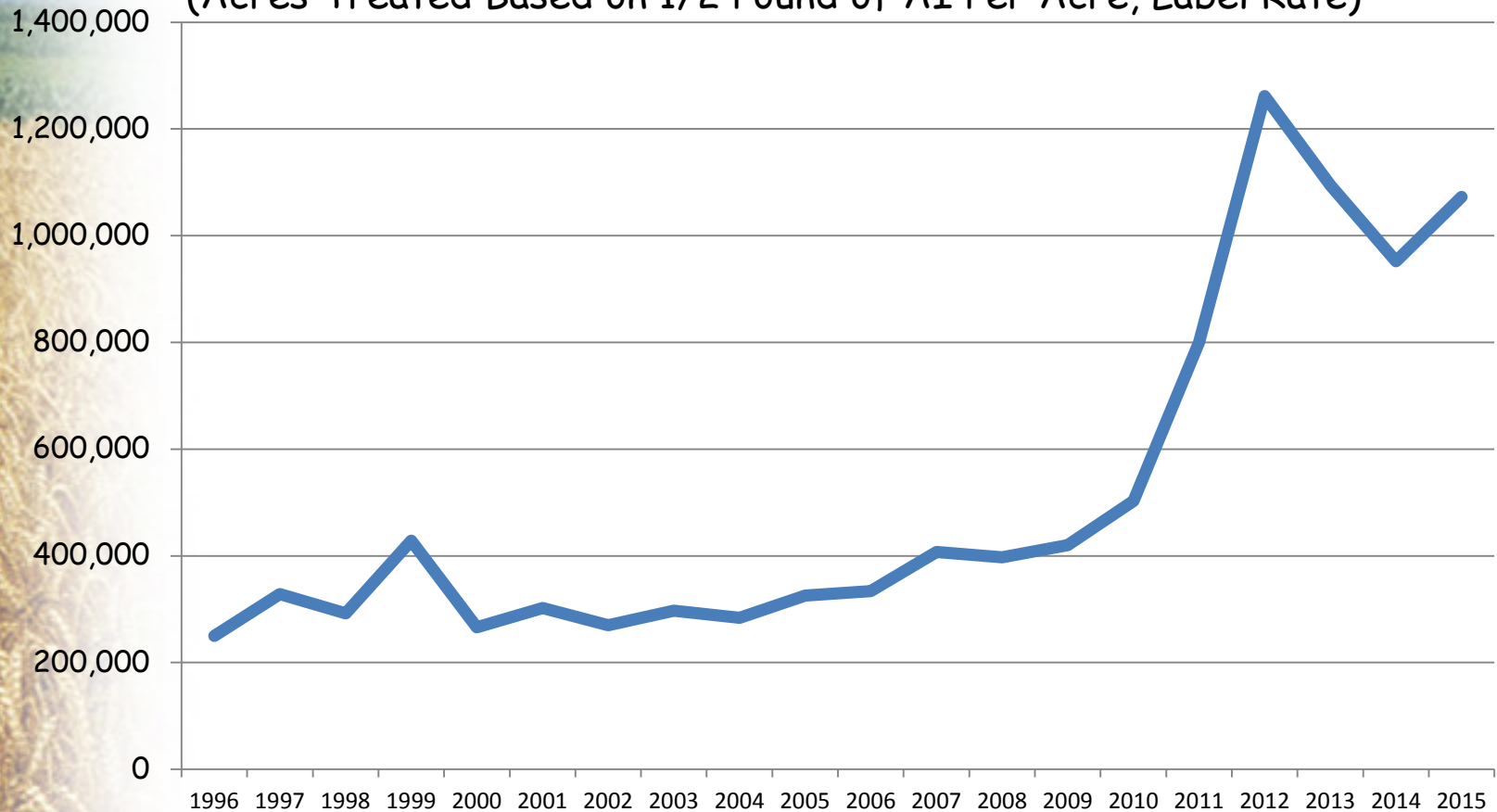


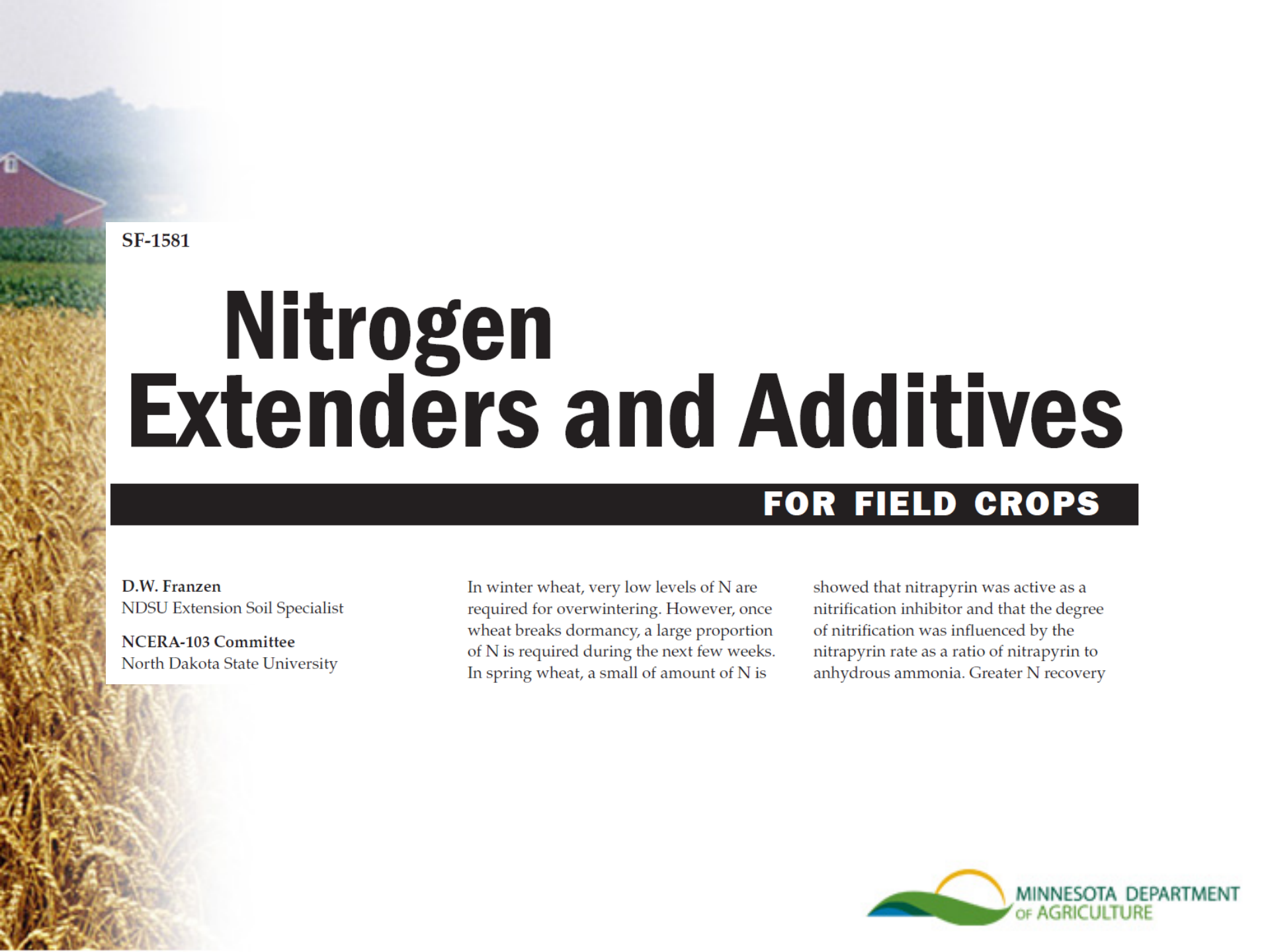
Nitrapyrin Sales: 1996-2015

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)

Estimated Corn Acres with either
N-Serve or Instinct Applied





SF-1581

Nitrogen Extenders and Additives

FOR FIELD CROPS

D.W. Franzen
NDSU Extension Soil Specialist

NCERA-103 Committee
North Dakota State University

In winter wheat, very low levels of N are required for overwintering. However, once wheat breaks dormancy, a large proportion of N is required during the next few weeks. In spring wheat, a small amount of N is

showed that nitrapyrin was active as a nitrification inhibitor and that the degree of nitrification was influenced by the nitrapyrin rate as a ratio of nitrapyrin to anhydrous ammonia. Greater N recovery

*Producers are pouring on the fertilizer with no
consideration of timing, sources, and rates*

“TRUE or FALSE”??

MYTHBUSTERS

Characterizing Regional and Statewide Fertilizer Practices

Survey of Nitrogen Fertilizer Use on Corn in Minnesota

Peter Bierman¹, Carl Rosen¹, Rod Venterea^{1,2}, John Lamb¹

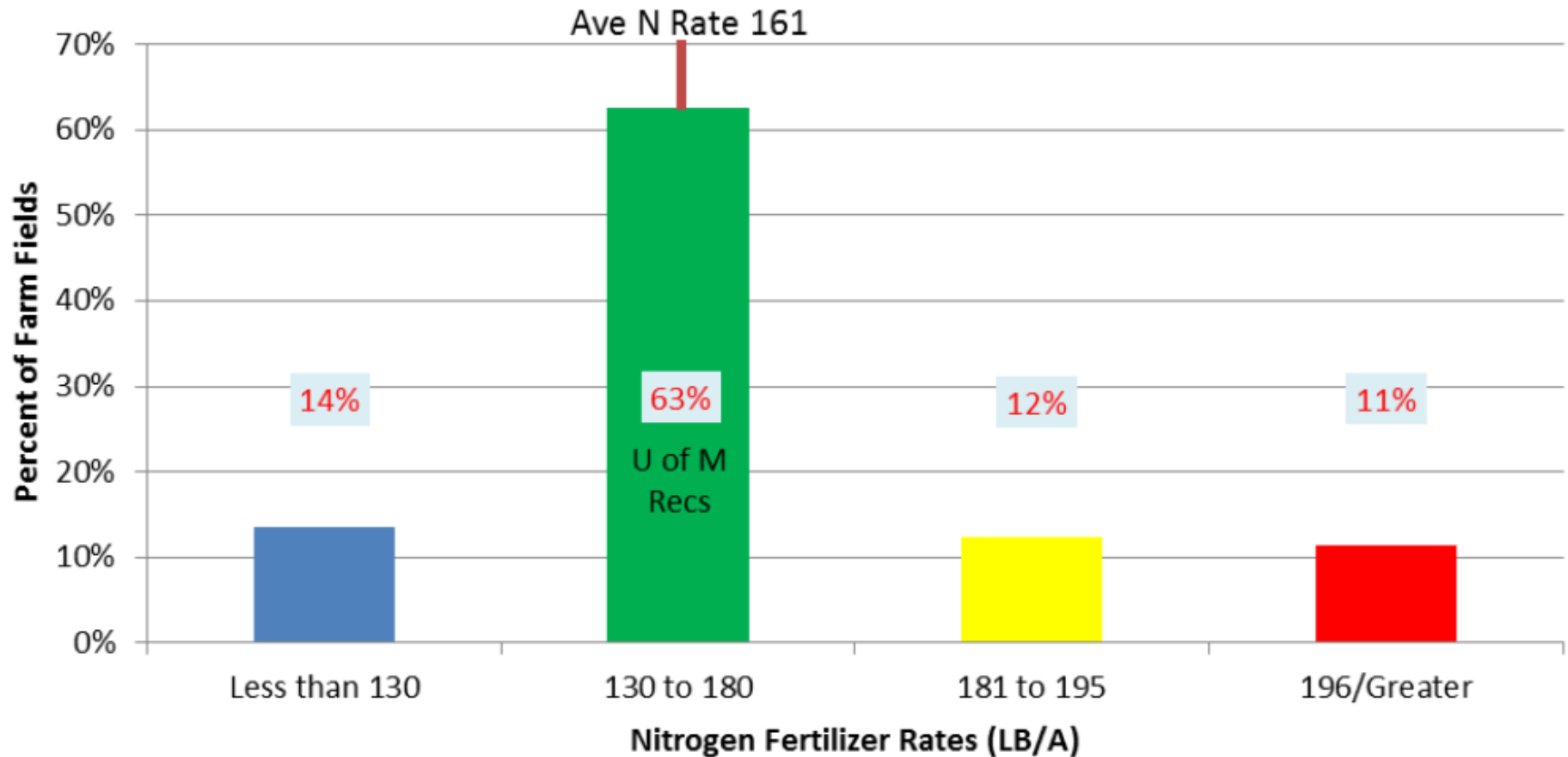
¹University of Minnesota – Department of Soil, Water, and Climate

²United States Department of Agriculture – Agricultural Research Service



NASS Corn Grower N Survey-2010

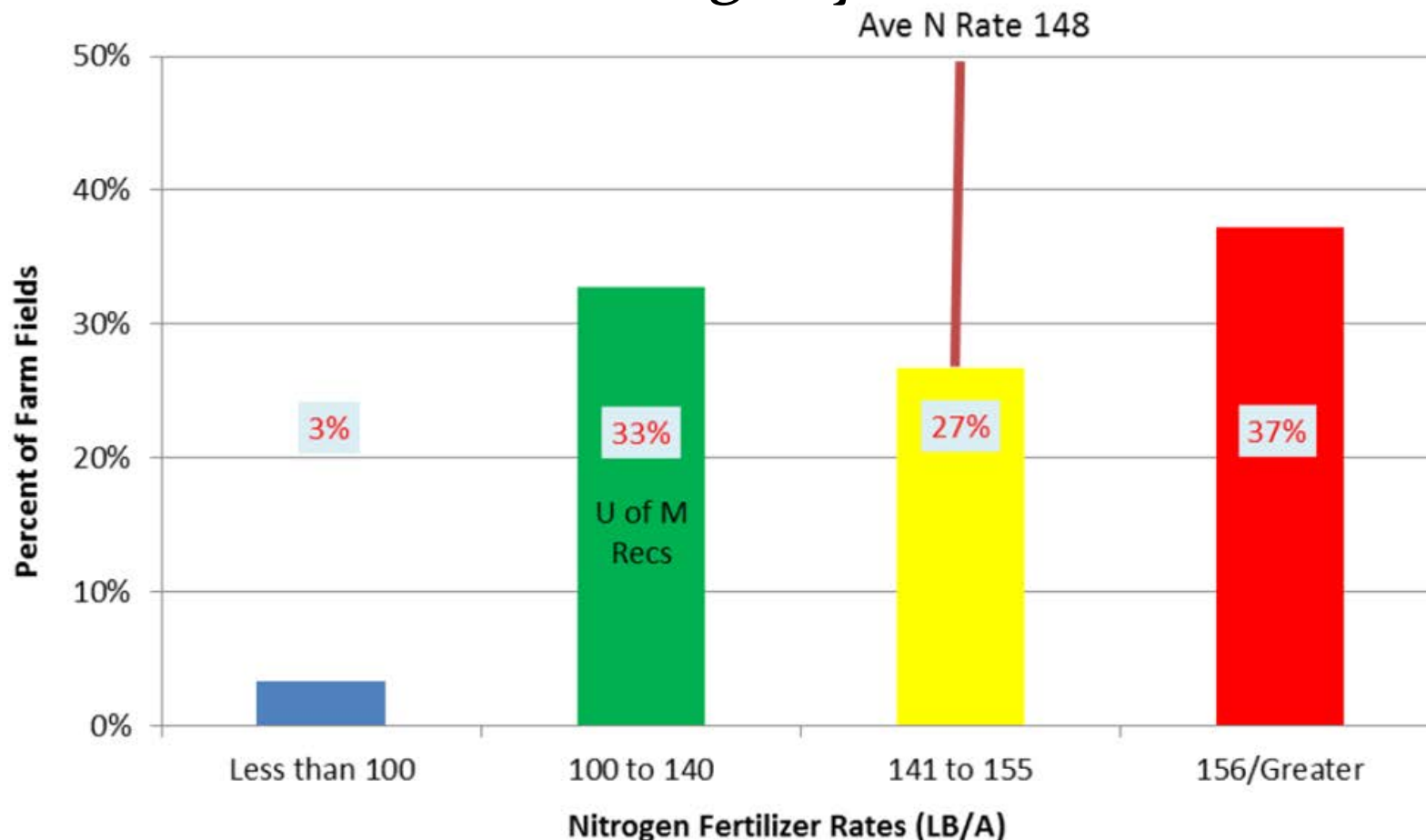
% of Fields Within UM Recommended N Ranges for Corn Following Corn---Statewide



Details: Analysis included 665 fields. Analysis uses "Nitrogen to corn price ratio" of 0.05 UM Recs at 0.10: 120-165 (140)
Manured fields not included in this scenario.

NASS Corn Grower N Survey-2010

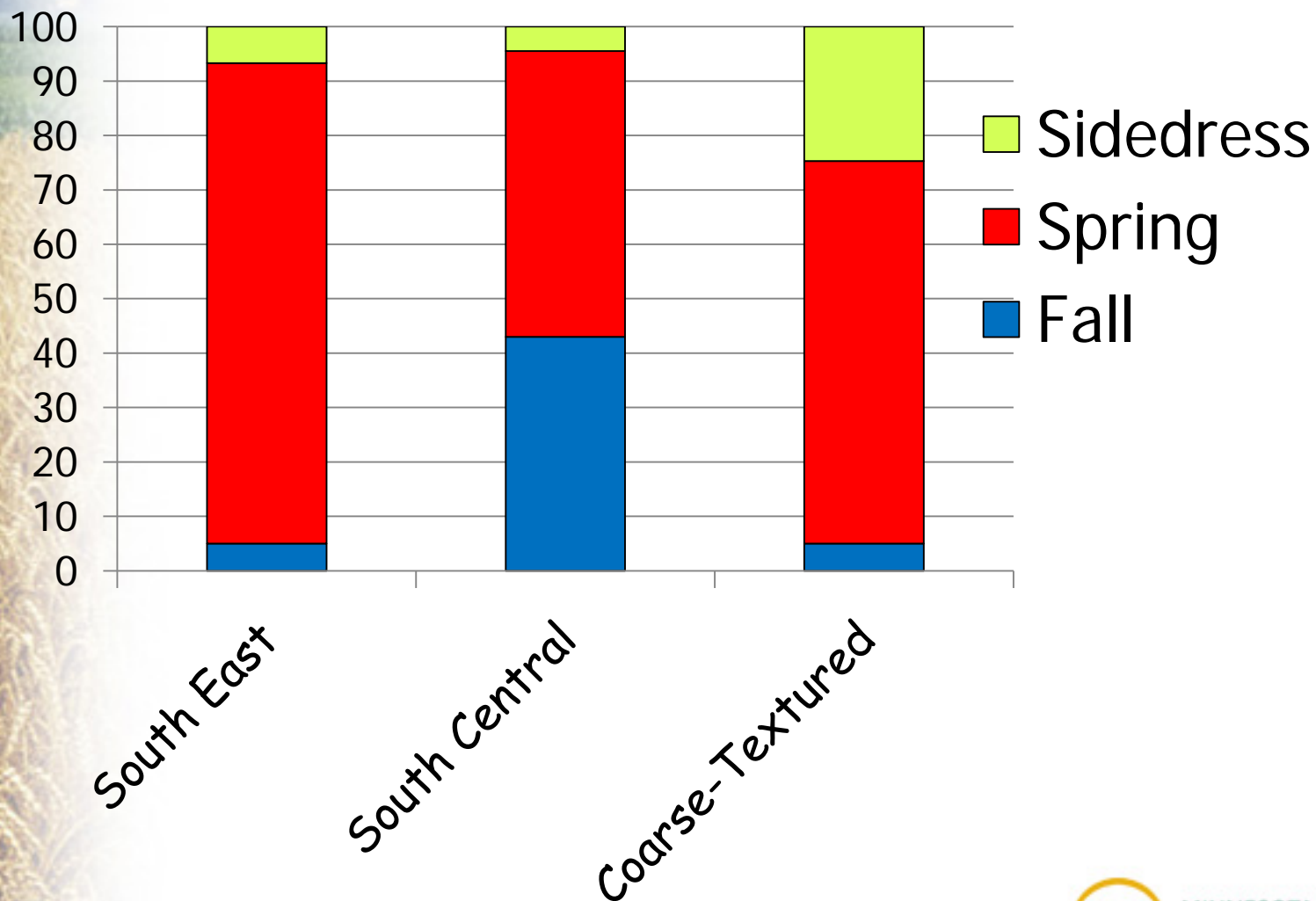
% of Fields Within UM Recommended N Ranges for Corn Following Soybeans---Statewide



Details: Analysis included 2,222 fields. Analysis uses "Nitrogen to corn price ratio" 0.05. UM Recs at 0.10: 90-125 (110)
Manured fields not included in this scenario.

NASS Corn Grower N Survey-2010

Timing of the Major N Source on Corn



*Producers are pouring on the fertilizer
“TRUE or FALSE”??*

*In general, MN producers do good to great jobs at
using the right source, timing and placement;*

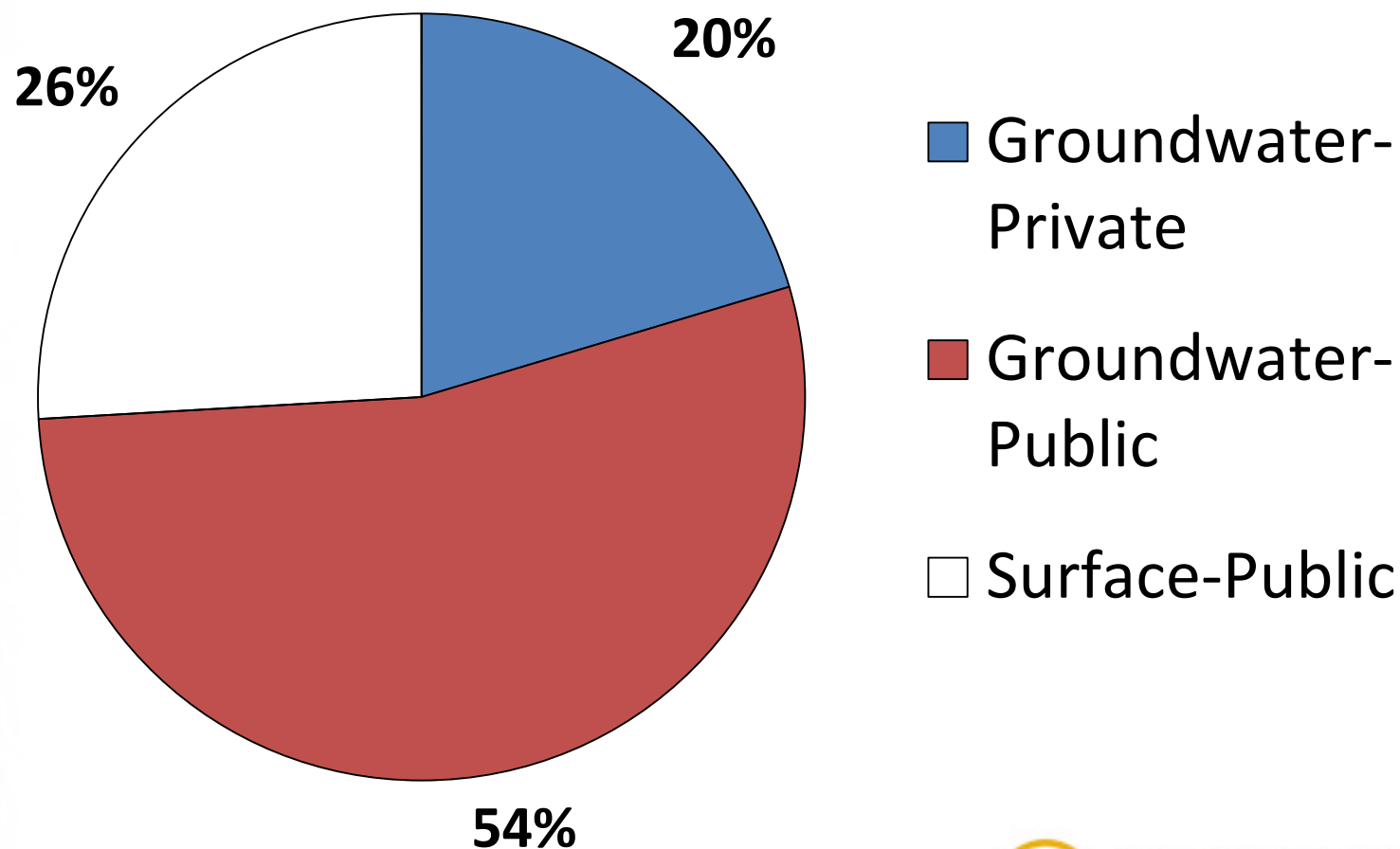
*Producers in many cases fail to take full advantage of
soybean credits;*

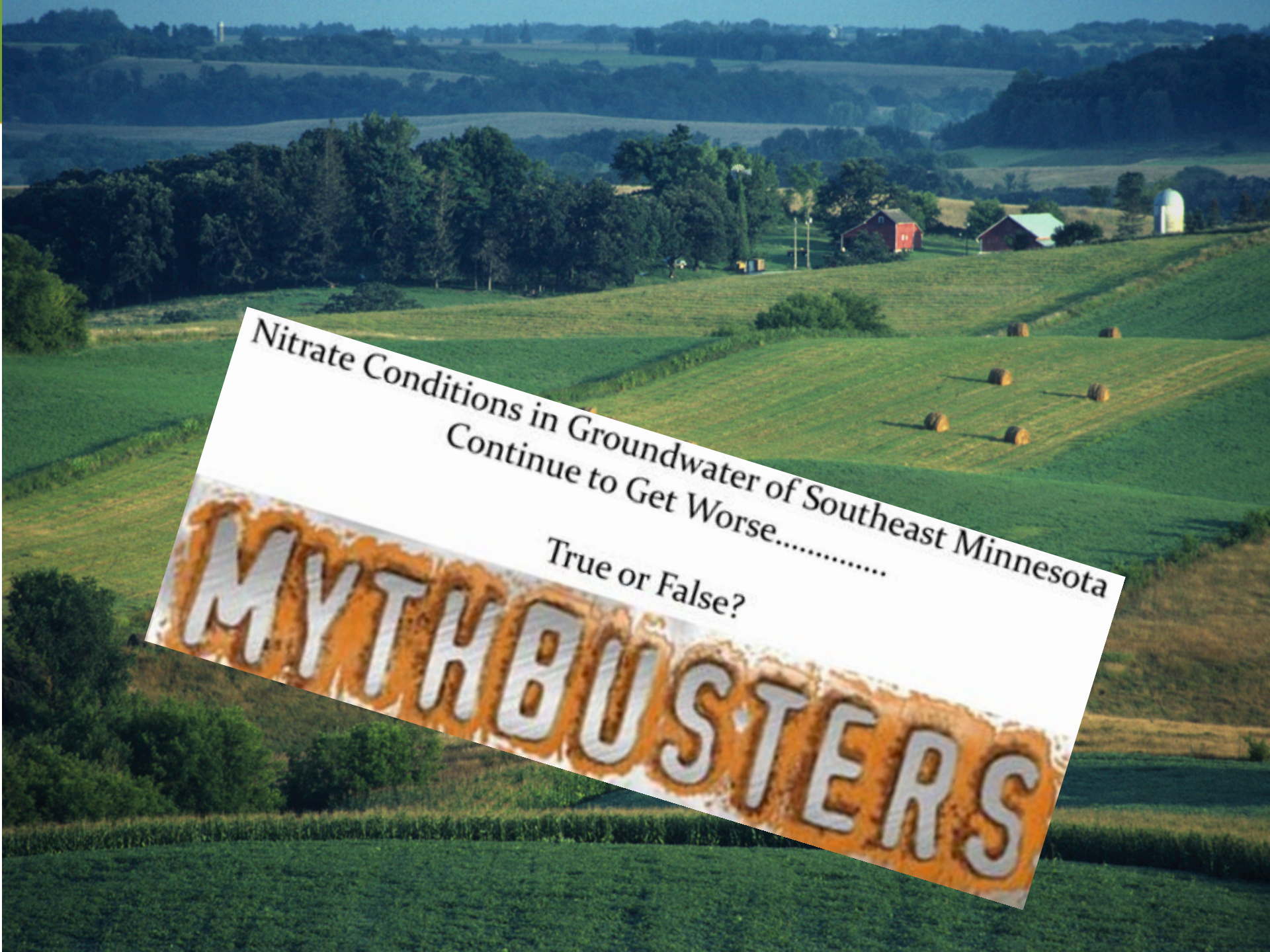
*Producers have made significant gains in manure
crediting and management*



Nitrate in Our Drinking Water---What 10,000 Wells Are Telling Us

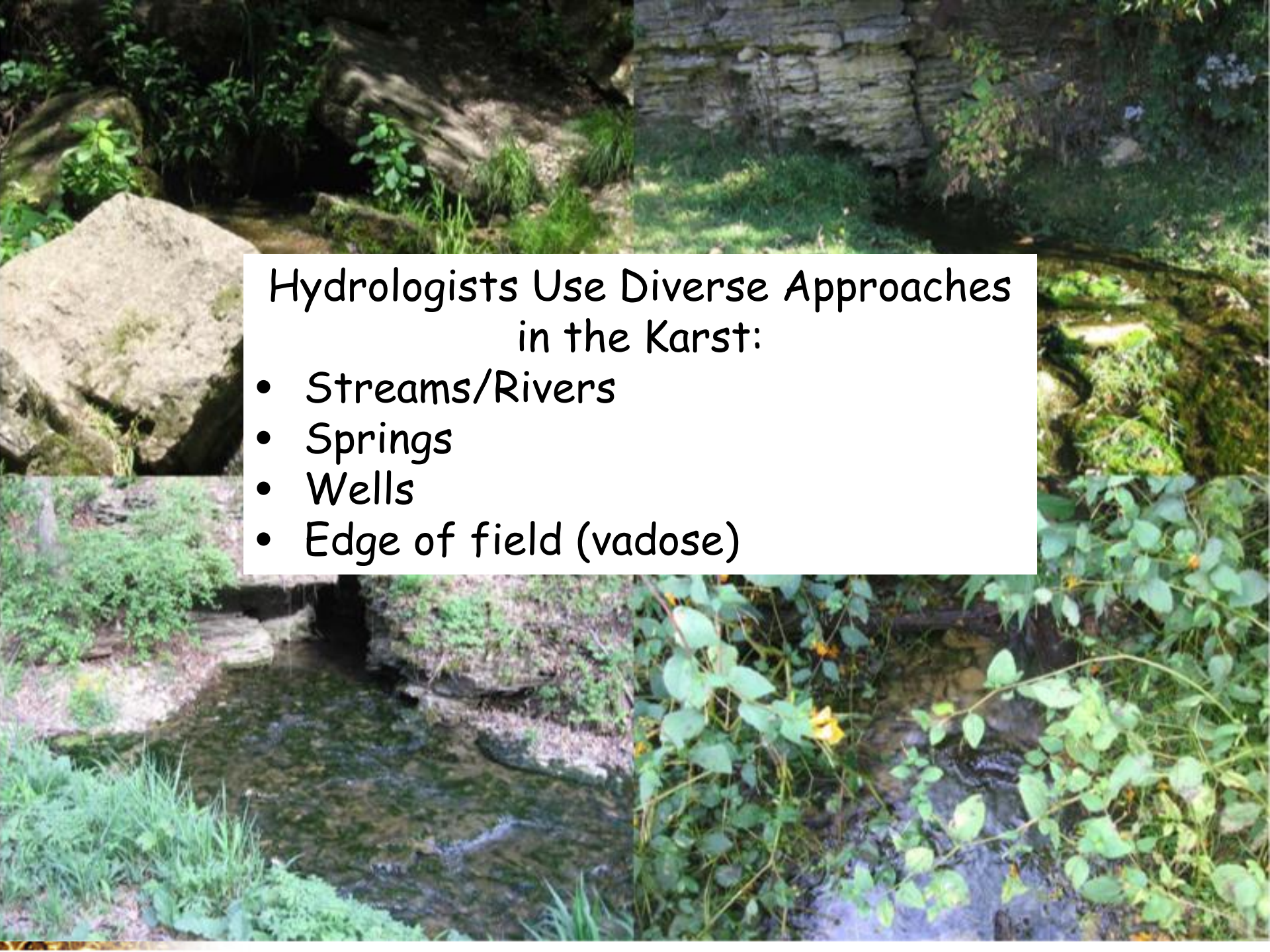
3 out of 4 Minnesotans get their drinking water
from GROUNDWATER





Nitrate Conditions in Groundwater of Southeast Minnesota
Continue to Get Worse.....
True or False?

MYTHBUSTERS



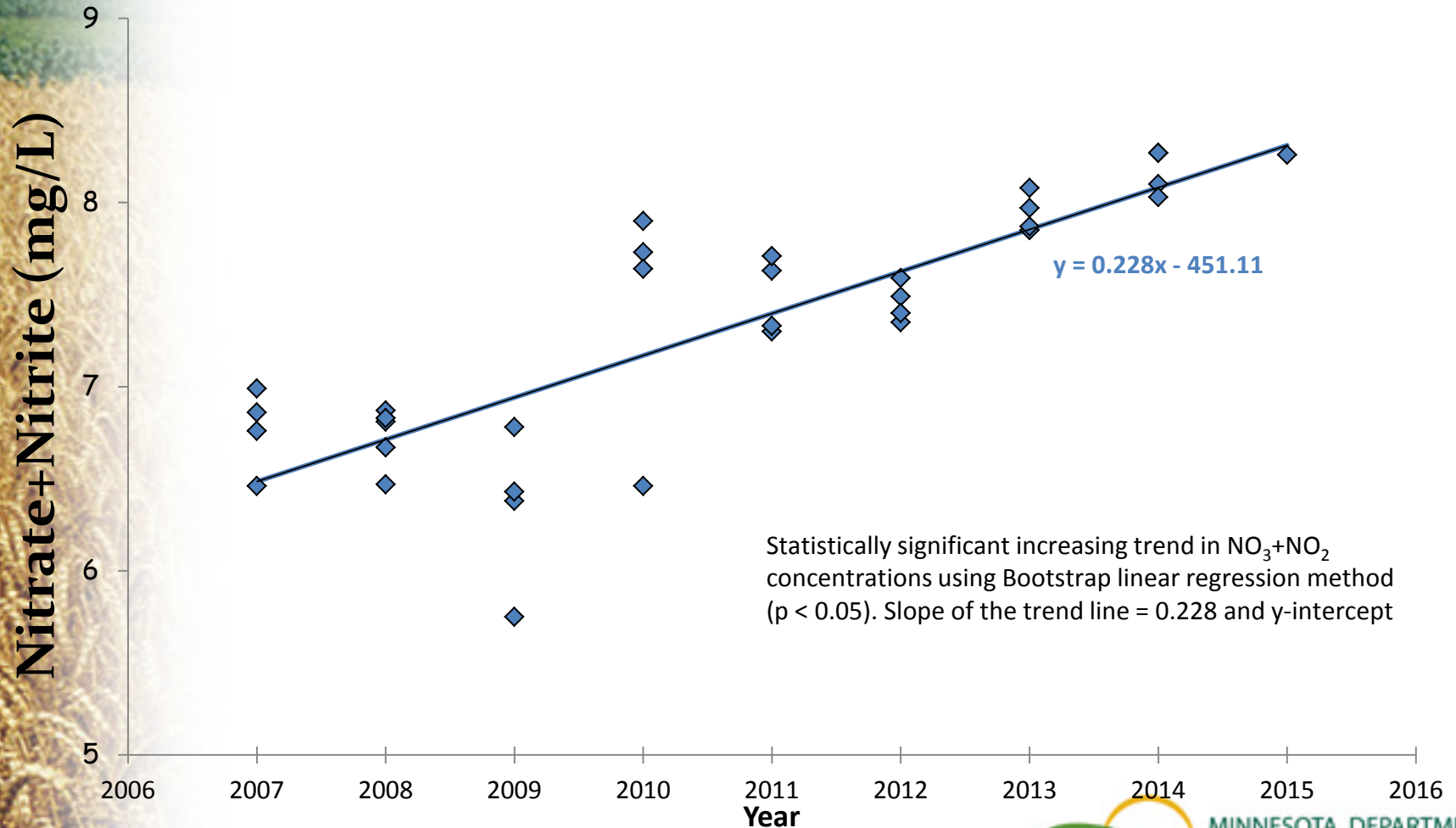
Hydrologists Use Diverse Approaches in the Karst:

- Streams/Rivers
- Springs
- Wells
- Edge of field (vadose)

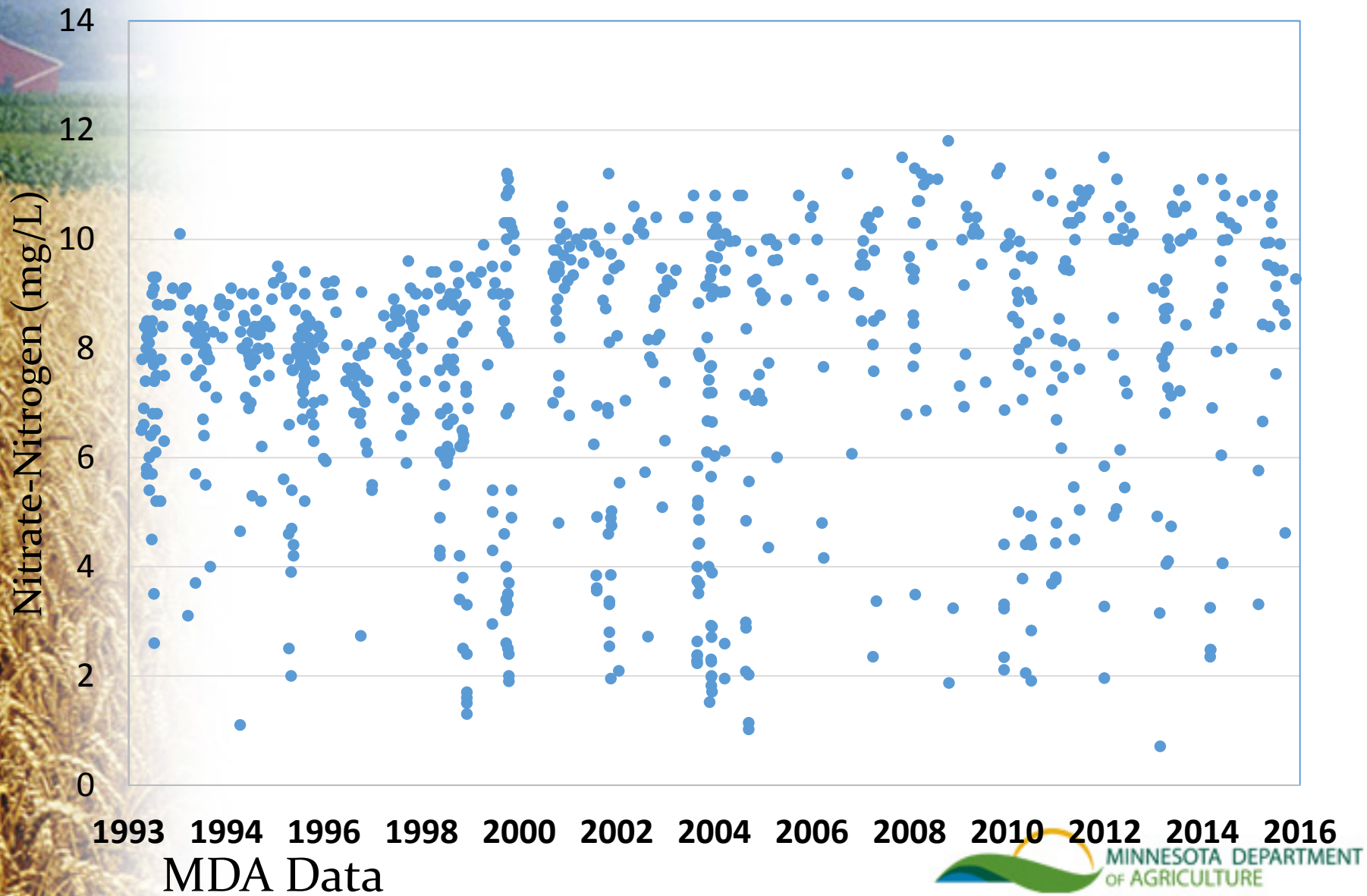
Spring Creek Spring Nitrate Trend Analysis

Goodhue County 2006-2015

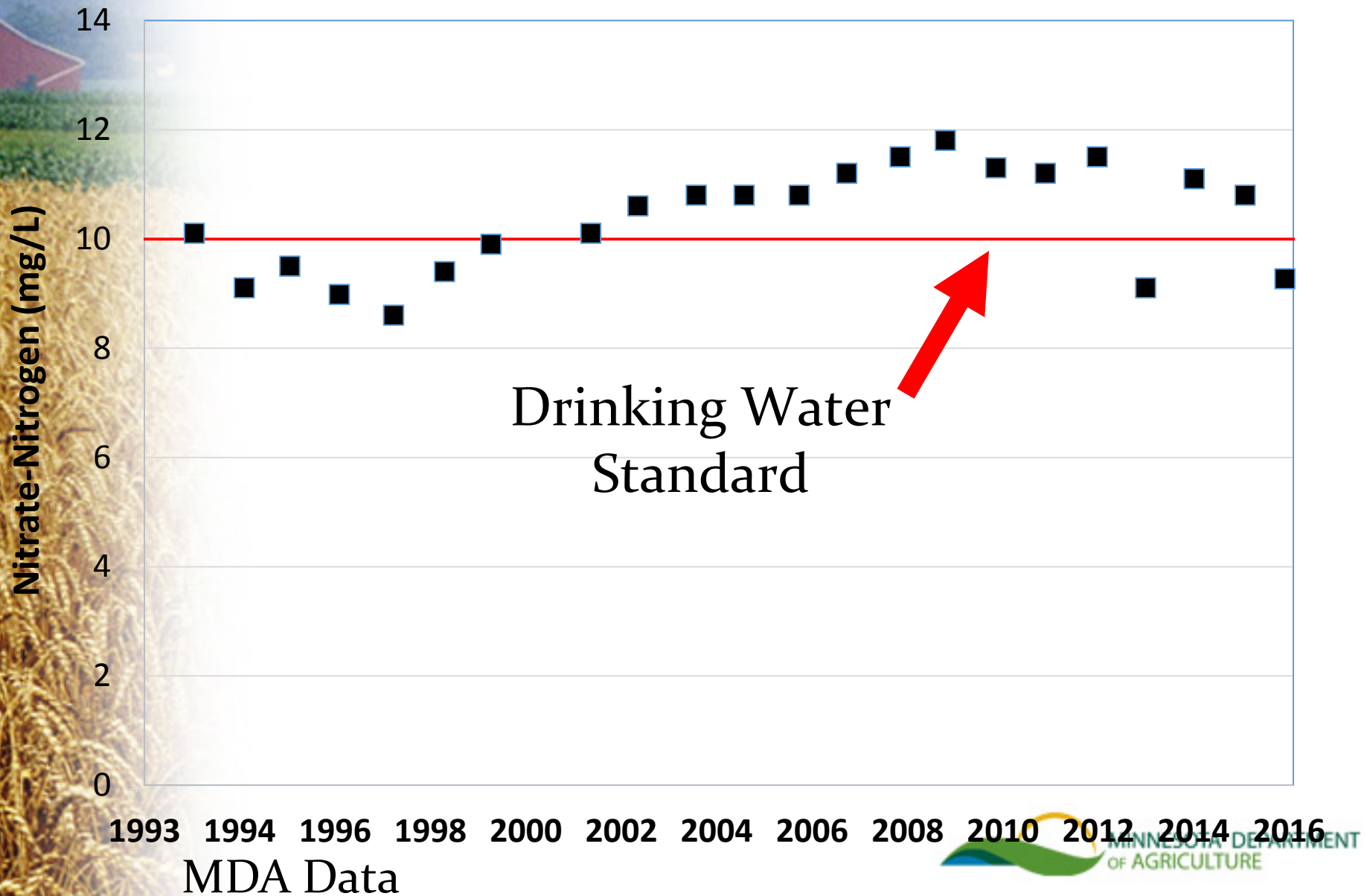
Spring Creek Spring $\text{NO}_3 + \text{NO}_2$ -N Concentrations



Middle Branch Whitewater River Nitrate-Nitrogen 1993-2015

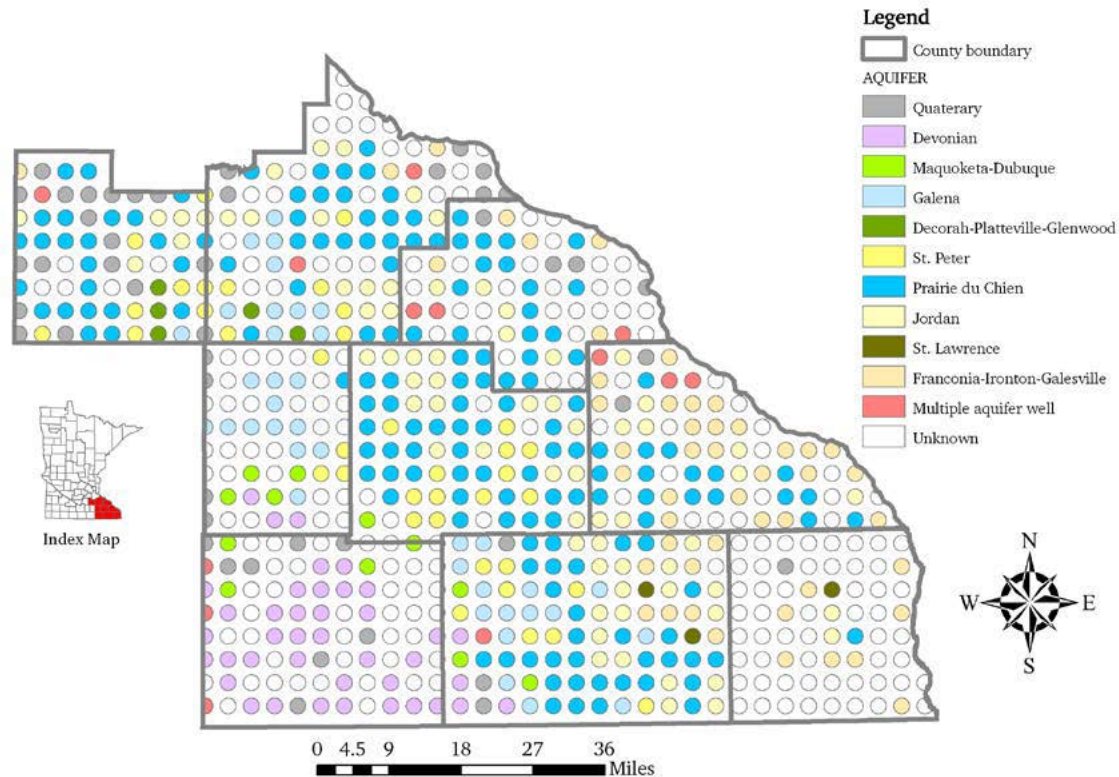


Middle Branch Whitewater River Nitrate-Nitrogen 1993-2015



Southeast Nitrate Monitoring Network

Figure 1: Southeast Minnesota Volunteer Nitrate Monitoring Network Buffer Locations and Aquifers of Completion

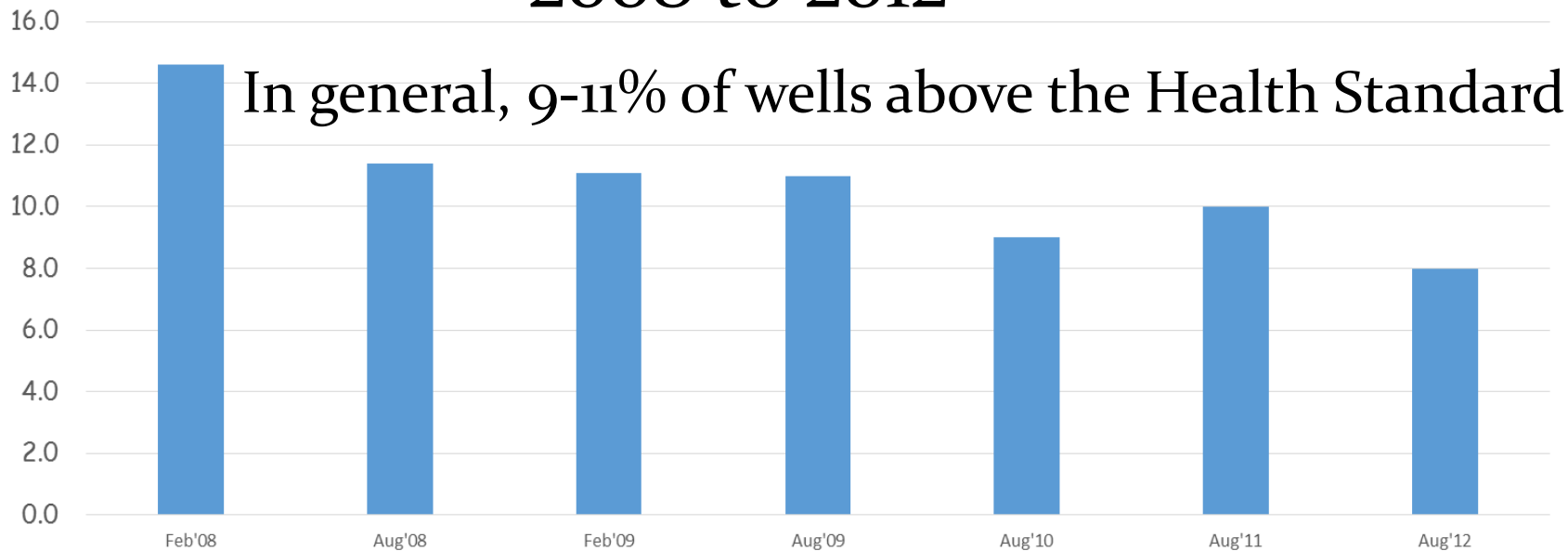


Data Source: MDH/MDA

Southeast Private Well Monitoring Network

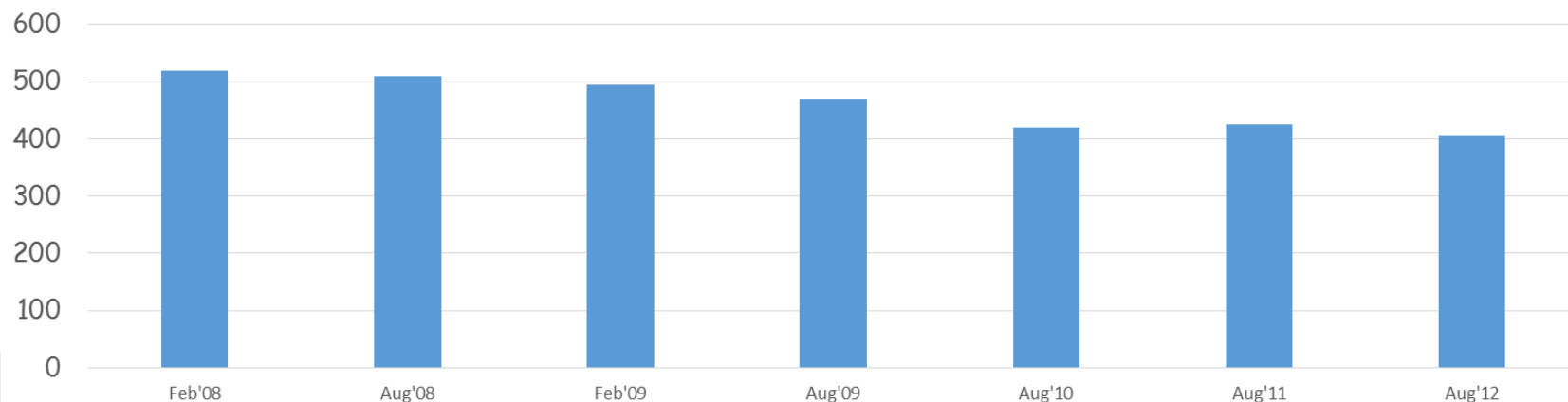
2008 to 2012

% Wells Above the Health Standard



Participating Households

Homeowners Trends



Data Source: MDH and MDA

Nitrate in Minnesota's Private Wells-----

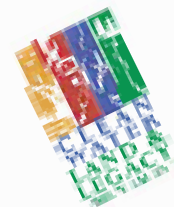
Recent Findings From 10,000 Wells Strongly Suggest That the
Severity of Nitrate Contamination is Much More Prevalent
That Originally Expected

MYTHBUSTERS

Minnesota Nitrogen Fertilizer Management Plan

March 2015

Minnesota Department of Agriculture
Pesticide and Fertilizer Management Division



In accordance with the Americans with Disabilities Act, this information is available in alternative forms of communication upon request by calling (651) 261-4900. TTY users can call the Minnesota Relay Service at 711 or 1-800-527-3523. The MDA is an equal opportunity employer and provider.



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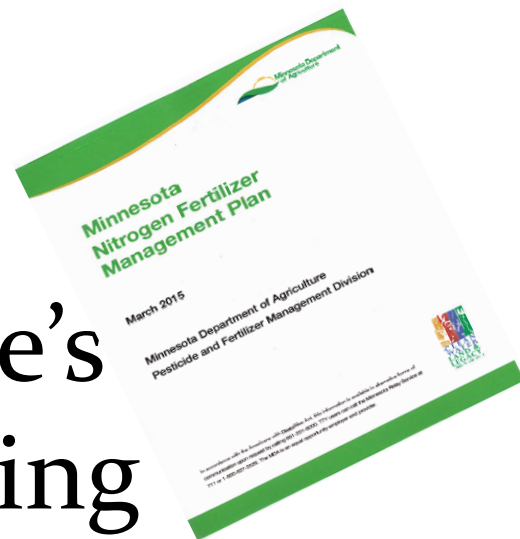
TING

THE

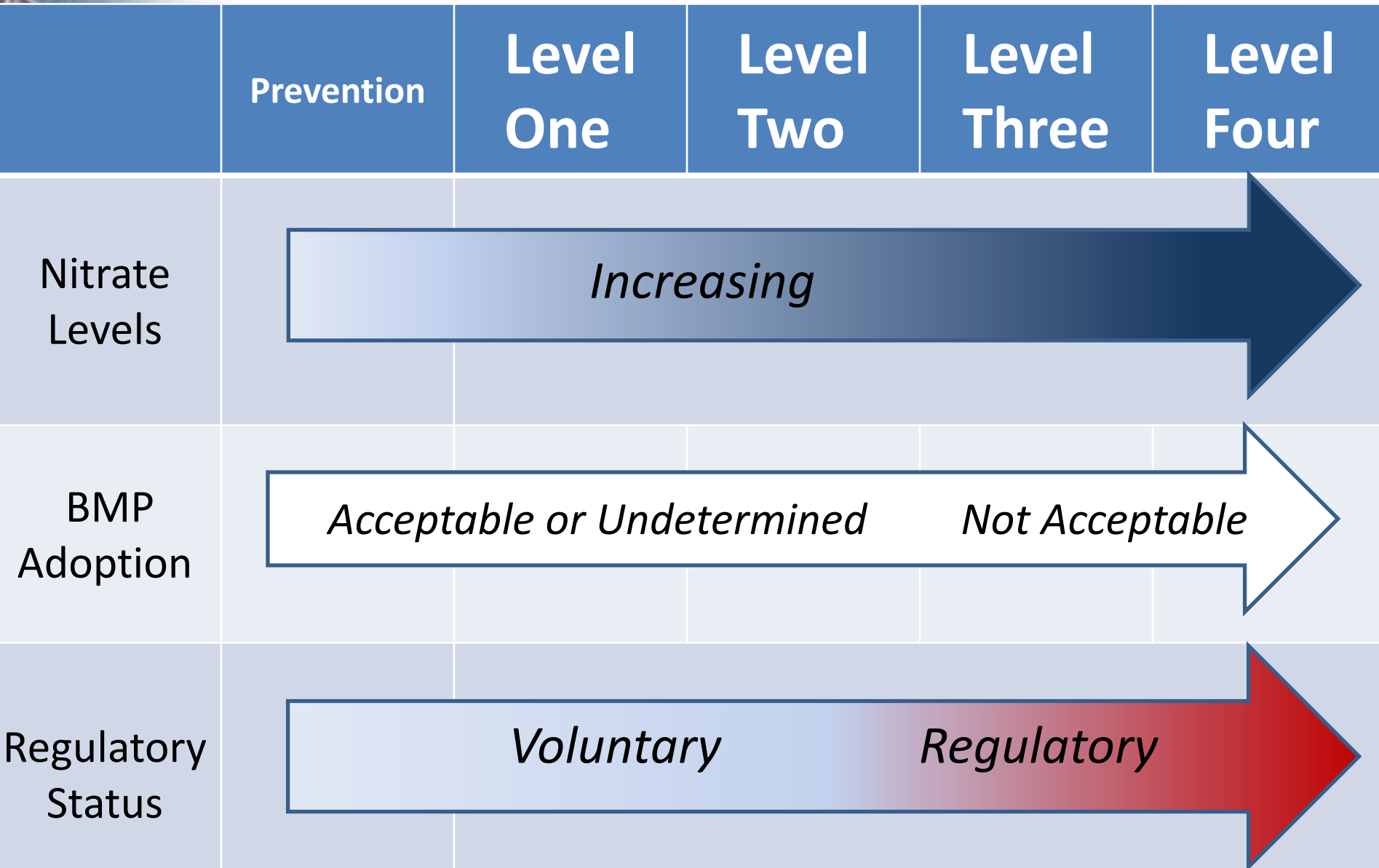
An Outcome of the 1989 Groundwater Protection Act-

Nitrogen Fertilizer Management Plan (NFMP)

The NFMP is the state's
blueprint for minimizing
groundwater impacts from
the use of nitrogen fertilizer



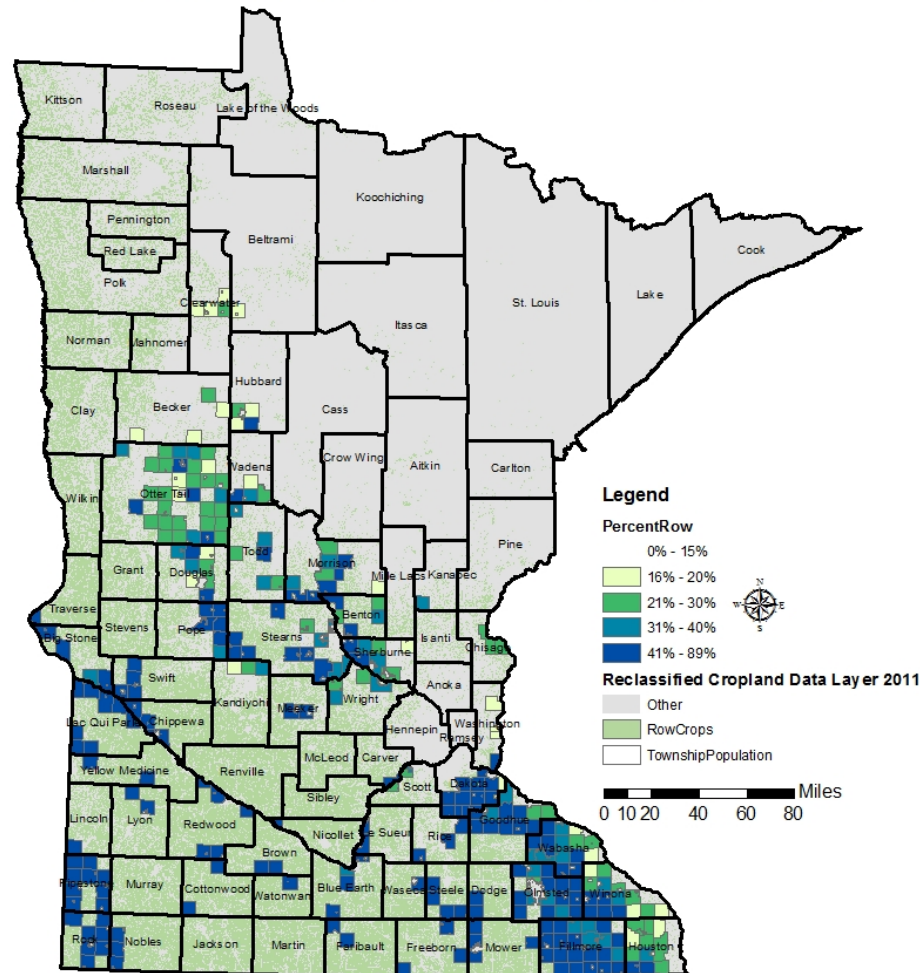
The Revised NFMP must Consider Water Quality and BMP Adoption to make Decisions on a Township Level



Long Term Goal

Characterize Nitrate Conditions in 250-300 Vulnerable Townships by 2018

Percent of Row Crops in Townships with > 30% Sensitive Surficial Geology



In a Nutshell, What Did We Find?

Based Upon the First 60 Townships Tested (7,342 Wells)

- Within some of the worst case scenarios, 14% of the private wells exceeded the 10 PPM Health Standard;
- In Dakota County, 7 of the 15 townships tested were found to have 30% or more above the Health Standard;
- Conversely, results in other locations were surprisingly better than anticipated.

Townships Tested to Date
% wells ≥ 10 mg/L

- <5%
- 5-9%
- $\geq 10\%$

MINNESOTA DEPARTMENT
OF AGRICULTURE

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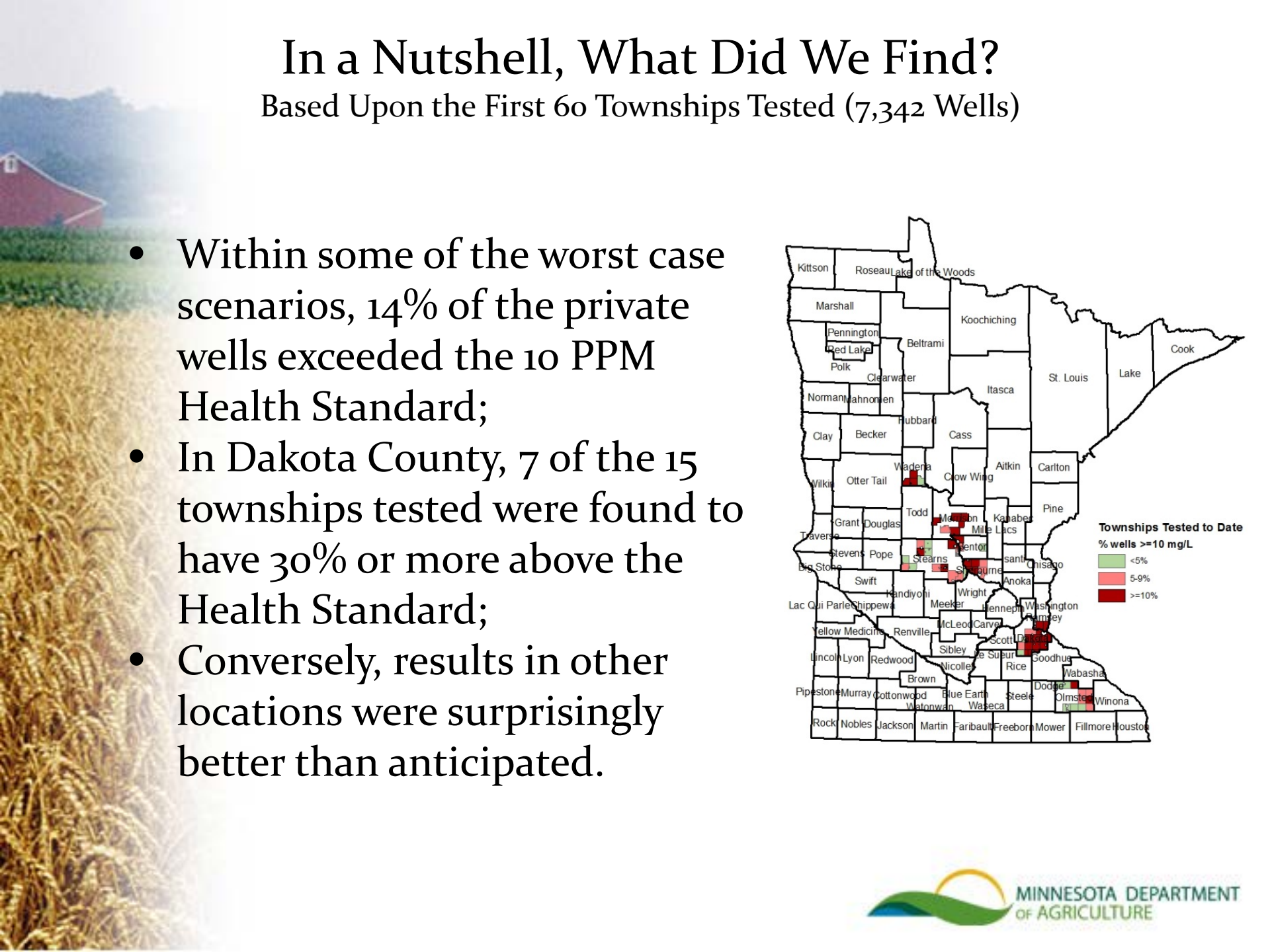
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MINNESOTA DEPARTMENT
OF AGRICULTURE

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-
- MINNESOTA DEPARTMENT
OF AGRICULTURE



% Townships with 10%+ Wells Exceeding Health Standard

First 60 Townships Tested (7,342 Wells)

Private Wells Tested

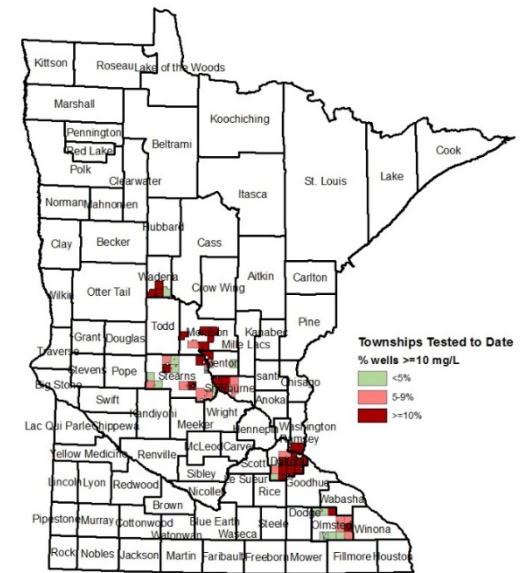
4000
3500
3000
2500
2000
1500
1000
500
0

18%

32%

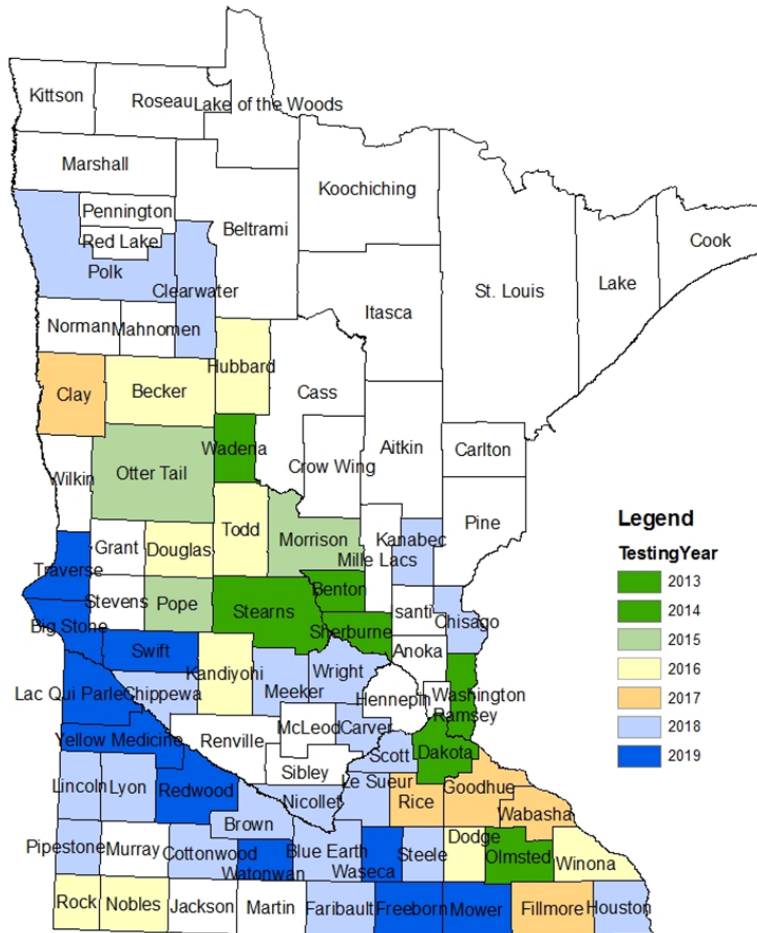
50%

■ < 5 PPM ■ 5-9.9 PPM ■ > 10.0

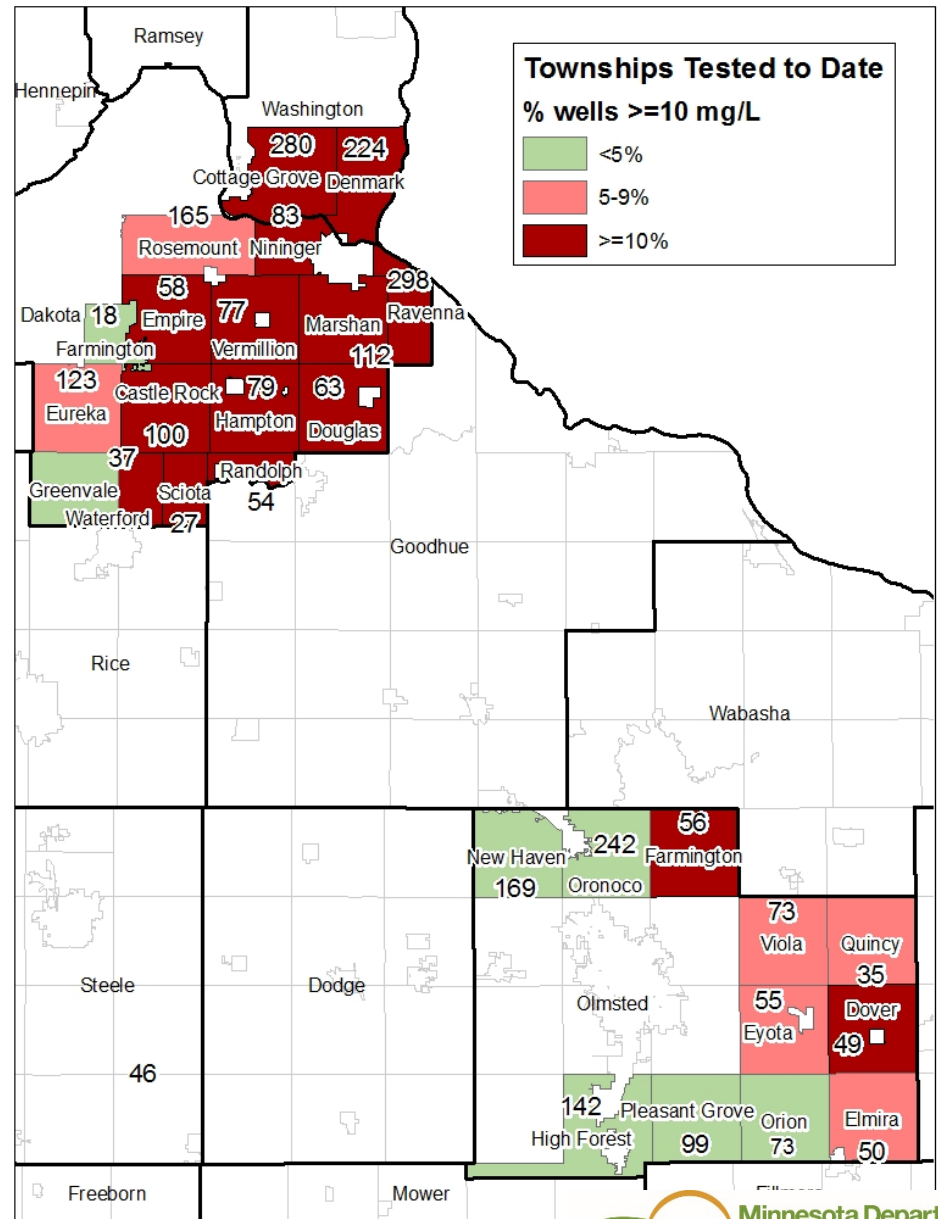


[illegible]

Tentative Township Testing Schedule (subject to change)



Prepared by the Minnesota Department of Agriculture 2015



Nitrate in Minnesota's Private Wells-----

Recent Findings From 10,000 Wells Strongly Suggest That the
Severity of Nitrate Contamination is Much More Prevalent
Than Originally Expected.....True

MYTHBUSTERS

There is very strong public perception that restrictions or banning on Nitrogen fertilizers must be achieved to protect water quality

“TRUE or FALSE”??

MYTHBUSTERS

Proposed Rules Restricting Timing of Nitrogen Fertilizer Applications

The MDA has started 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.

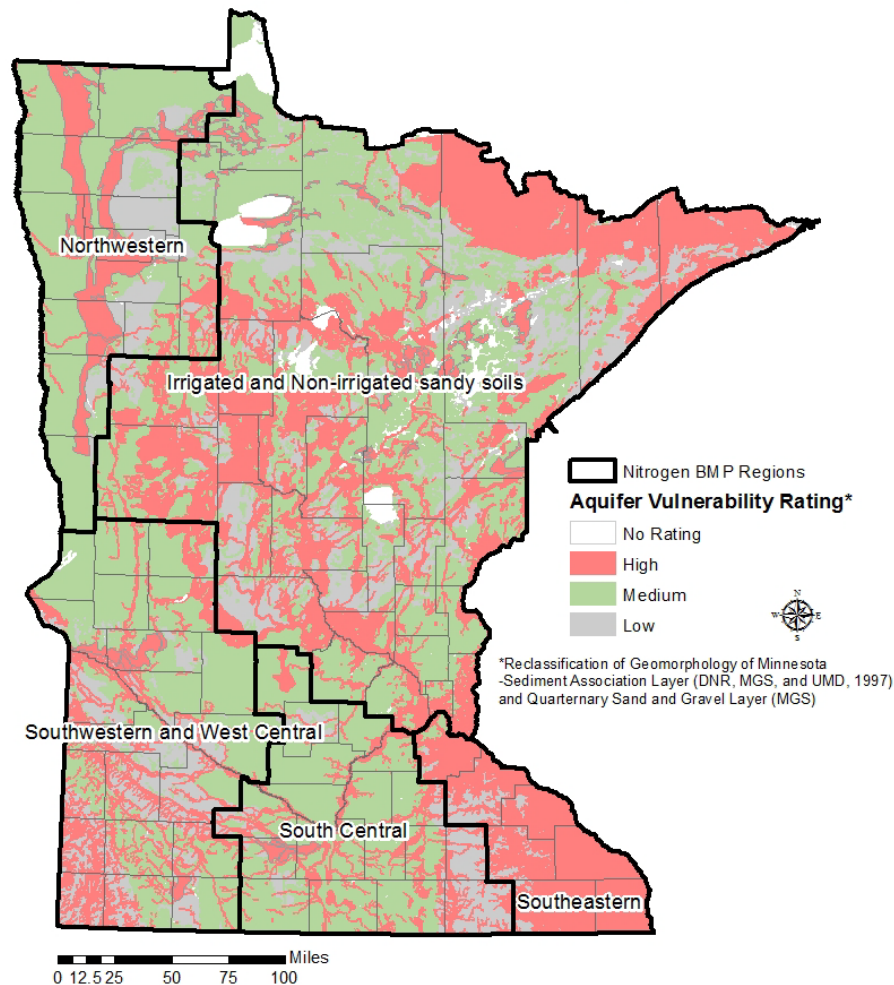
Part One—Proposed rules will restrict the fall application and application to frozen ground of nitrogen fertilizer in areas that are vulnerable to groundwater contamination.

Proposed Rules Restricting Timing of Fertilizer Application

Where?

In areas with vulnerable groundwater. Restrictions vary by N BMP Region

Aquifer Vulnerability and Regions for Nitrogen Fertilizer Best Management Practices





Closing Comments

Bruce Montgomery
MN Department of Agriculture
bruce.montgomery@state.mn.us