

# Understanding Nitrogen Dynamics When Converting Forest/Managed Timber to Irrigated Agricultural Production

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# Past Work Experience.....assessing the environmental impacts of the Garrison Diversion Irrigation Project in North Dakota



Oakes Irrigation Test Area

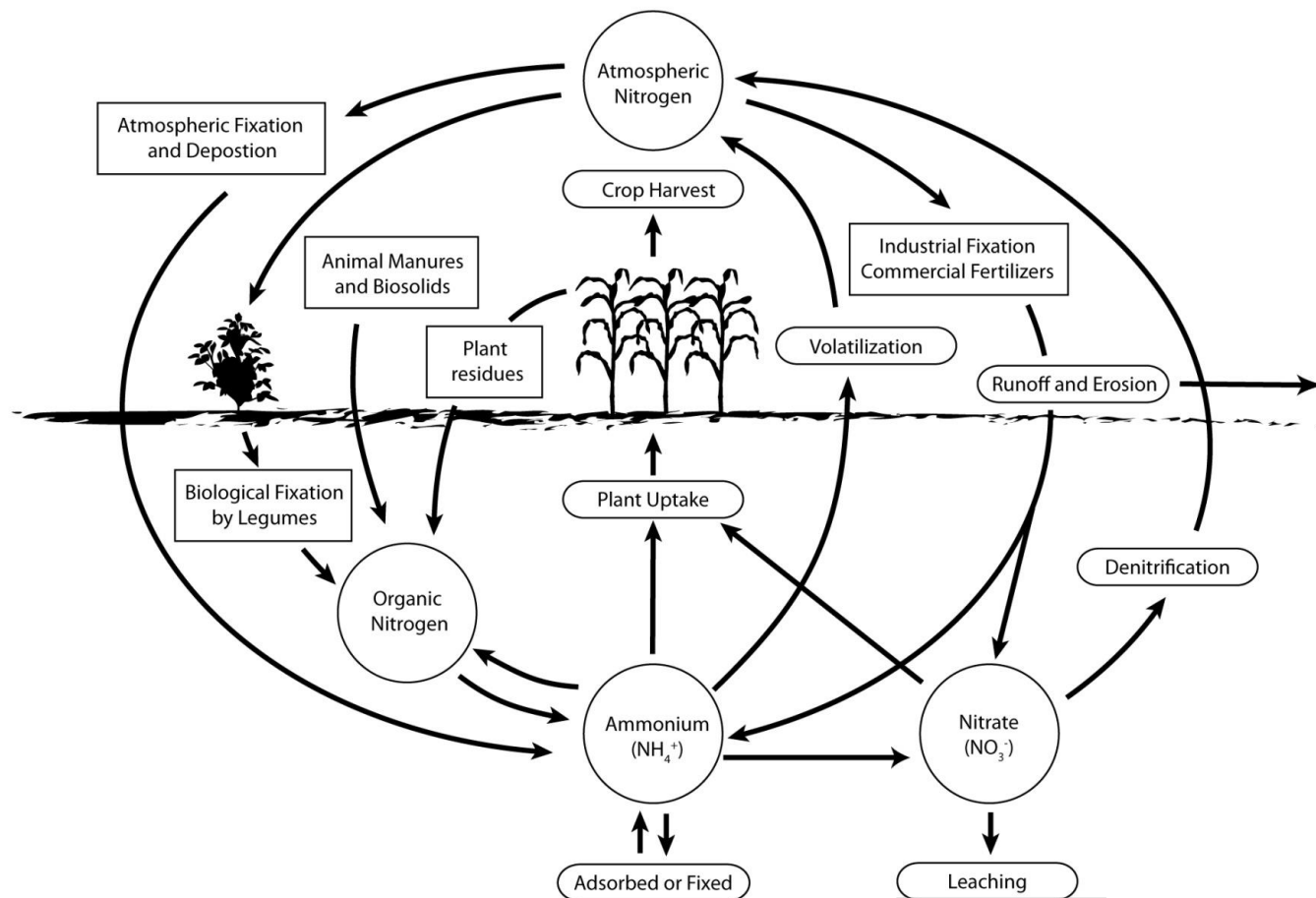
# Key Environmental Issues---Garrison Diversion

A large center pivot irrigation system is shown over a lush green field. The system consists of a long metal structure supported by a series of wheels, with multiple arms extending from a central point. The sun is low in the sky, creating a hazy, golden light over the scene. The field is densely packed with green plants, likely corn.

Could we manage nitrogen losses adequately to protect Hudson Bay with this massive irrigation expansion?

Biota transfer from the Missouri River into Hudson Bay was another significant concern.

# Understanding Nitrogen Behavior Is Critical

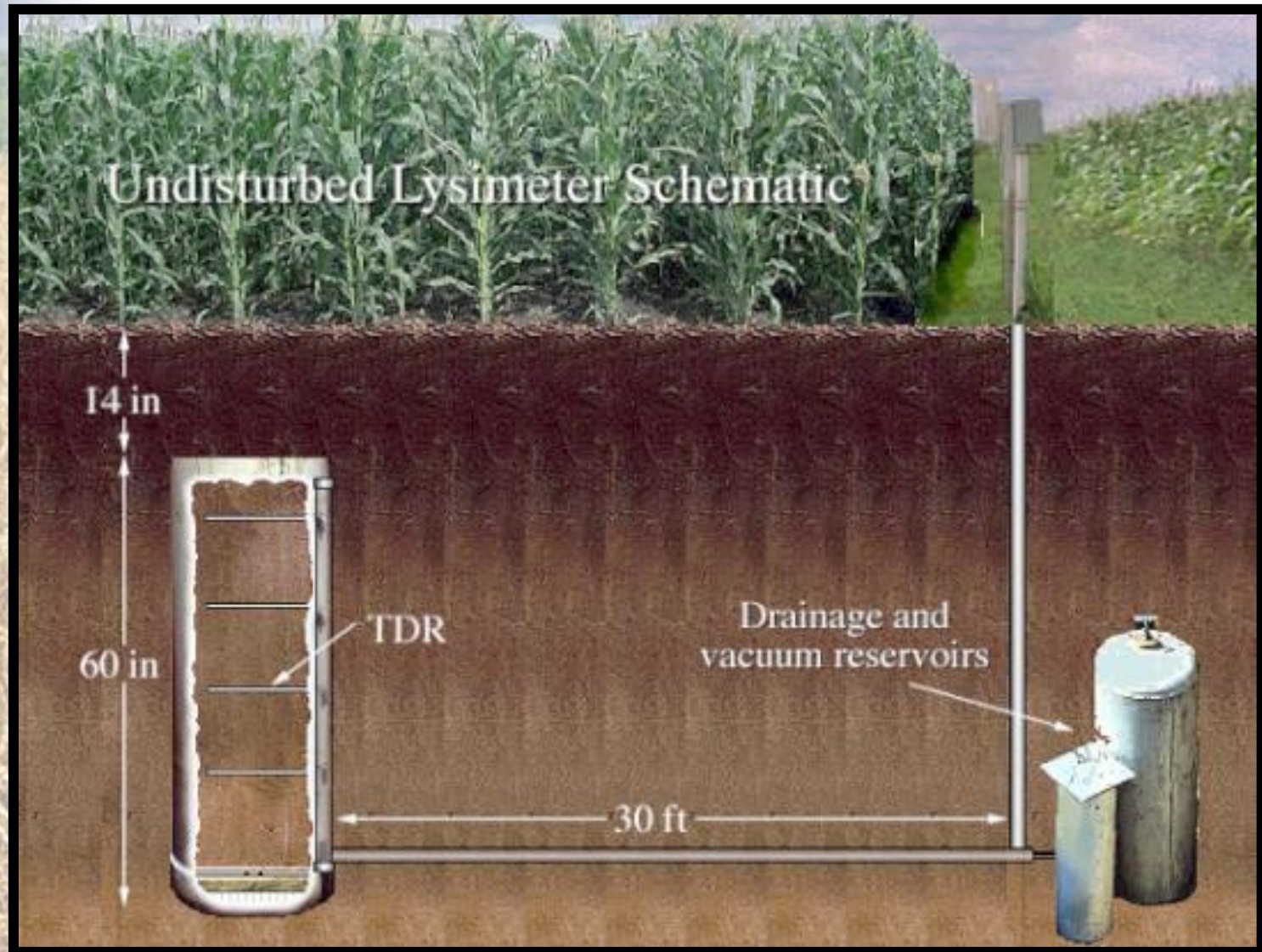




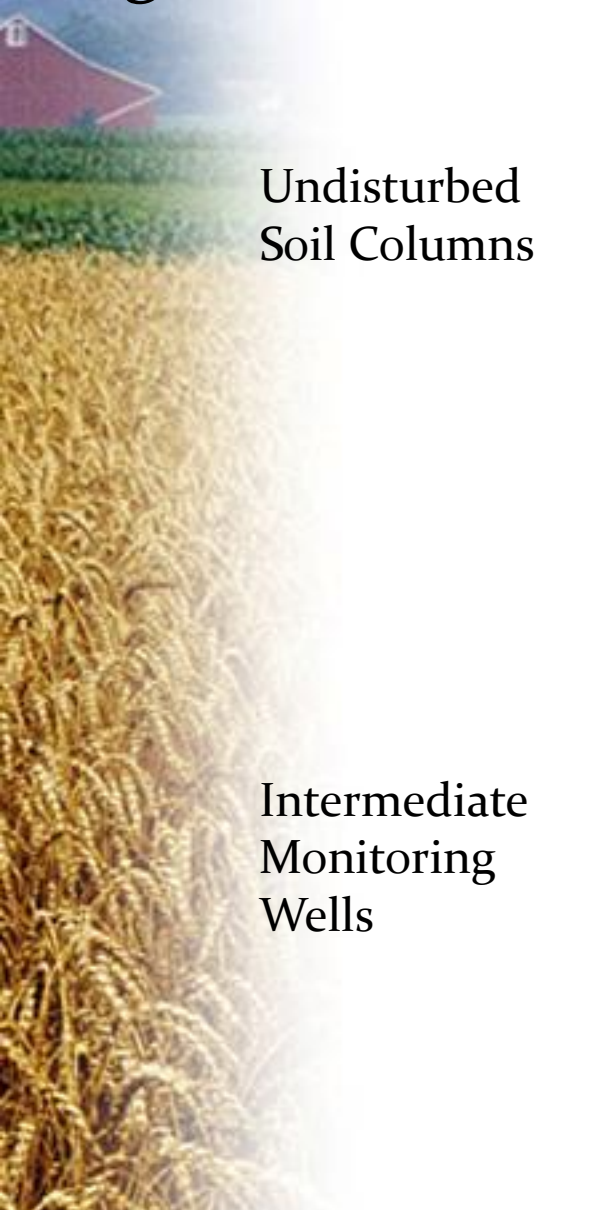
Drastic Land Use Changes Such as Plowing  
Virgin Prairie or Woodlands Will Have Temporal  
Impacts on the Release of Organic Nitrogen

These Changes Are Rarely Documented

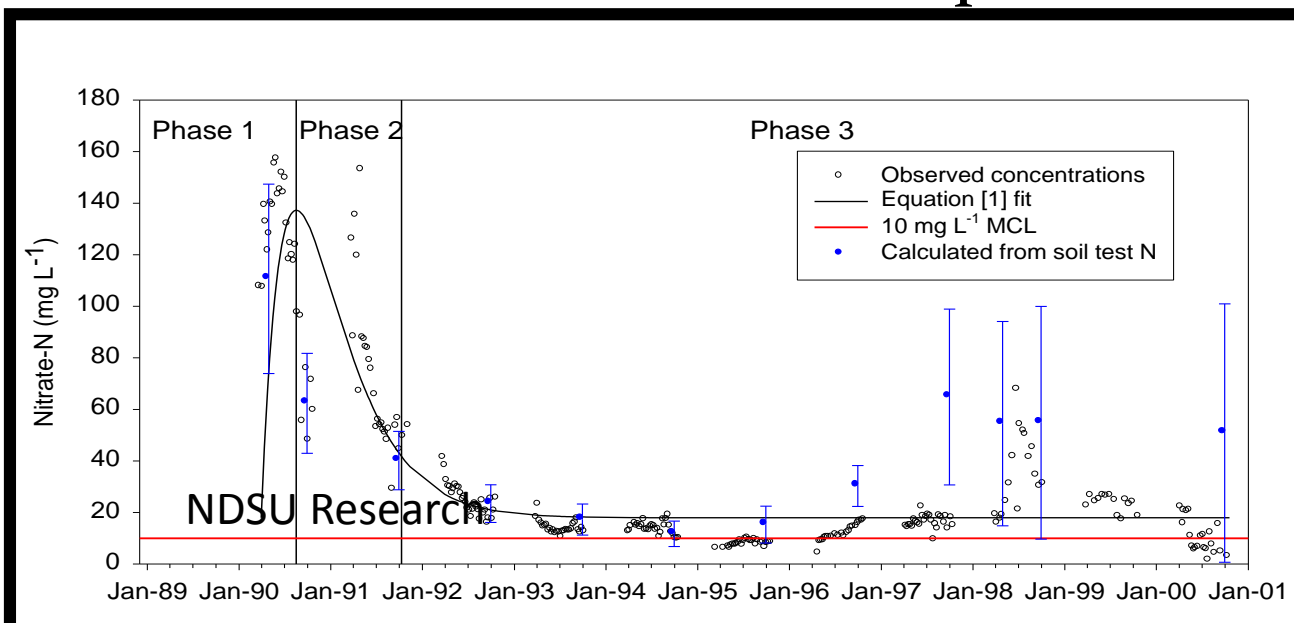
# Large Undisturbed Soil Columns Were Used at the N.D. Research Sites to Monitor Nitrogen Movement



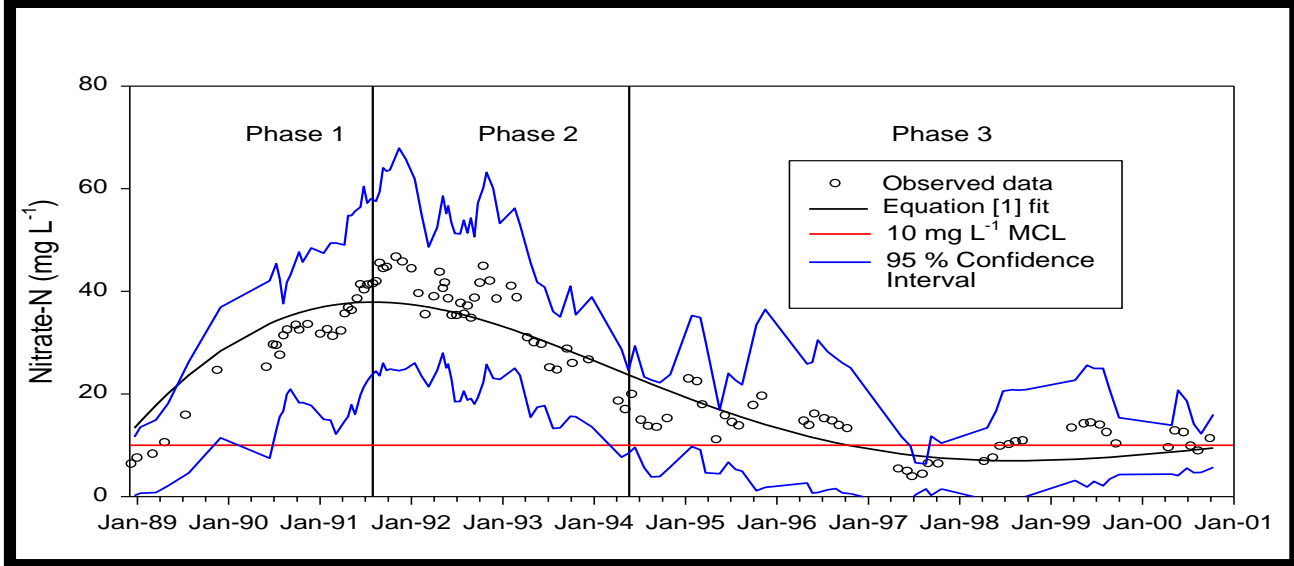
# “Nitrogen Flush” from the Conversion of Dryland to Irrigated Conditions Took Two to Five Years to Equilibrate



Undisturbed  
Soil Columns



Intermediate  
Monitoring  
Wells



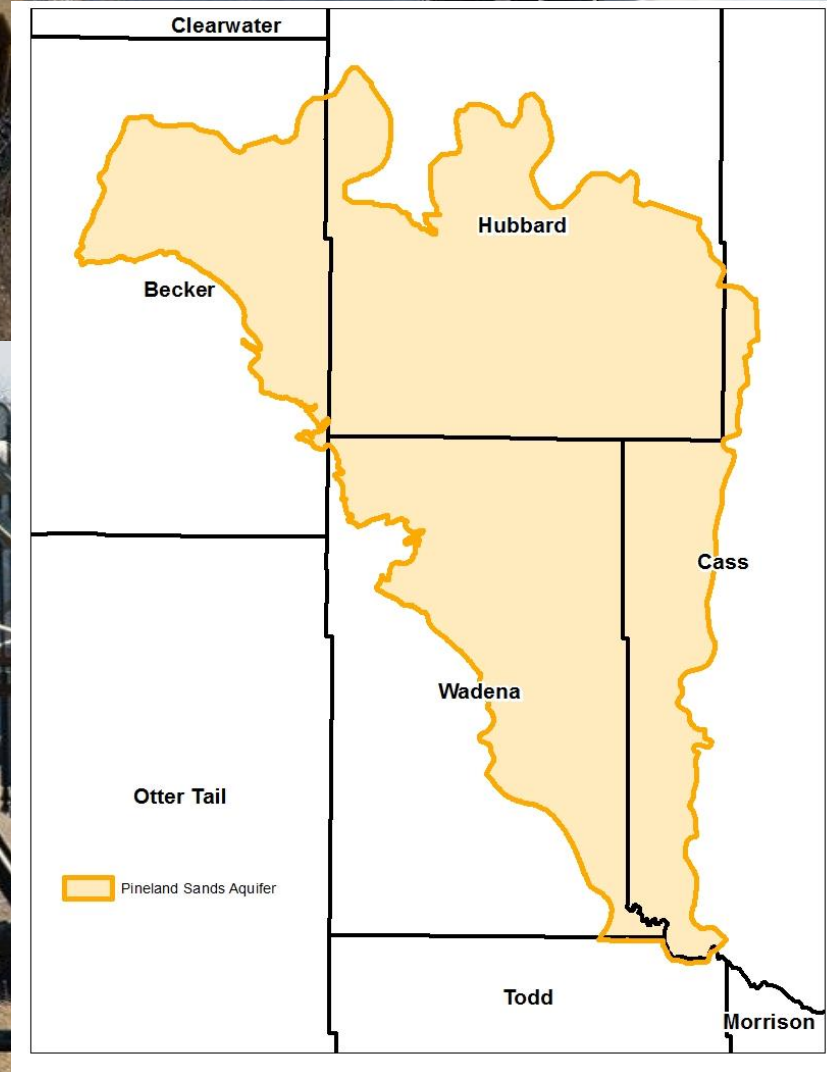
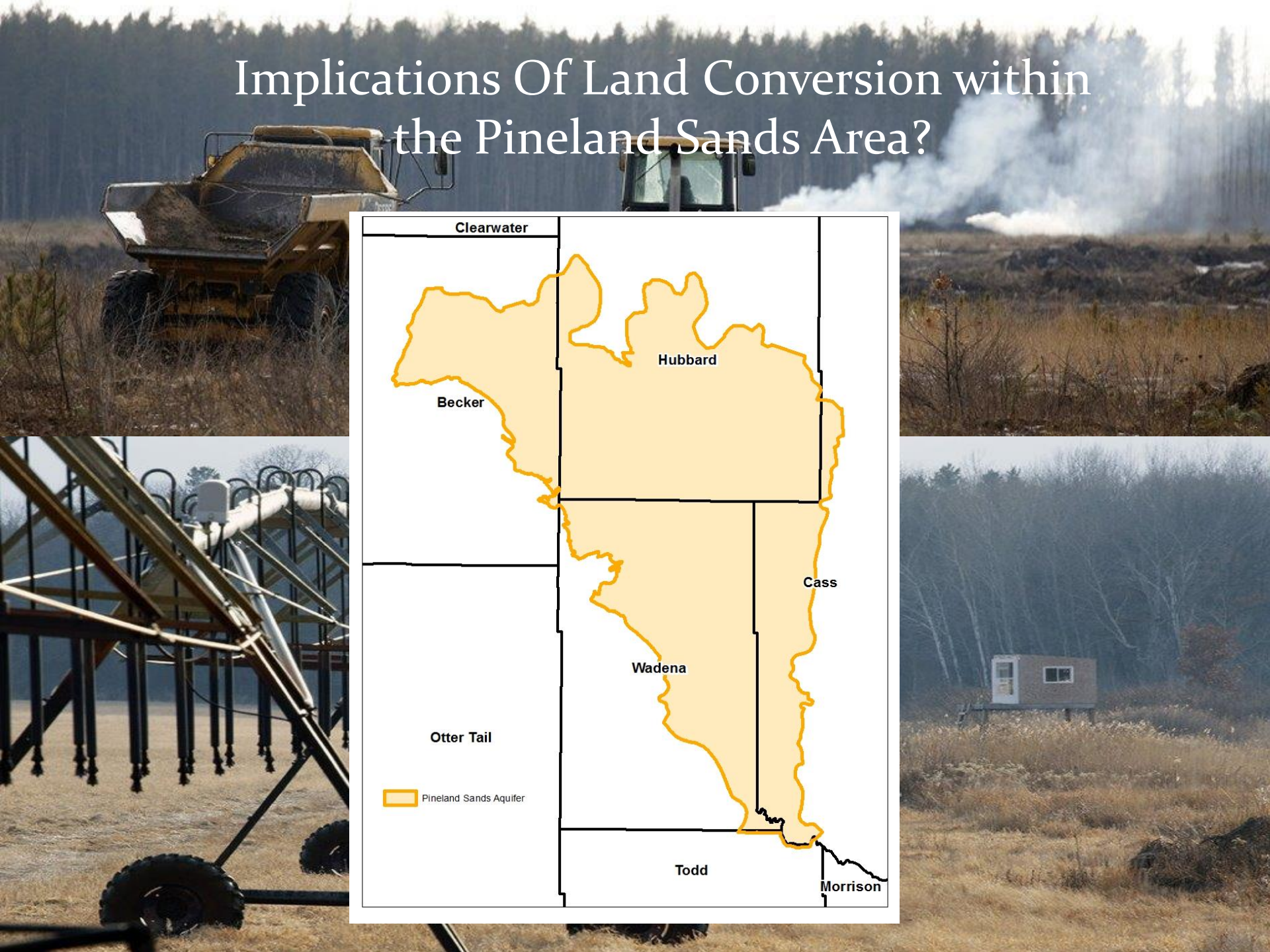


Understanding the accelerated mineralization rates from the Garrison Diversion Project provided the opportunity to:

- Significantly reduce nitrogen fertilizer rates for the first 2-3 years after the conversion;
- Separate water quality impacts from the organic N pool vs from the addition of nitrogen fertilizer



# Implications Of Land Conversion within the Pineland Sands Area?



## A Few Quick Stats Regarding the Potlatch/RDO Land Conversion Issue

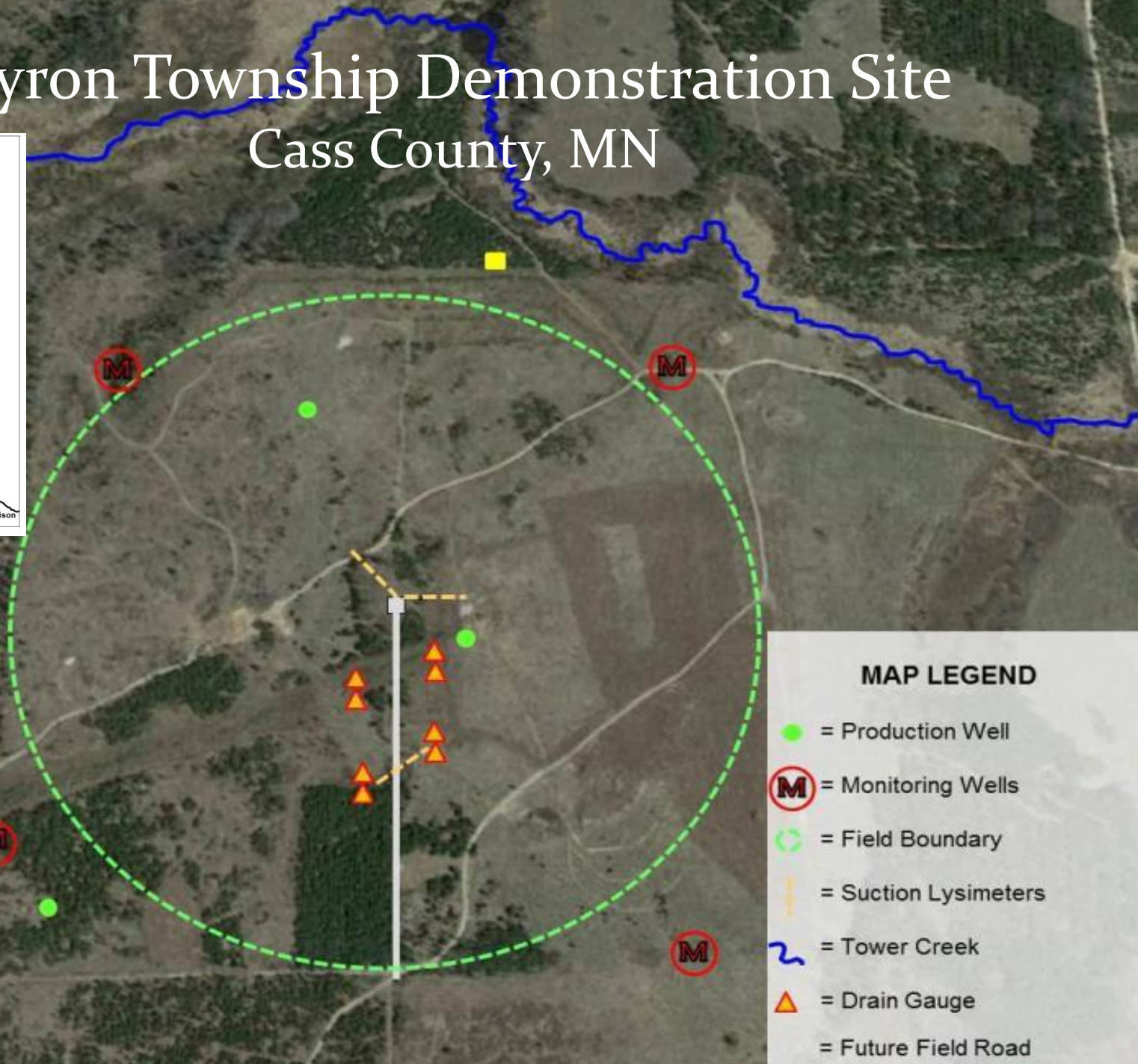
- Potlatch has sold 60,000 acres of timber/pine plantation holdings in MN but only 6,000-8,000 suitable for irrigation;
- The RDO Corporation originally planned to convert about 7,800 acres for agricultural use;
- Potlatch: Taxes are 2-3 X as high in Minnesota than the southern states and northern trees take 50-70 years to mature while southern trees take 25-30.

# Byron Township Demonstration Site Cass County, MN








Anticipating many environmental questions from the public, the foundation for a very unique partnership and water quality demonstration site began in 2013



# Byron Township Demonstration Site Cass County, MN



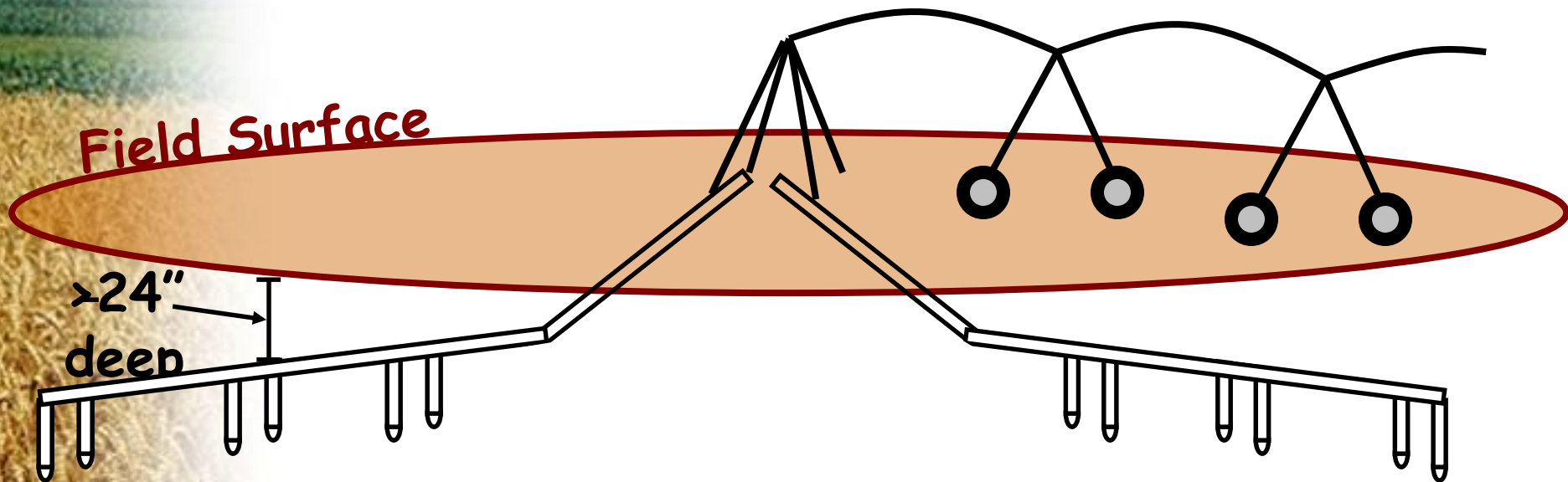
## MAP LEGEND

-  = Production Well
-  = Monitoring Wells
-  = Field Boundary
-  = Suction Lysimeters
-  = Tower Creek
-  = Drain Gauge
-  = Future Field Road

# Byron Site is Equipped to Monitor Nutrient and Percolation Losses Beyond the Root Zone



# Typical Long-Term Installation Field Design Used by the MN Department of Agriculture



## Installation Notes:

- All piping placed below the depth of tillage operations
- Lysimeters pull water from a depth of 4-6 feet deep
  - Below the crop root zone

# Demonstration Goals at the Byron Site

Starting with “NEAR PRISTINE” CONDITIONS.....

Quantify the magnitude of temporal N flushes from the conversion of “managed timber” to irrigated production;

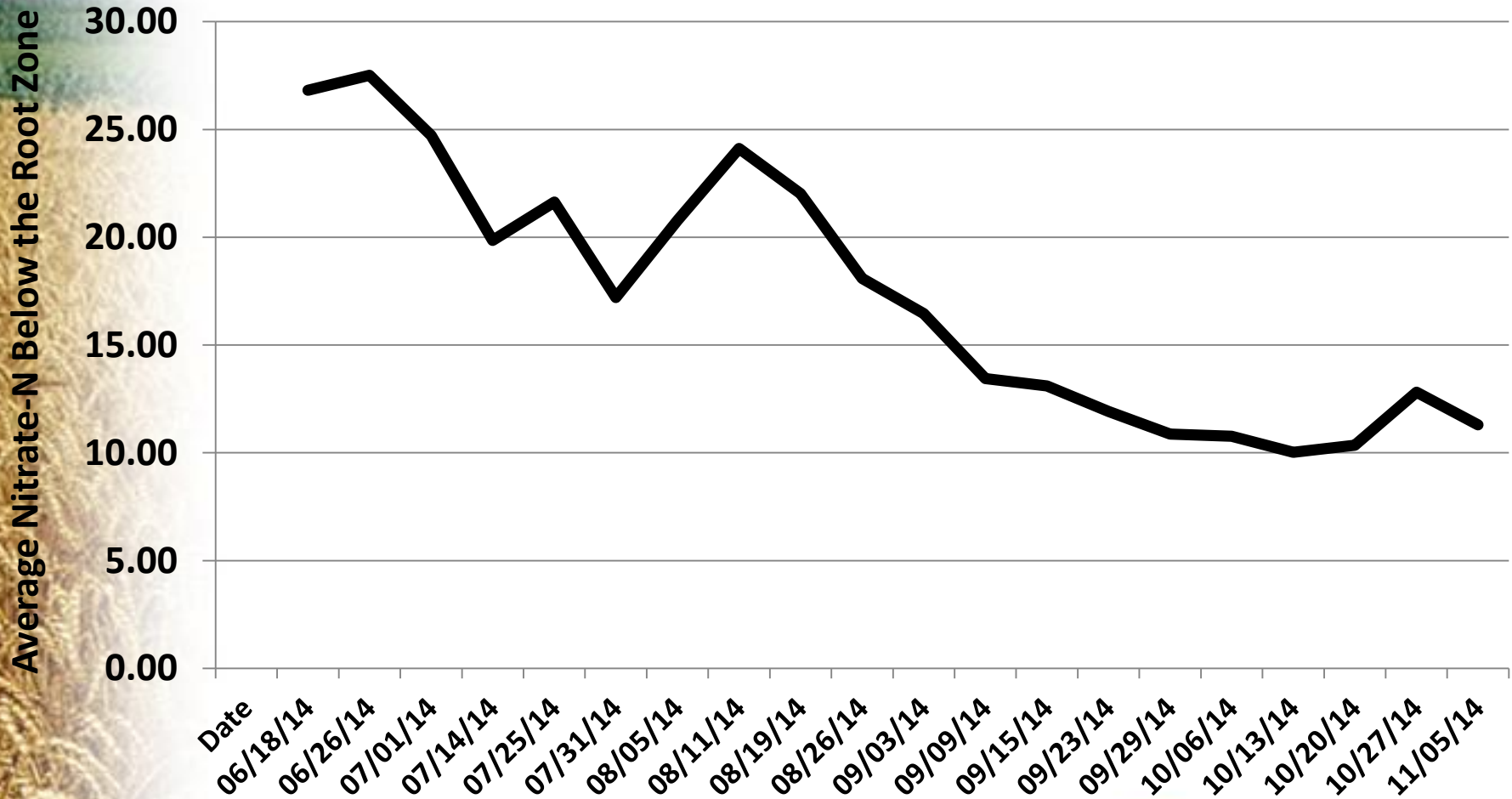
Quantify nitrate leaching losses over multiple rotations which would include seed potatoes once every 3<sup>rd</sup> or 4<sup>th</sup> year;

Minimize inputs and potentially reducing N losses by integrating “low input” crops within the rotation;

Use cover cropping systems to the fullest extent possible to control off-season losses AND to minimize the use of soil fumigants such as Vapam.

# Some Evidence of a Temporal Nitrate Flush During the First Production Year But Dissipated Relatively Quickly

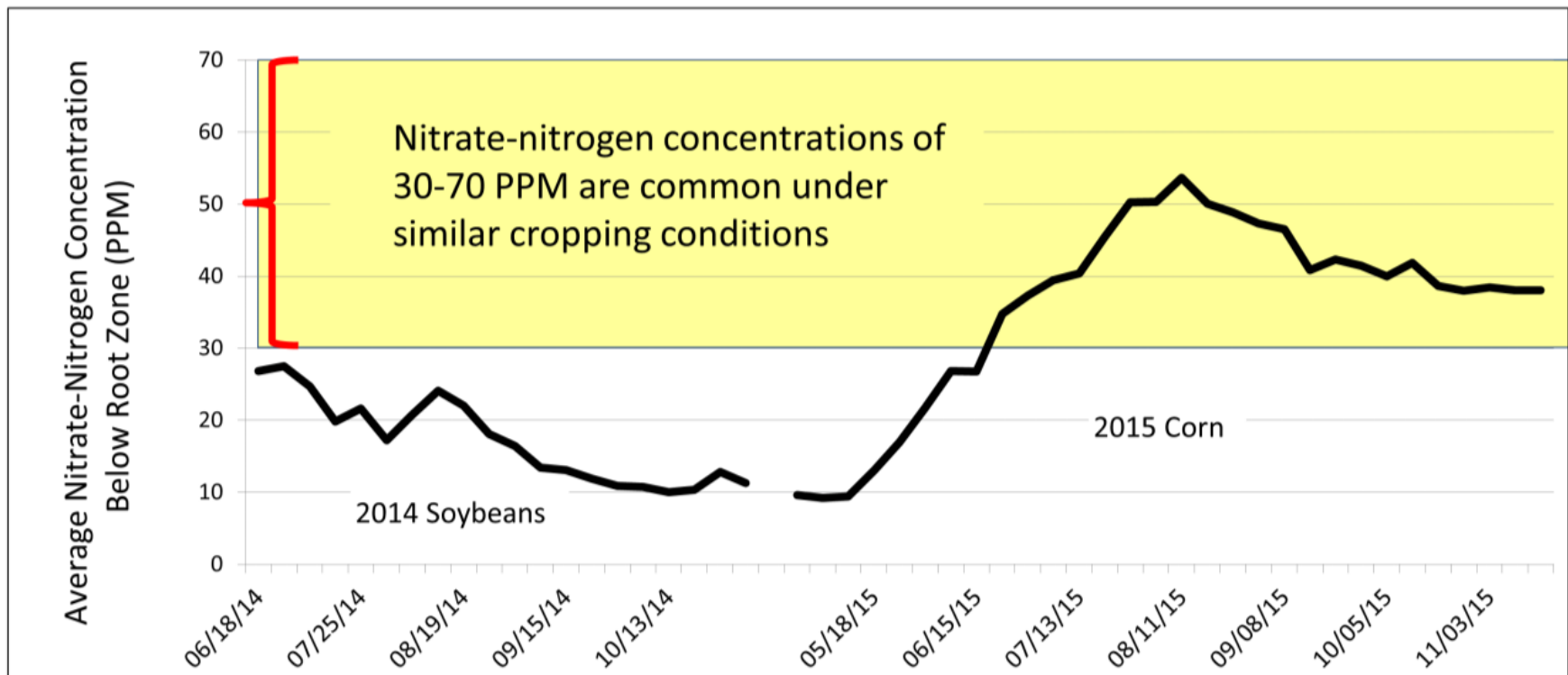
(Crop: Soybeans No Commercial Nitrogen Applied)





# Nitrogen Losses Will Occur Even When BMPs and Water Management Are Implemented

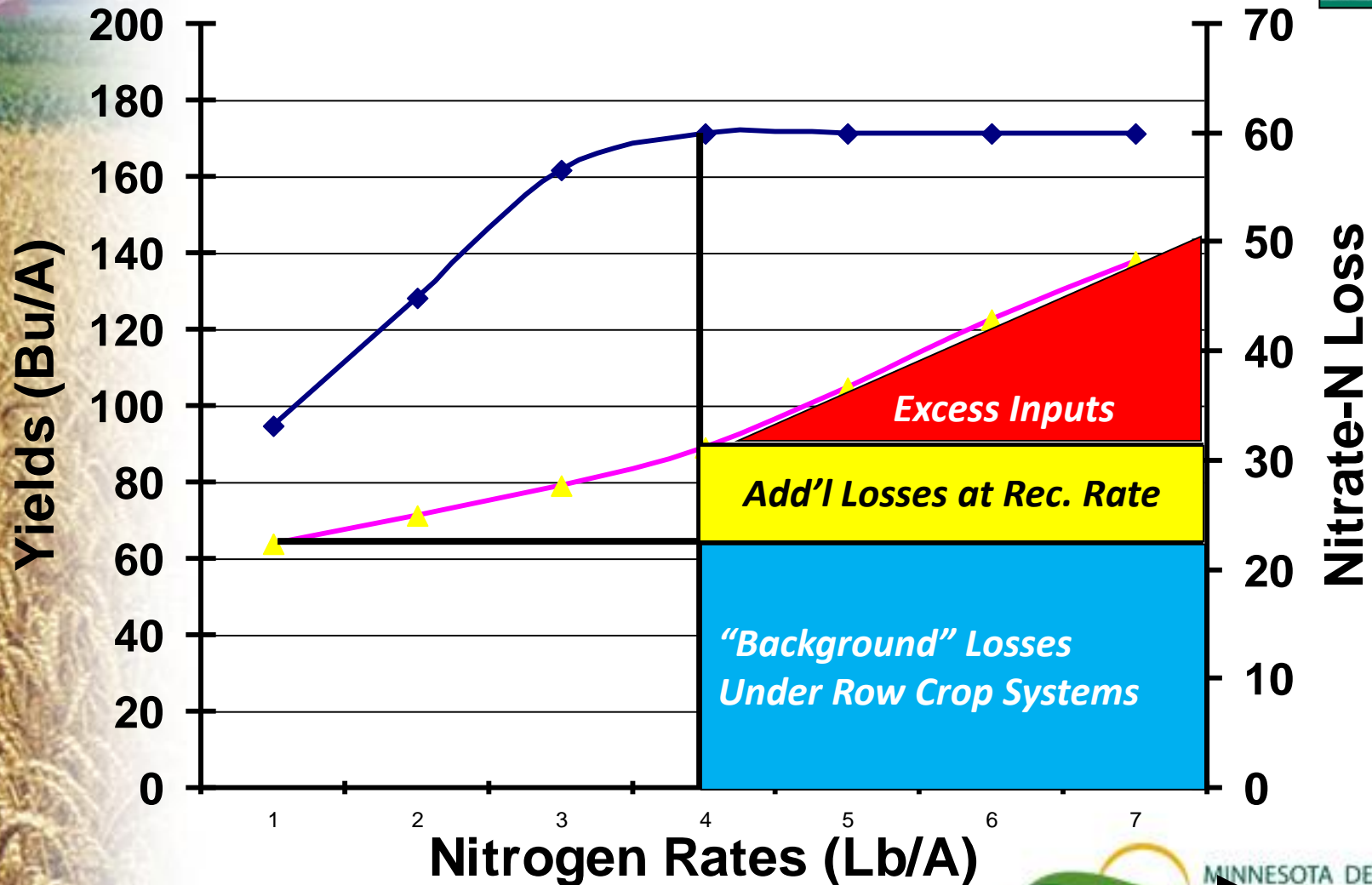
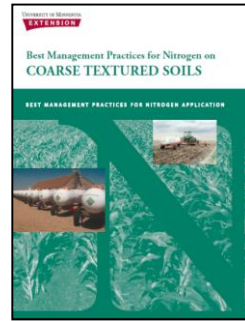
## Soil Water Nitrate-Nitrogen Concentration Byron #1 2014-2015



This graph shows the average soil water nitrate-nitrogen concentrations observed under Byron #1 in 2014 under soybeans and 2015 under corn. Soil water data from other similarly managed fields in Central MN have shown nitrate-nitrogen concentrations that range from 30-70 ppm throughout a corn/soybean/bean rotation. This preliminary data shows soil water nitrate-nitrogen concentrations at Byron #1 measuring in a range comparable to other locations.

# Conceptual Relationship under Corn Production: Inputs, Yields and Environmental Outputs

1993-97 Simulation Year



# Typical Irrigated Crop Rotation with Late Season Potatoes---Pineland Sands Region



**Russet Potatoes**



**Edible Beans**



**Corn**



# Proposed Alternative Rotation at Byron

Potential N Inputs Reduced: 70-80%  
Potential Irrigation Use Reduced: 30-40%



Peas



Soybeans

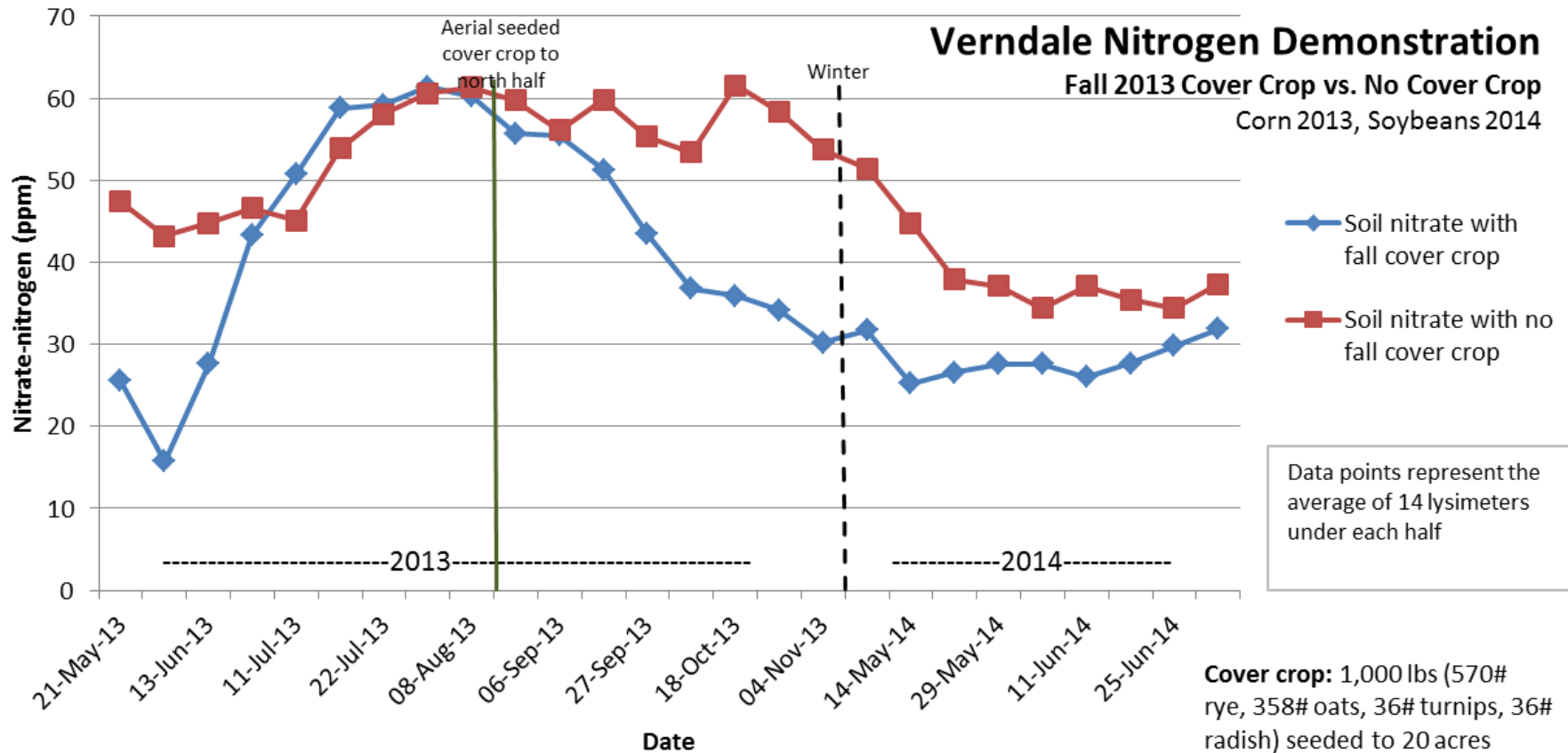


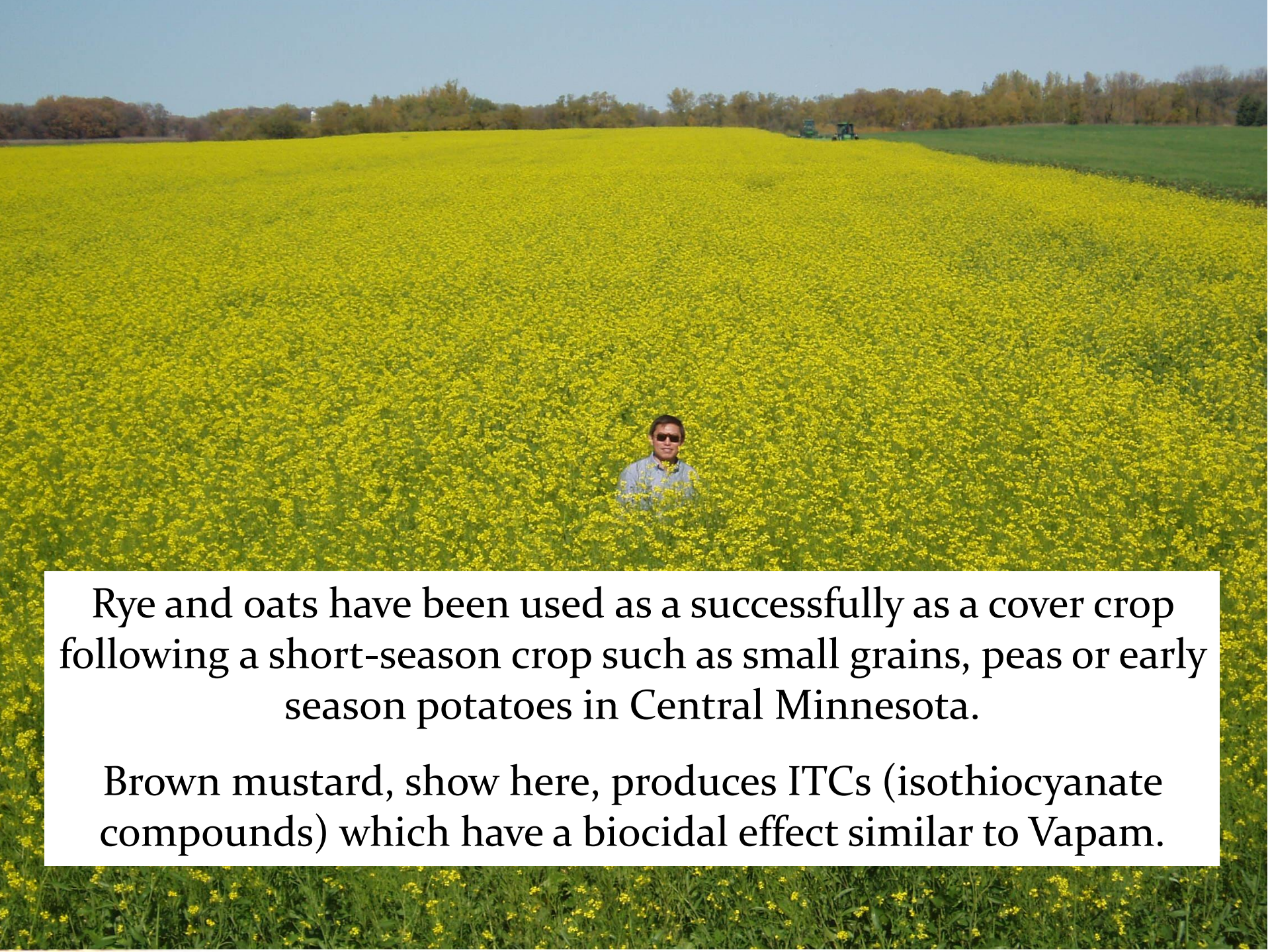
Dark Red Kidney Beans



Seed Potatoes

# Cover Crops Following Short Season Crops Will Serve an Important Role in Reducing Fall Soil Nitrate Levels

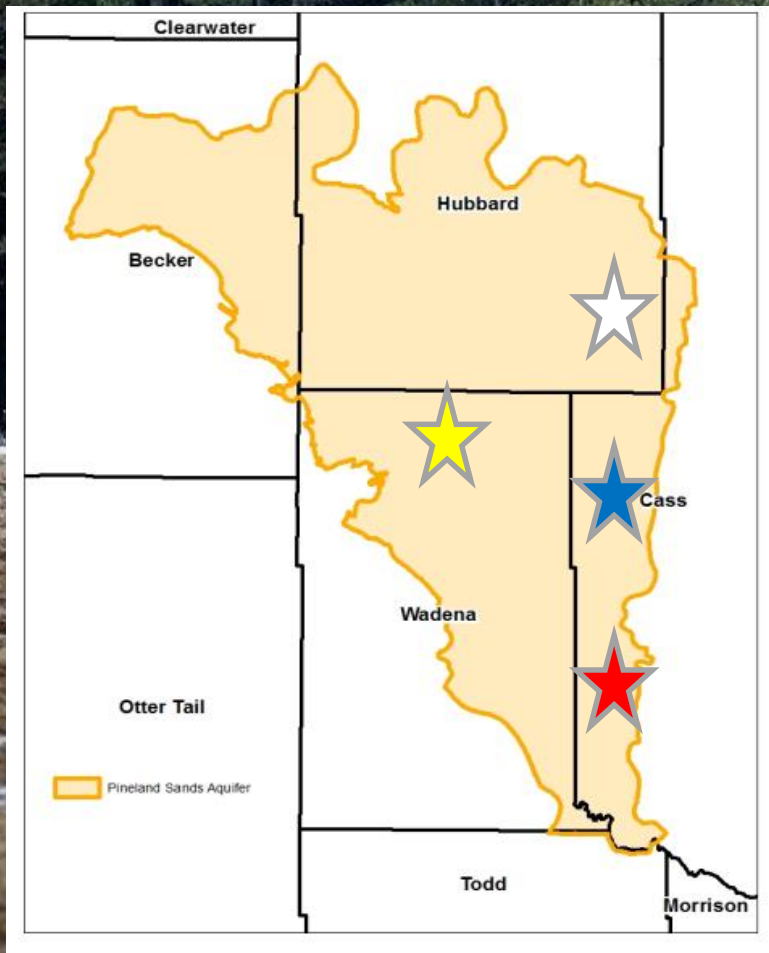




Rye and oats have been used as a successfully as a cover crop following a short-season crop such as small grains, peas or early season potatoes in Central Minnesota.

Brown mustard, show here, produces ITCs (isothiocyanate compounds) which have a biocidal effect similar to Vapam.

# Additional Rotations Proposed in Phase 2 of the Special Study (State Agencies)



Late Season Potatoes Rotated with Low Impact Crops



Traditional Irrigated Rotation Crops---No Potatoes



Late Season Potatoes with Conventional Rotation



Existing Byron Site-Low Impact Crops with Seed Potatoes

# Today's "Take Home" Message

- The unique partnership and associated demonstration site is well positioned to answer some probing nitrogen related questions about timberland conversion and the long-term substantiality of a "highly input reduced" rotation;
- Outcomes will help refine agricultural practices across Minnesota's irrigated acres;
- Additional sites are highly recommended to accurately reflect agricultural practices and rotations currently practiced across the Pineland Sands;