Tonight's host and co-host

Clain Jones
MSU Extension
Soil Fertility Specialist
Clainj@montana.edu, 994-6076

Jennifer Fosjord Solf
Musselshell County Extension Agent
Jennifer.solf@montana.edu, 323-2704

Fundamentals of Soil N Fertility

Winter Soil Fertility Series: Week 2

Jan 13, 2021

Clain Jones, Extension Soil Fertility Specialist
406-994-6076, clainj@montana.edu

Photo by K. Olson-Rutz

Goal: Present N management practices that increase fertilizer use efficiency, decrease losses, increase profits

N is most common lacking nutrient, also one of greatest input costs

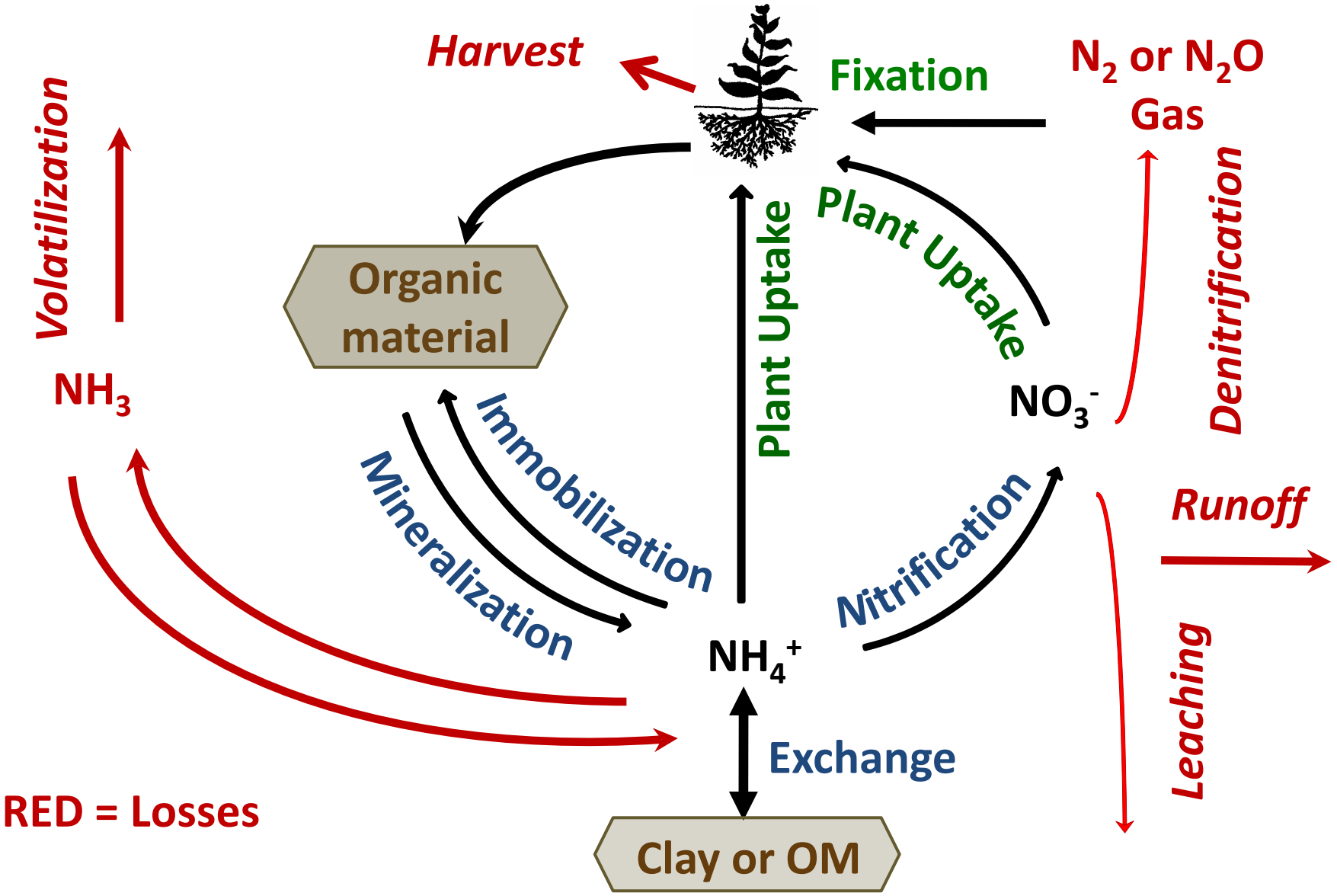
N is removed by:

- Harvest
- Leaching/runoff – up to $1 billion leached N in MT groundwater
- Volatilization – averages about 18%, but up to 44% loss of N applied from broadcast urea in MT
- Denitrification to N gas – 5 to 10 lb N/acre per yr

N management practices to have N available when needed and reduce losses

- Soil testing – covered last week
- N rate – more detail next week
- N source
- Timing
- Placement
- Rotations to supply and ‘catch and release’ N
- Conservation Tillage
- Irrigation
- Tools and technology - e.g. online N calculators, chlorophyll meters, Nutrient Tracking Tool – mostly outside scope of this series

Nitrogen cycle



High risk conditions for urea and UAN volatilization

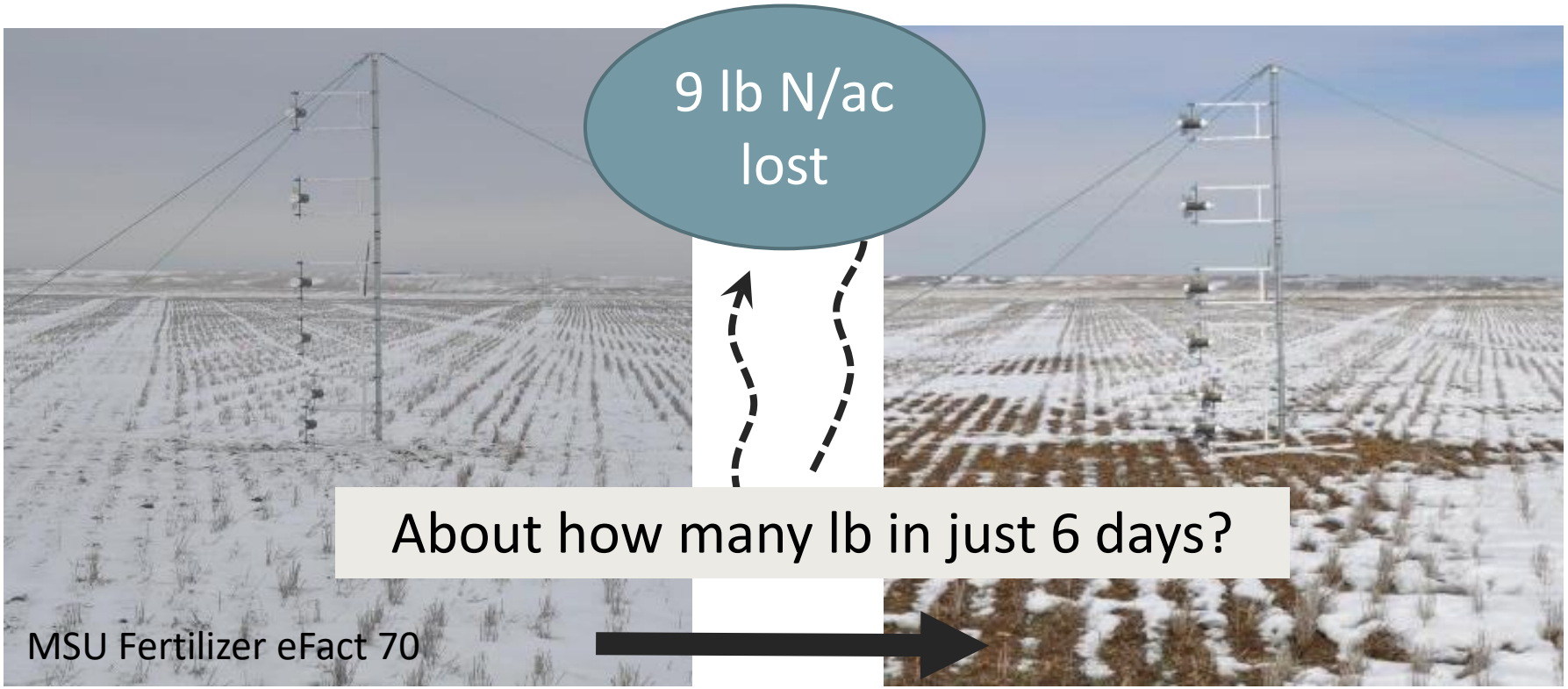
- Moist soil, heavy dew
- Time between application and incorporation by water or tillage
- High soil pH (>7.0)
- High soil temperature (>50°F)
- Crop residue, perennial thatch, sod
- Low cation exchange capacity soil (sandy)
- Poorly buffered soils (low soil organic matter, coarse)

Does application on frozen soil belong on this list? YES!

Engel et al. 2011, MSU Fertilizer Facts FF59 & 60

Most important factors affecting urea volatilization

- Surface soil moisture at time of fertilization
- Best case: ½" precipitation or tillage within 7 days
- Worst-case – moist soil surface w/ only sprinkles for the next few weeks.



High risk conditions for N leaching

- Coarse soils, sand>loam>silt>clay
- Irrigation
- High rain when no crop in place to take up water
- Fields w/ high residual N and no crop in place to take it up

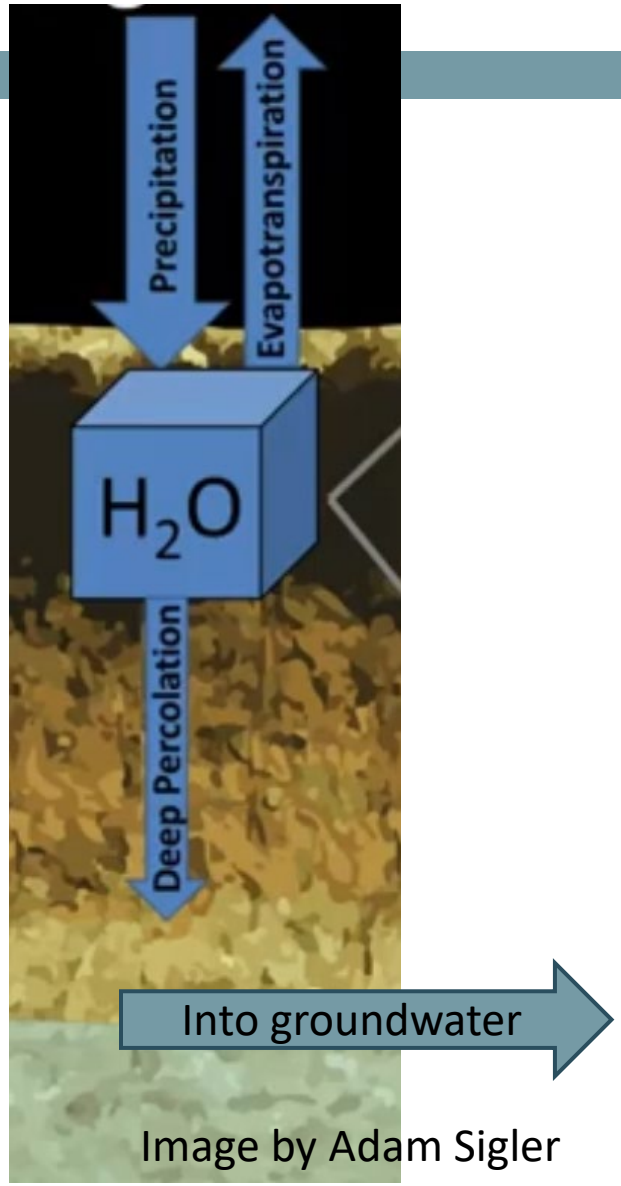
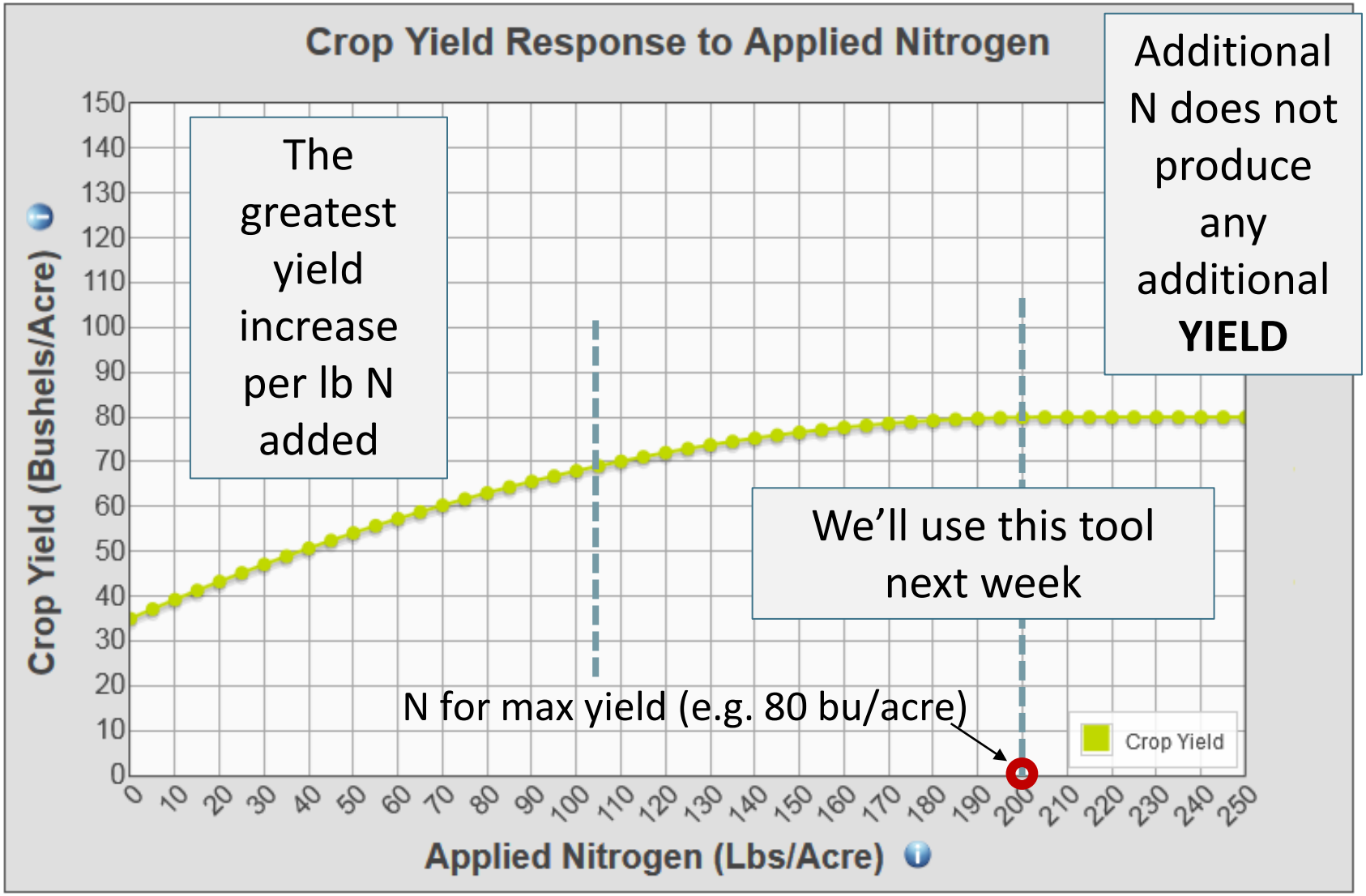


Image by Adam Sigler

Questions?

On to Rate and Source

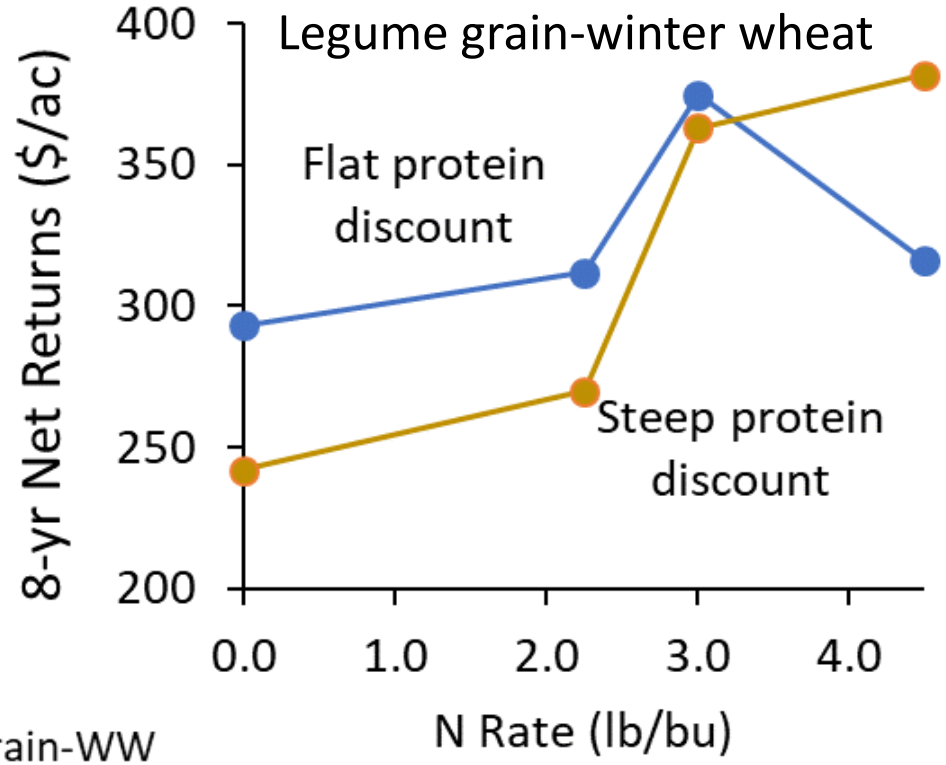
More ≠ better: Law of diminishing returns

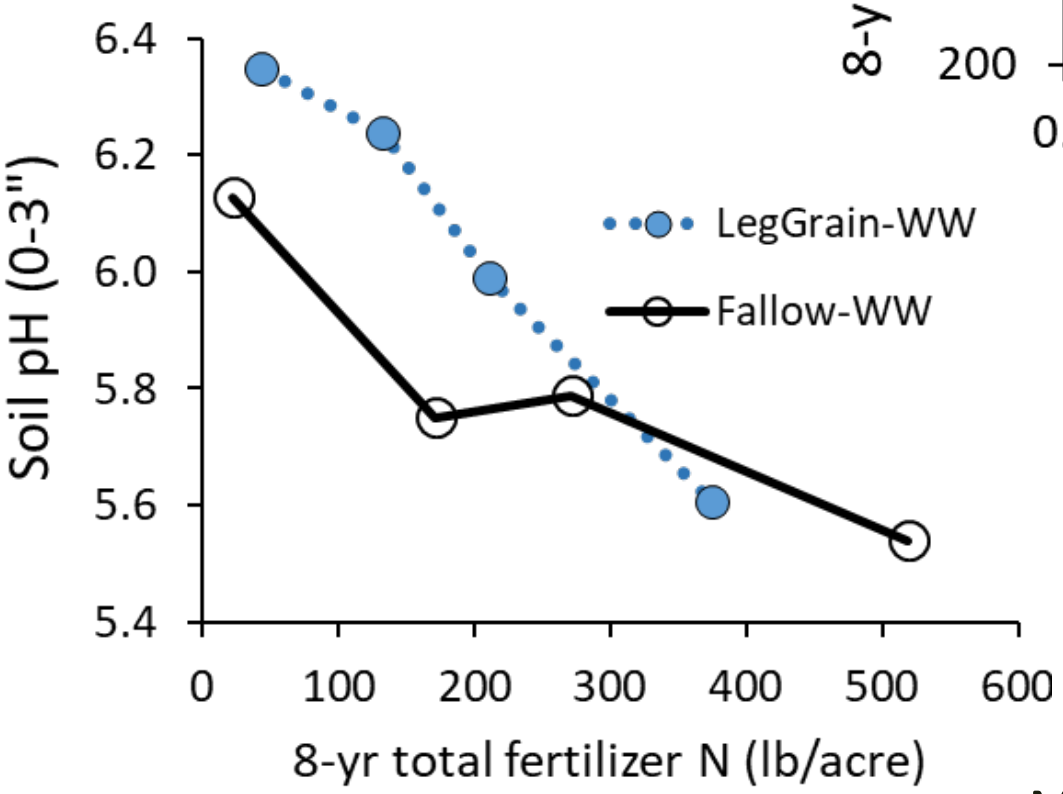


http://econtools.msuextension.org/nitrogen/

Higher N rates are costly

1. By lower net returns when discounts low





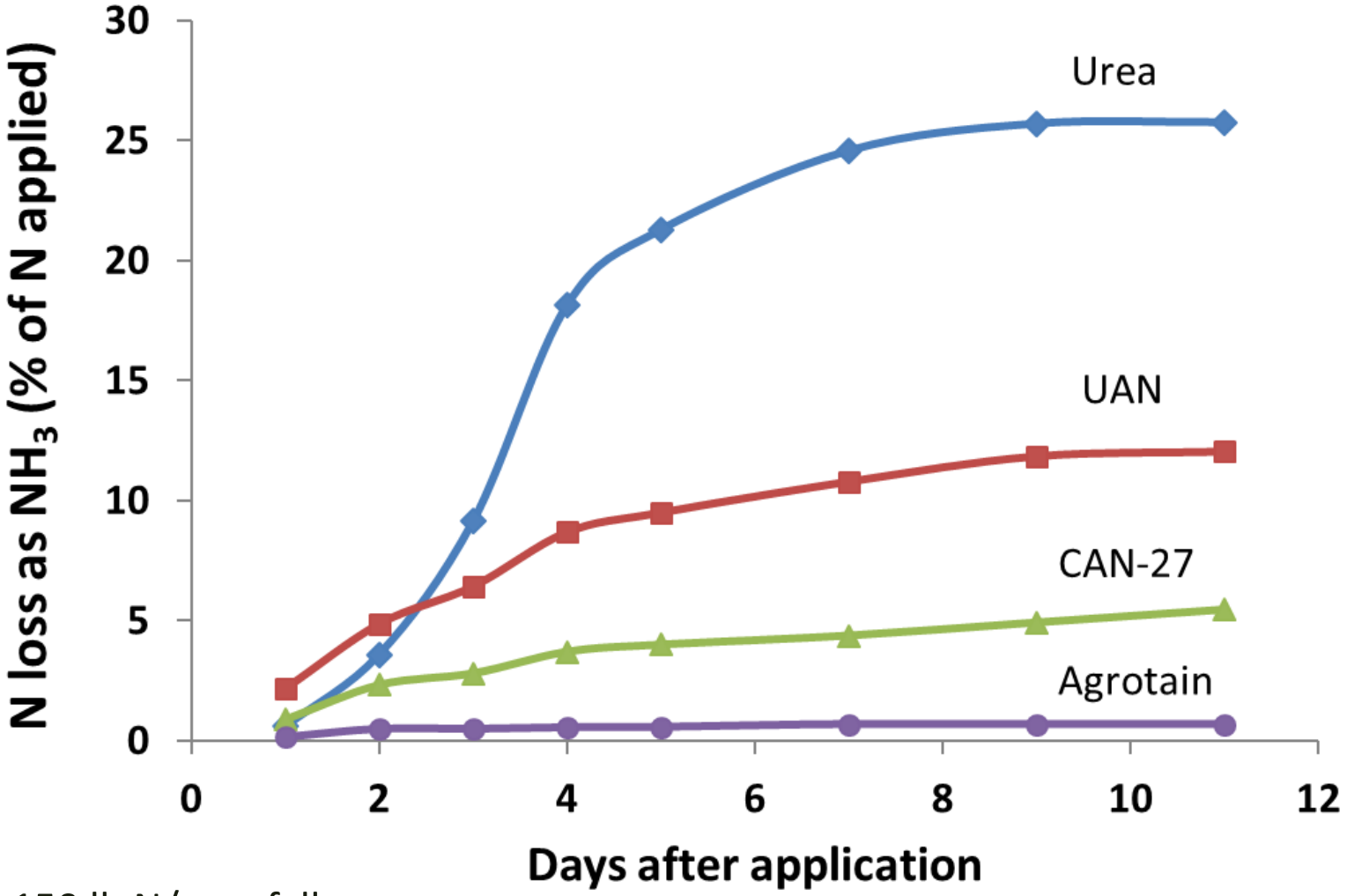
2. And by lowering soil pH to near toxic levels (~5.2). More on Feb 10

Miller et al. unpub data. Big Sandy, MT

N sources have different volatilization and leaching loss potential

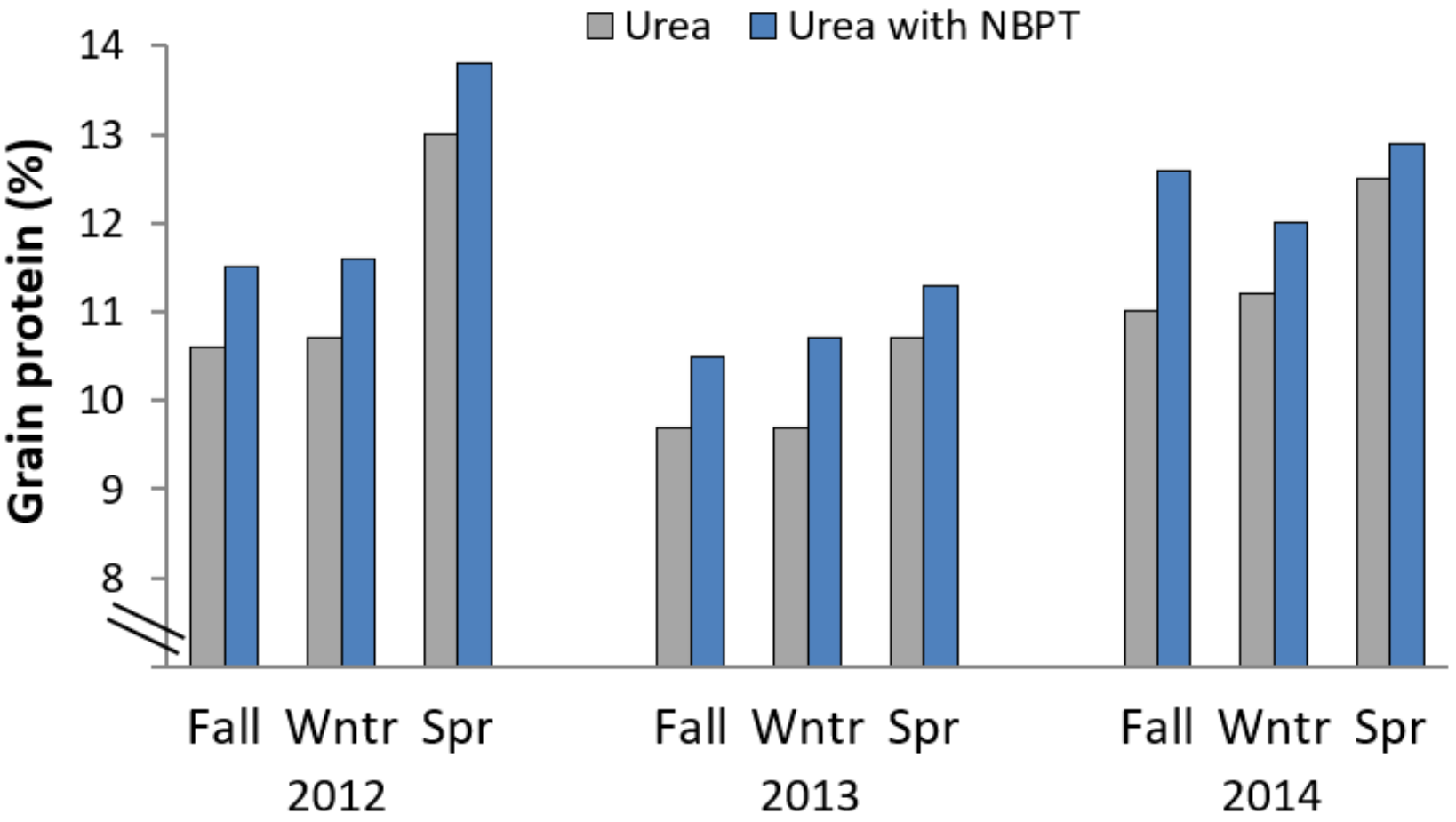
	***POTENTIAL* loss vs urea**	
Source	Volatilization	Leaching
Conventional		
Ammonium nitrate, CAN, ammonium sulfate	less	≈
UAN (solution 28 or 32)	less	≈
Enhanced Efficiency Fertilizers		
Urease inhibitors (NBPT=Agrotain, N-Fixx, Arborite® AG)	less	≈
Nitrification inhibitors (DCD, N-Source, N-Serve, Instinct)	≈	less
Combinations (SuperU)	less	less
Controlled release polymer coated (ESN)	less	less
Slow release (Nitamin, N-Sure, N-Demand)	≈	less?

Sources to reduce volatilization on newly seeded grass field



Oregon, 150 lb N/acre fall applied, Horneck et al. 2011

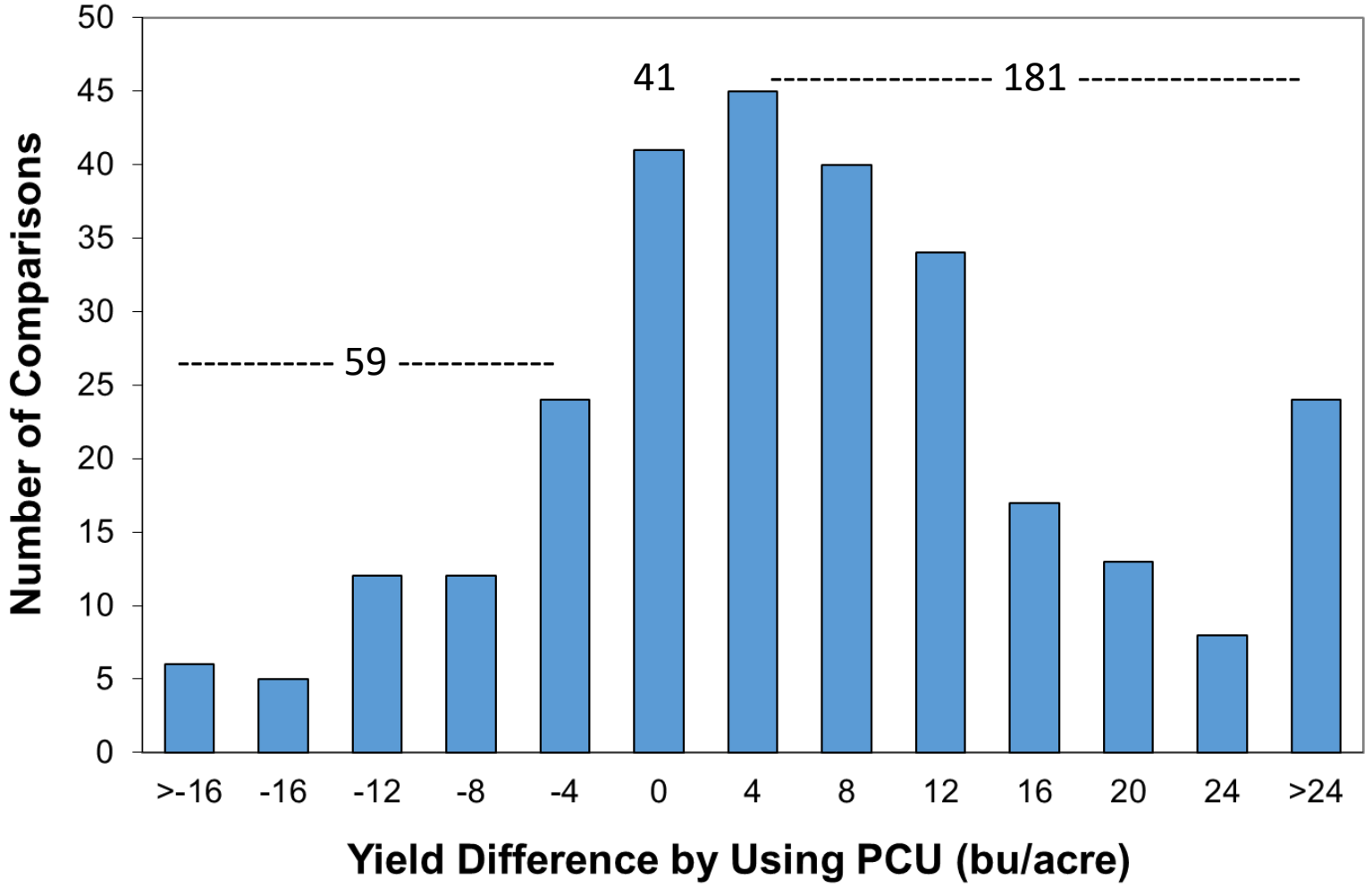
NBPT and spring application increased wheat protein



NBPT sig increased protein by 0.4 to 1.6% points.
NBPT only increased yield in Fall applied 2012.

Coffee Creek, MT MSU
Fertilizer eFacts 71

Corn yields more often higher with pre-plant PCU (ESN®) than conventional N at equal rates (US corn-belt (2000-2004)



Blaylock et al, 2006

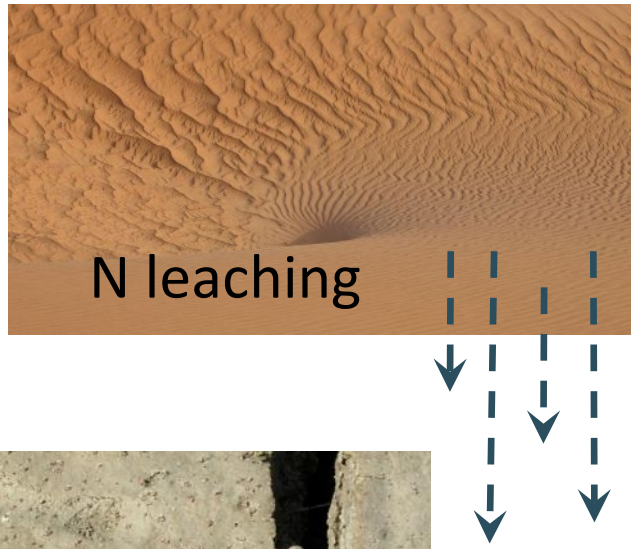
Slow- and controlled-release

Photo courtesy Agrium

- Benefit depends on climate/weather
- Consider in areas with high leaching or denitrification potential
- Release of polymer coated urea depends on temp and moisture, can be too slow with late winter/early-spring application in cool/dry environments
- If fall application to reduce spring workload is important, then extra cost might be worth it
- May benefit protein more than yield, and protect water quality

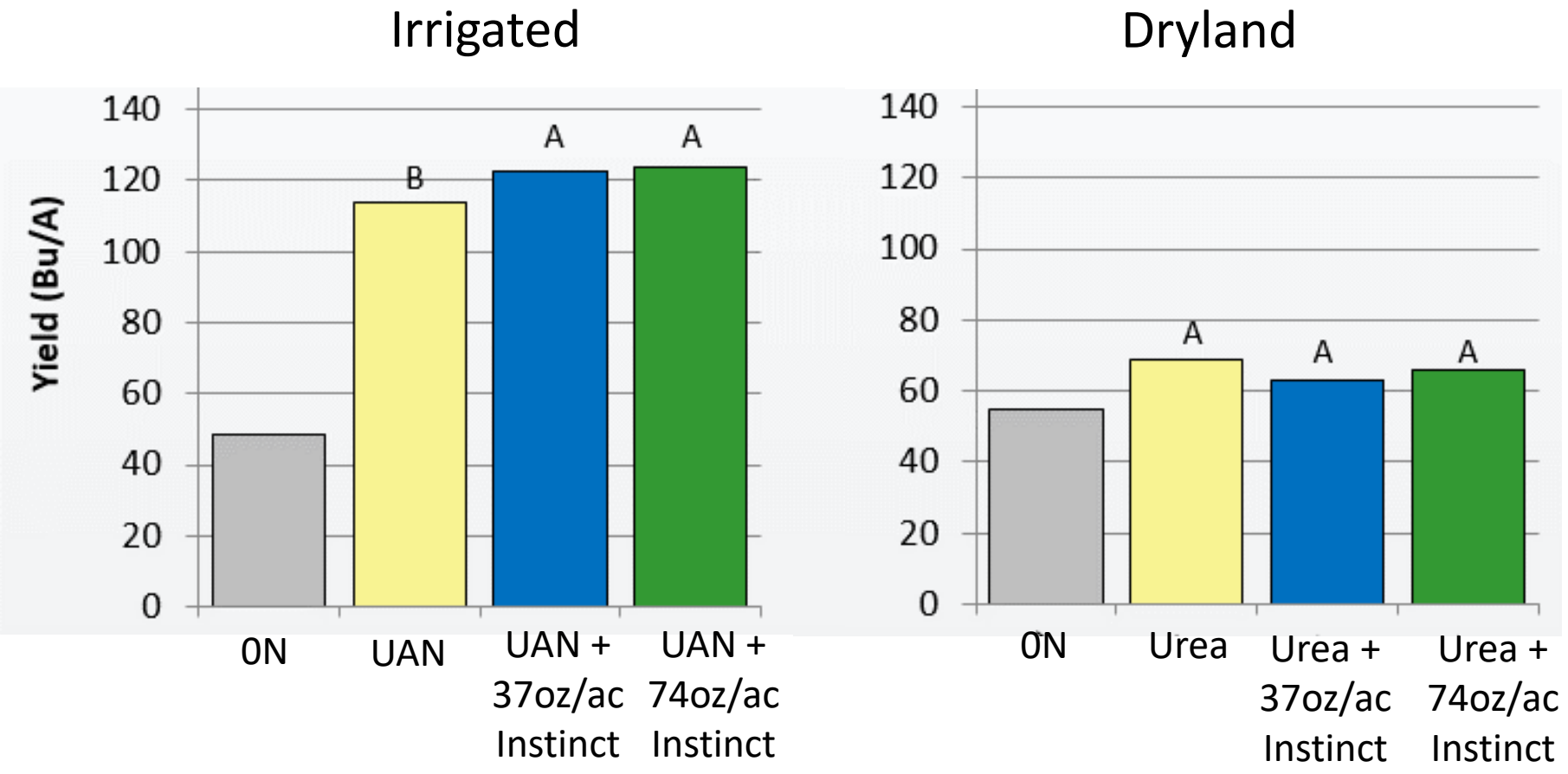
Nitrification inhibitors (e.g. DCD) delay ammonium (NH_4^+) to nitrate (NO_3^-) conversion

- Reduces leaching and N_2 gas loss
- Potential benefit with fall-banded urea where:
  - high precip with leaching in sandy soils
  - denitrification (nitrate → N_2 gas) in water logged/clay soils



- Benefits less likely in dry or well drained soils
- DCD sprayed before fall plow-down can slow nitrification and leaching loss (Francis 1995)

Instinct II® (nitrification inhibitor) increased winter wheat grain yield under irrigation but not dryland



Scherder et al., 2015, inland Pacific NW
UAN sidedress dribble stream bar, urea preplant incorporated

Questions?

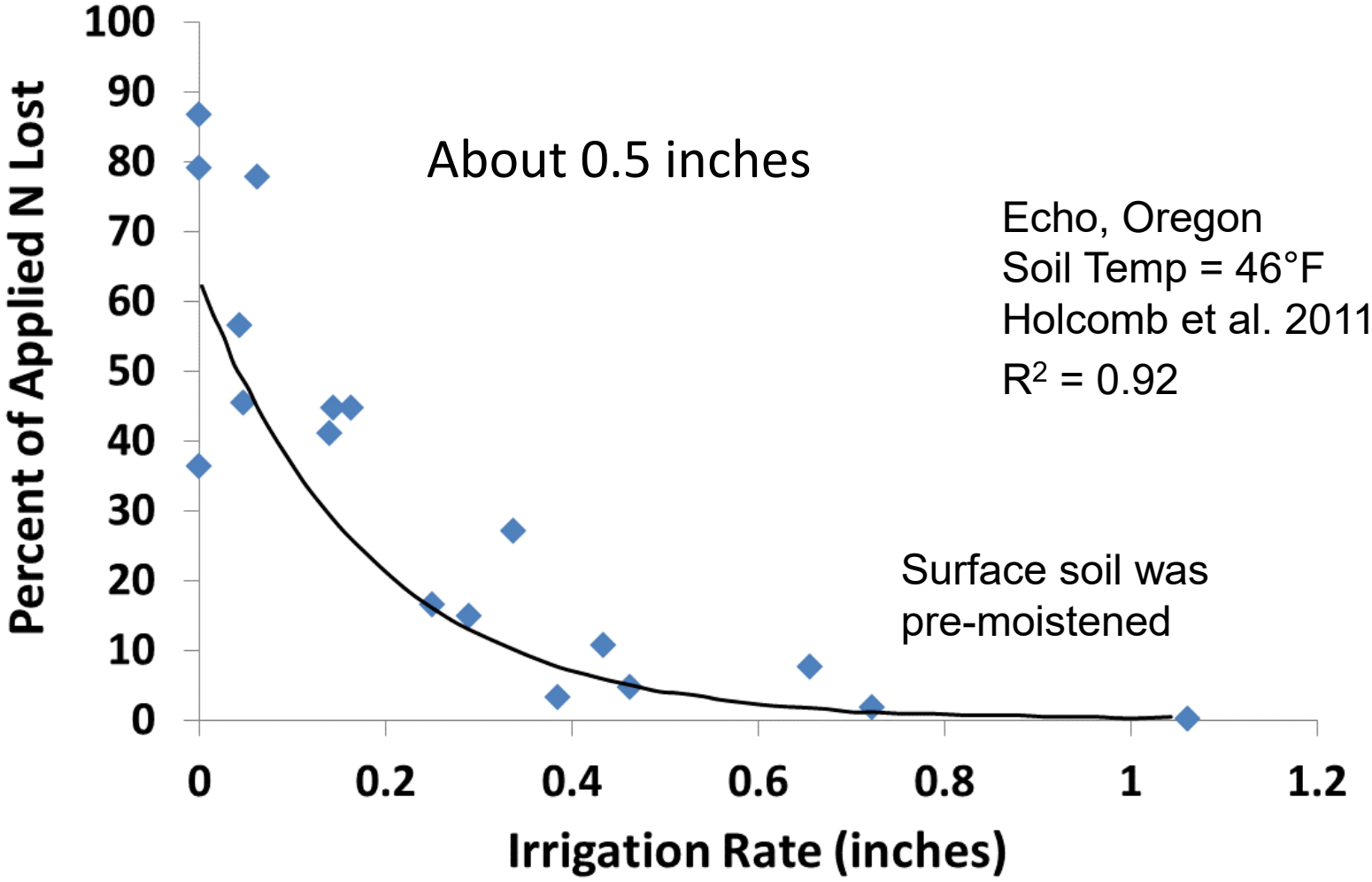
On to Placement and Timing

N placement

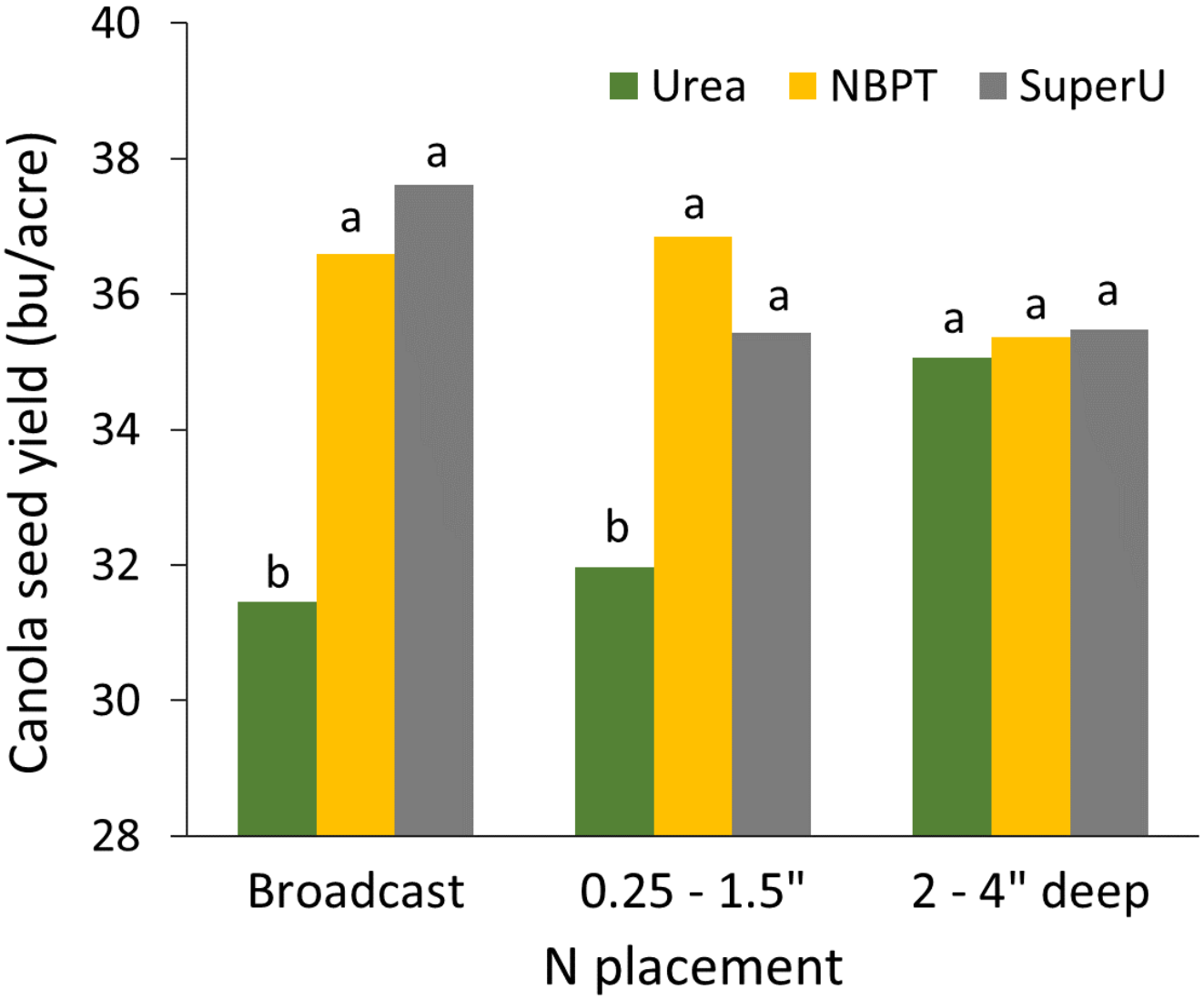
In general, subsurface placement/incorporation of N fertilizer decreases losses and increases availability

- Does application on snow or frozen ground protect from volatilization? NO!
- Caution with seed-placed. Avoid germination damage with too high of rates

How much water does it take to protect urea from volatilization?



Best-case – subsurface band at least 2” deep, packed, OR use ‘urease inhibitor’ like NBPT



Karamanos, Barker 2016 Top Crop Manager

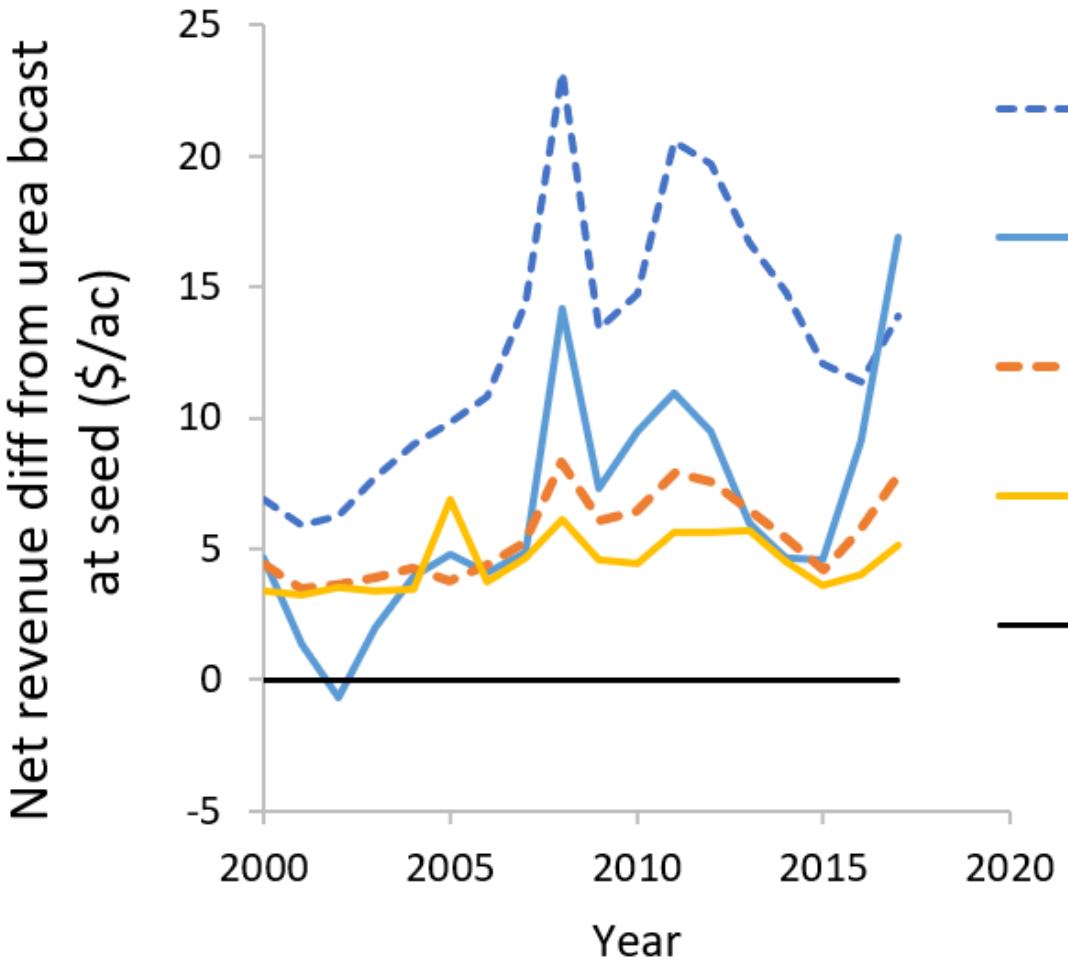
Time application to supply when needed and protect from losses. Depends on N source

- Readily available [urea (46–0–0), urea ammonium nitrate (28–0–0)]

  Shortly before seeding up to mid-tillering. See *Nutrient uptake timing by crops.* Will cover more in Jan 20 session http://landresources.montana.edu/soilfertility/nutuptake.html

- Slowly available (manure, slow-release N)
  - take time to become available
  - apply before needed – e.g., fall in semi-arid conditions

Split-application increases options and maybe net returns



Yield bu/ac
56.5
54.1
56.1
56.5
55.9

8 lb N/ac applied with seed, total fertilizer 67 lb N/ac

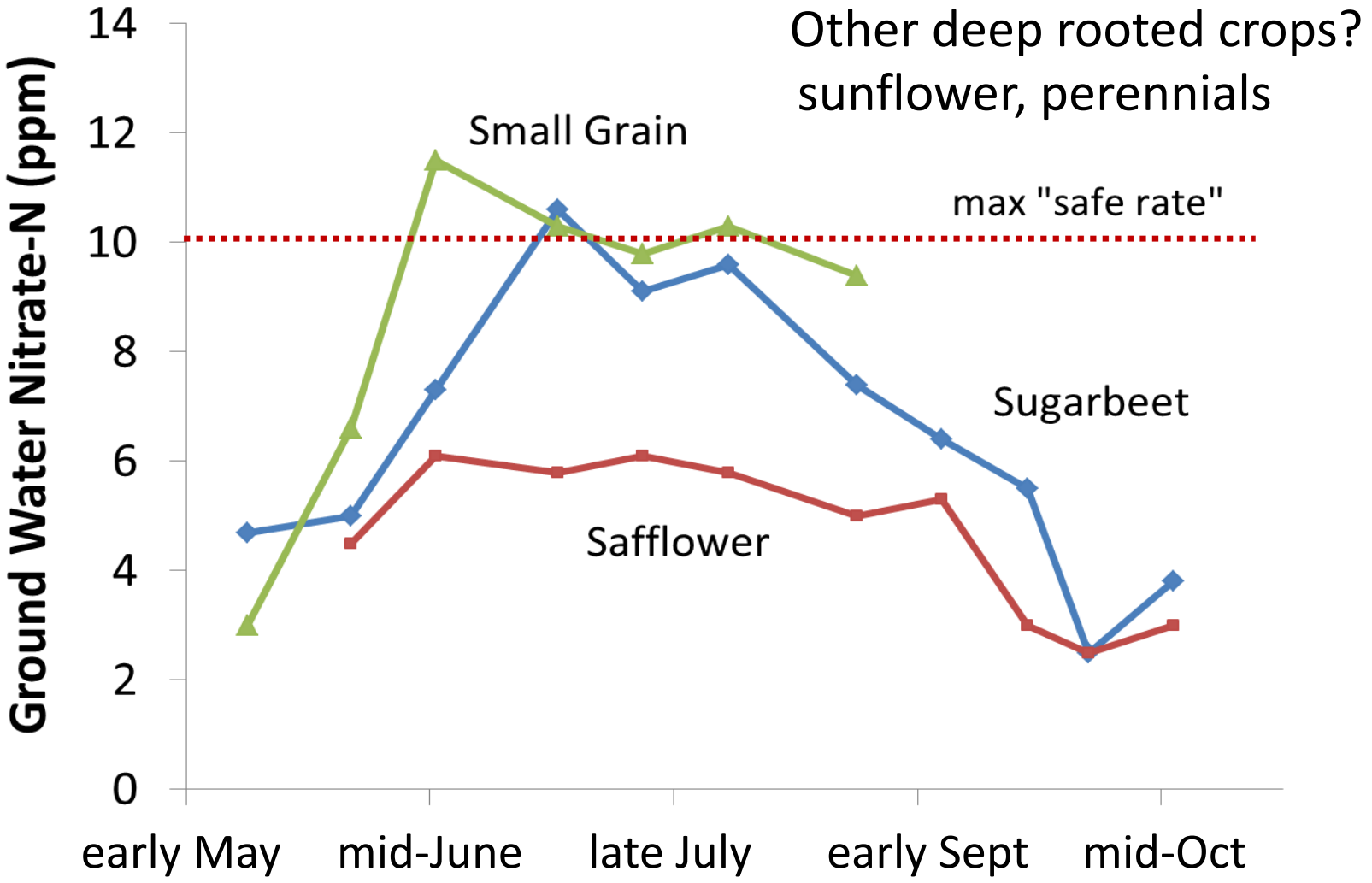
Graham and Stockton 2019, SD, dryland winter wheat

Use regionally available tools to decide if late-season N or not. Ex. flag leaf N, pre-sidedress N test, chlorophyll readings

Questions?

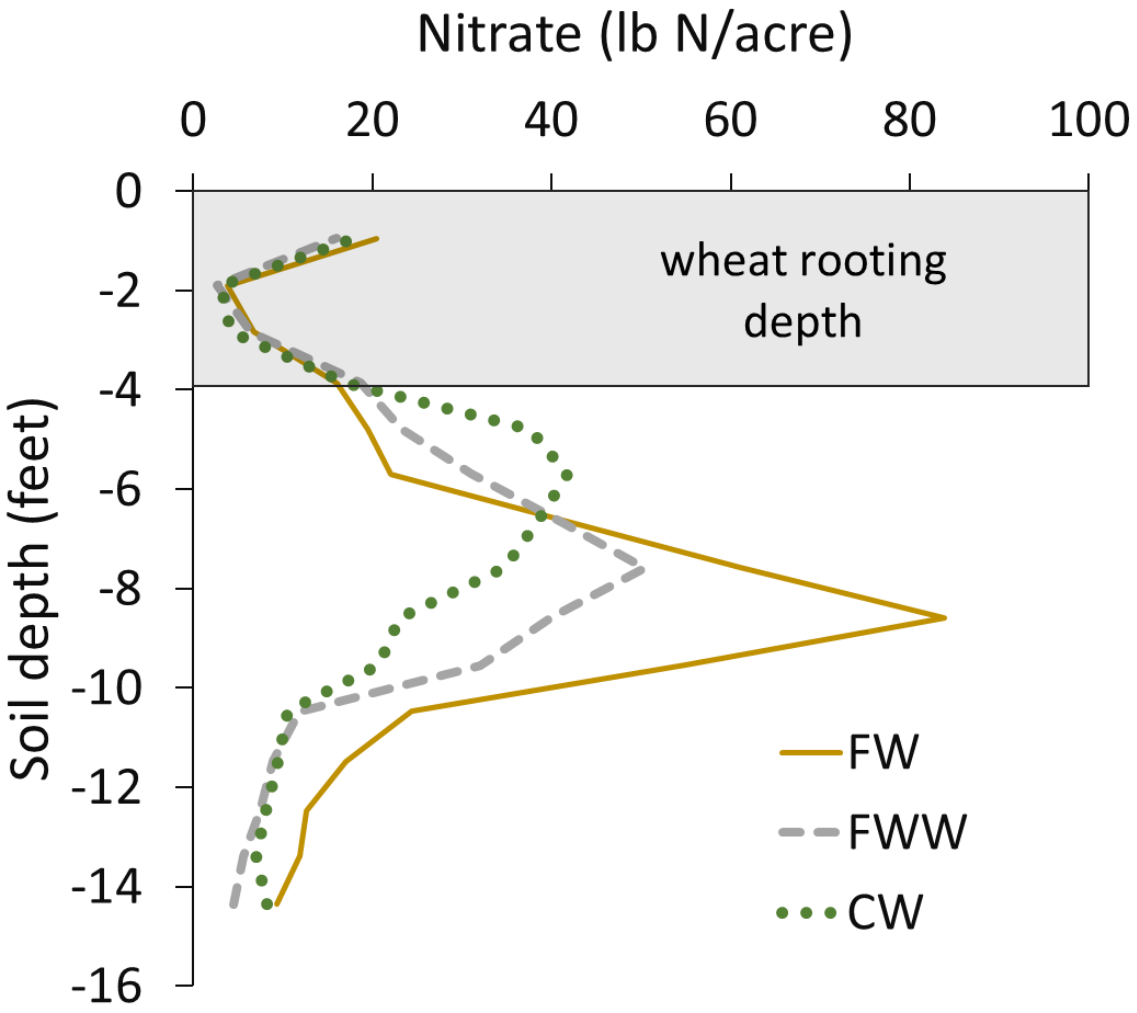
On to Crop Rotations to catch residual N and reduce loss from system

Deep rooted crops dig deep for N and help keep nitrate out of groundwater



6-yr average, Sidney, MT, MSU Fertilizer Fact 9

Continuous cropping leaves less nitrate in soil to leach

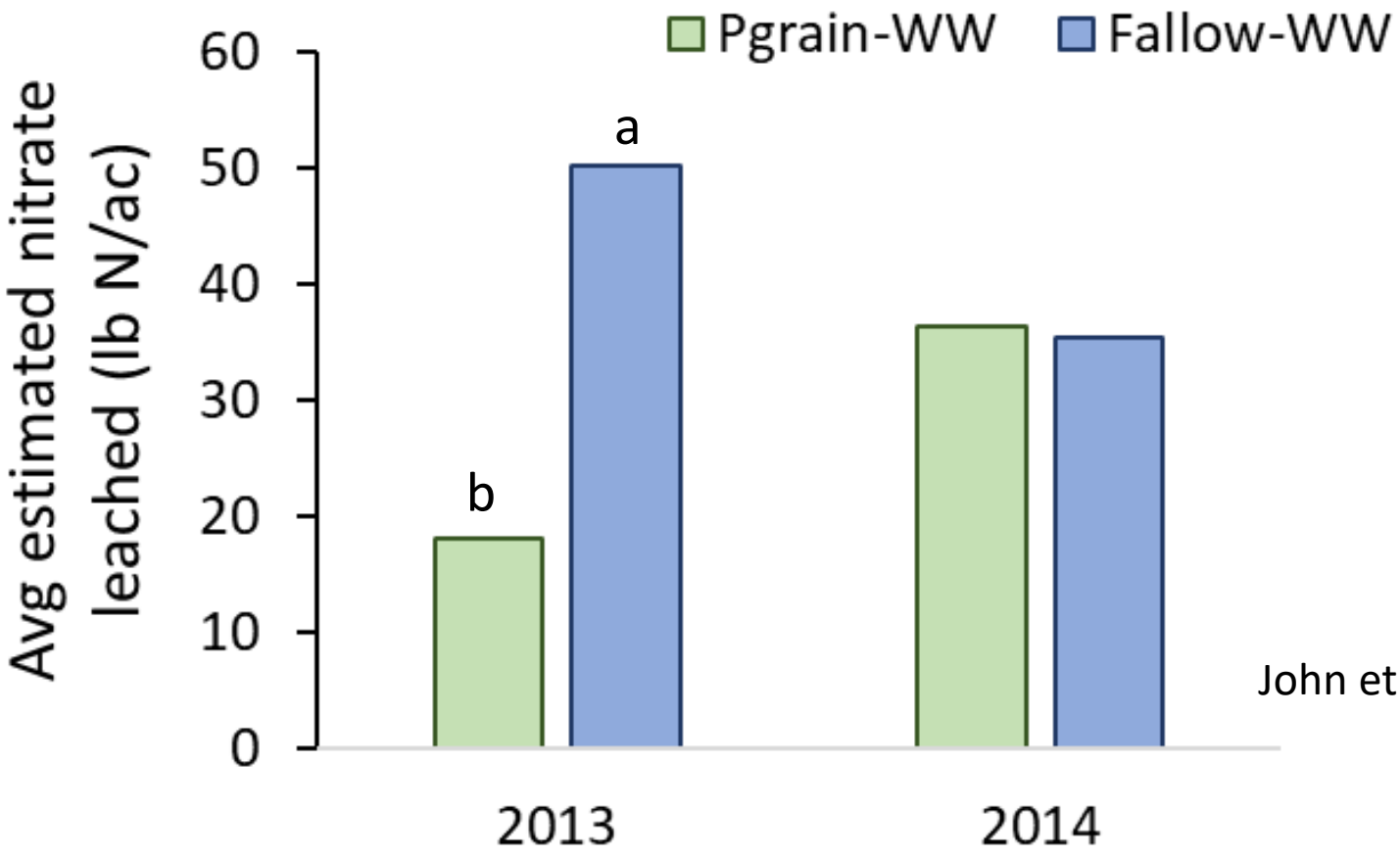


37 years of each dryland cropping system with spring wheat

Campbell et al, 2006
Swift Current, SK

Judith Basin Nitrogen Project

Pea grown for grain decreased leaching when replaced fallow.



John et al. 2017

Pea grain-wheat leached less one year than fallow-wheat, equal NR.
Leaching no diff between rotations in 2nd year, NR greater with pea-wheat.

N management factors to decrease N leaching

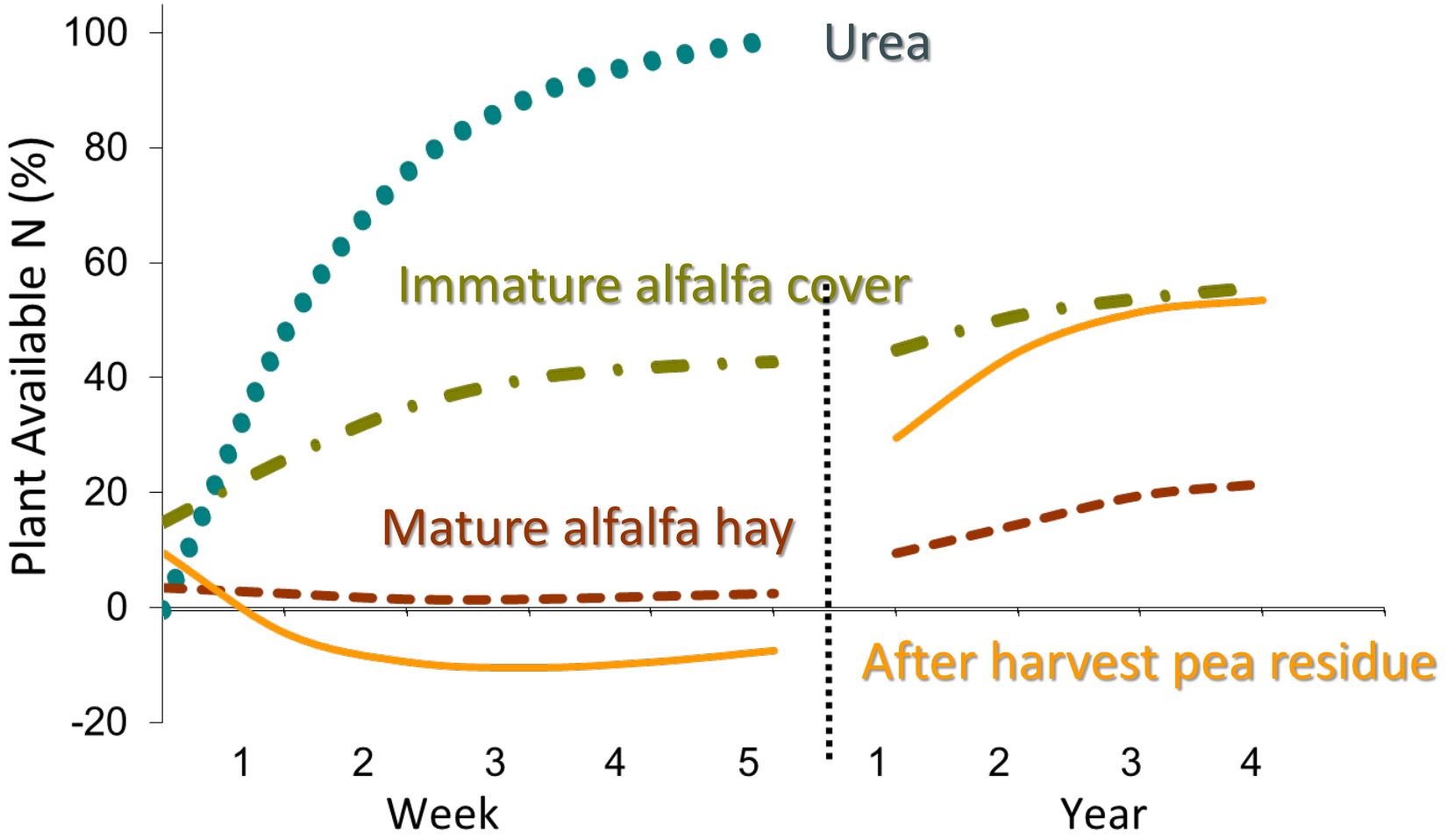
- Apply N based on spring soil test
- Use conservative N rate at seeding and apply 2nd application ONLY if a wet year
- Avoid fall application on shallow and/or coarse soils
- Consider applying less N in areas that yield less or have shallow soils (variable rate application)
- Recrop when possible or grow perennials

Questions?

On to Crop Rotations to supply N and increase profit

Plant available N **RATE** from plant residue

- Microbial activity higher with increased moisture and warm temps
- Fresh/young/high N = rapid; mature/coarse/low N = slow



Montana State University Extension Bulletin EB0200

Plant available N **AMOUNT** from plant residue

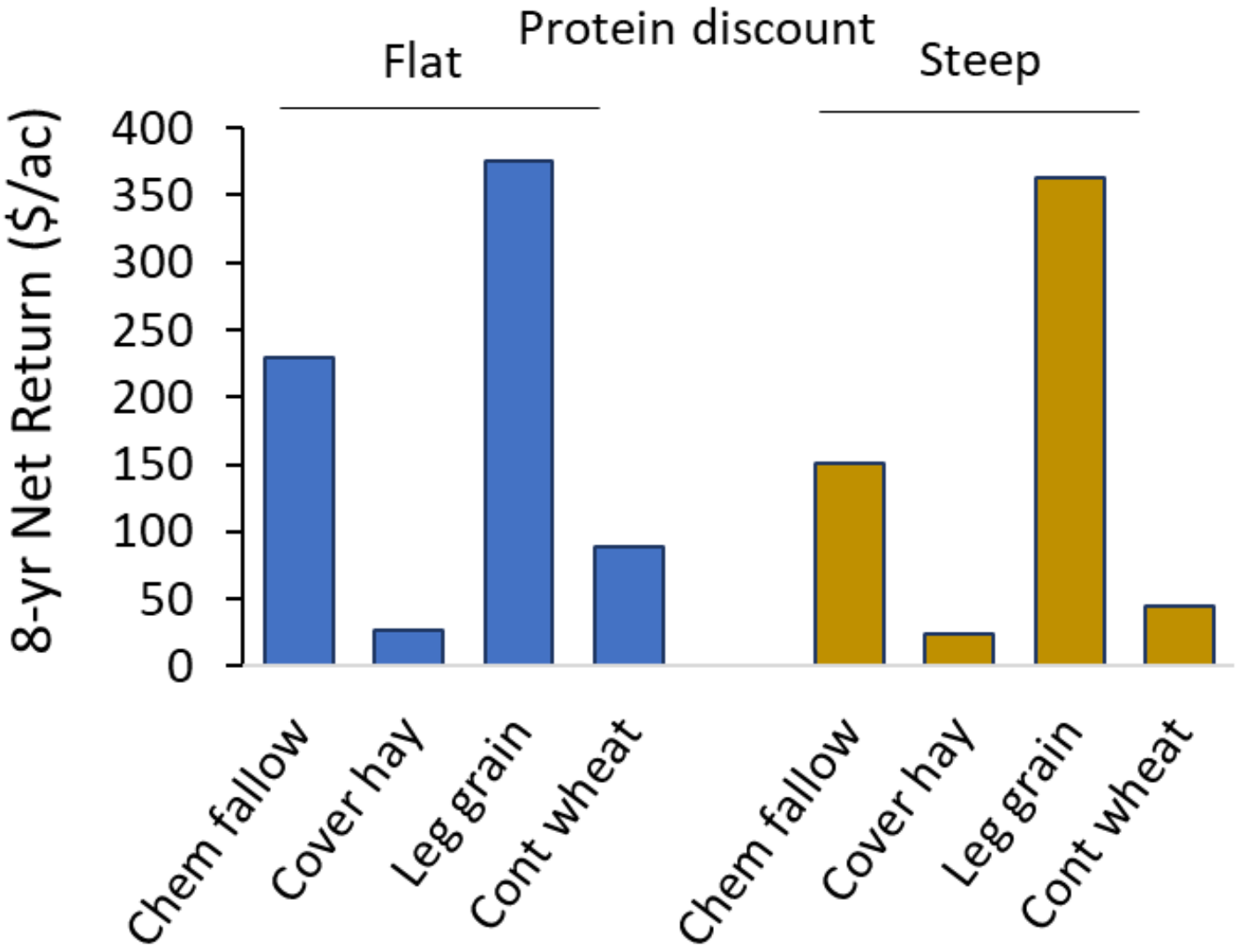
Depends on residue amount and N concentration

- Leafy green: high N concentration = more PAN
- Mature plant residue: lower N concentration, N used by microbes and not available for crop

N amount for next crop = “N credit”

- Will discuss in N by crop species session and in cover crop session

Pea grown for grain – wheat rotation is most profitable



Miller and Jones unpub data. Big Sandy, MT
N rate 3 lb/bu yield goal, adjusted for residual soil N

Summary

- A combination of management changes is likely needed to substantially increase N use efficiency (NUE)
- Manage N with the N-cycle in mind to supply N when needed, reduce N losses, and protect soil, water, and air quality and pocket book
- Each growing region will have unique best management practices to increase NUE – look for local information
- Research can't test all possible conditions – do strip trials

Photo by Ann Ronning

Thank you! Questions?

Please help us improve this seminar series by completing the short evaluation; link provided in chat box soon.

Future sessions
Jan 20: N by specific crop types
Jan 27: Micronutrients
Feb 3: Forage Nutrient Mgt
Feb 10: Sustainable Nutrient Mgt
Feb 13: Cover crops

This presentation and more information on soil fertility is available at http://landresources.montana.edu/soilfertility