# Optimizing N Fertilizer Use

## Swank Tour

July 21, 2011

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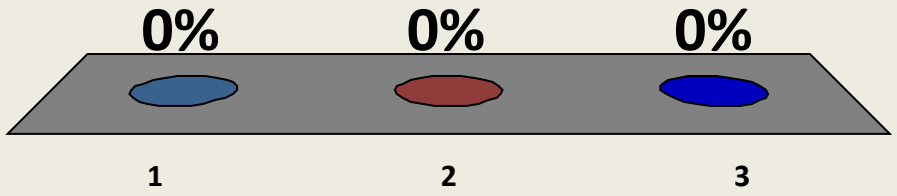
MONTANA STATE UNIVERSITY
EXTENSION

AGRICULTURE

MAKING A DIFFERENCE IN MONTANA COMMUNITIES

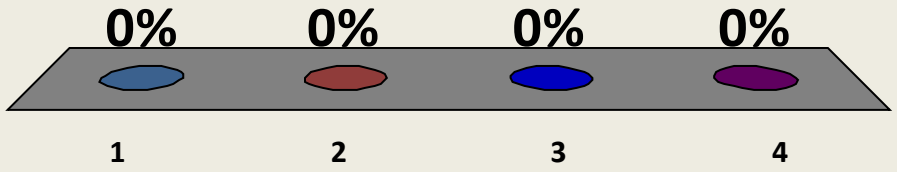
# Evening presentations are best because:

1. I get an early start on my beauty rest
2. I get out of doing dishes
3. The coffee has worn off and I can concentrate



# N fertilization costs are approximately what percent of your input costs (seed, chemical, fuel, fertilizer)?

1. < 10%
2. 10 - 20%
3. 20 - 30%
4. > 30%

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# Management practices to optimize N fertilizer use and boost grain protein

1. Base fertilizer N rate on reasonable yield potential and accurate soil nitrate
2. Split/in season N applications
3. Minimize N losses
4. Consider an enhanced efficiency fertilizer
5. Consider legumes, perennials and deep rooted crops in rotation

# Determining fertilizer N rate

Increase accuracy of soil nitrate-N levels
(affects N rate)

- Collect sufficient number of sub-samples
  Ideally more than 8 sub-samples per composite should be collected; more on a large field.

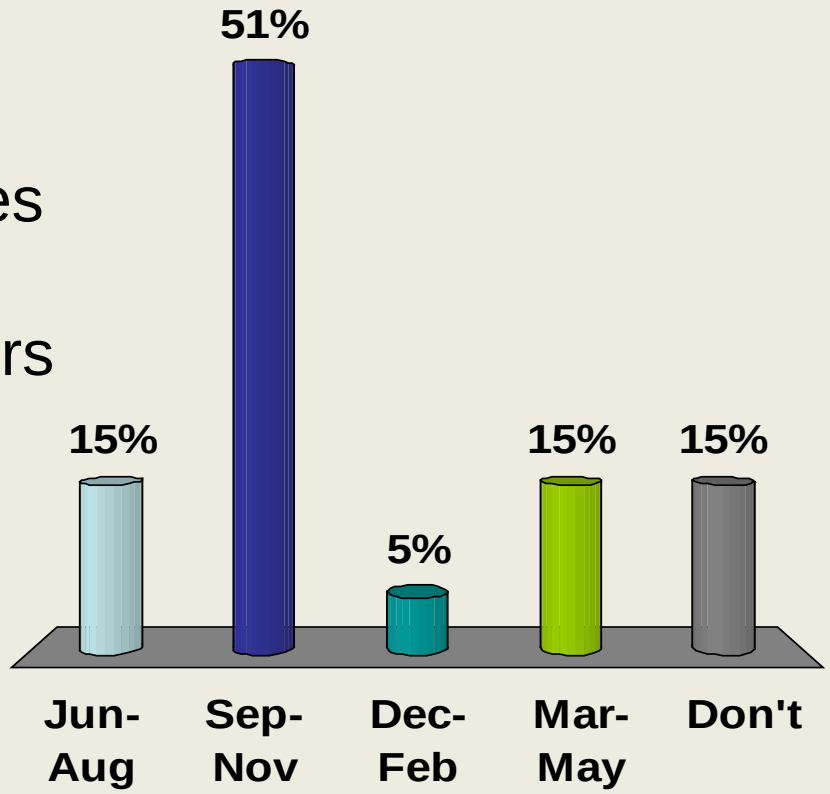
- Timing of sampling
  Soil sample in late winter/early spring if possible b/c soil nitrate levels can change overwinter.

# Timing of soil sampling

- Nitrogen fertilizer guidelines are based on spring soil samples for nitrate in Montana
- BUT, most sampling in MT occurs from late summer to late fall

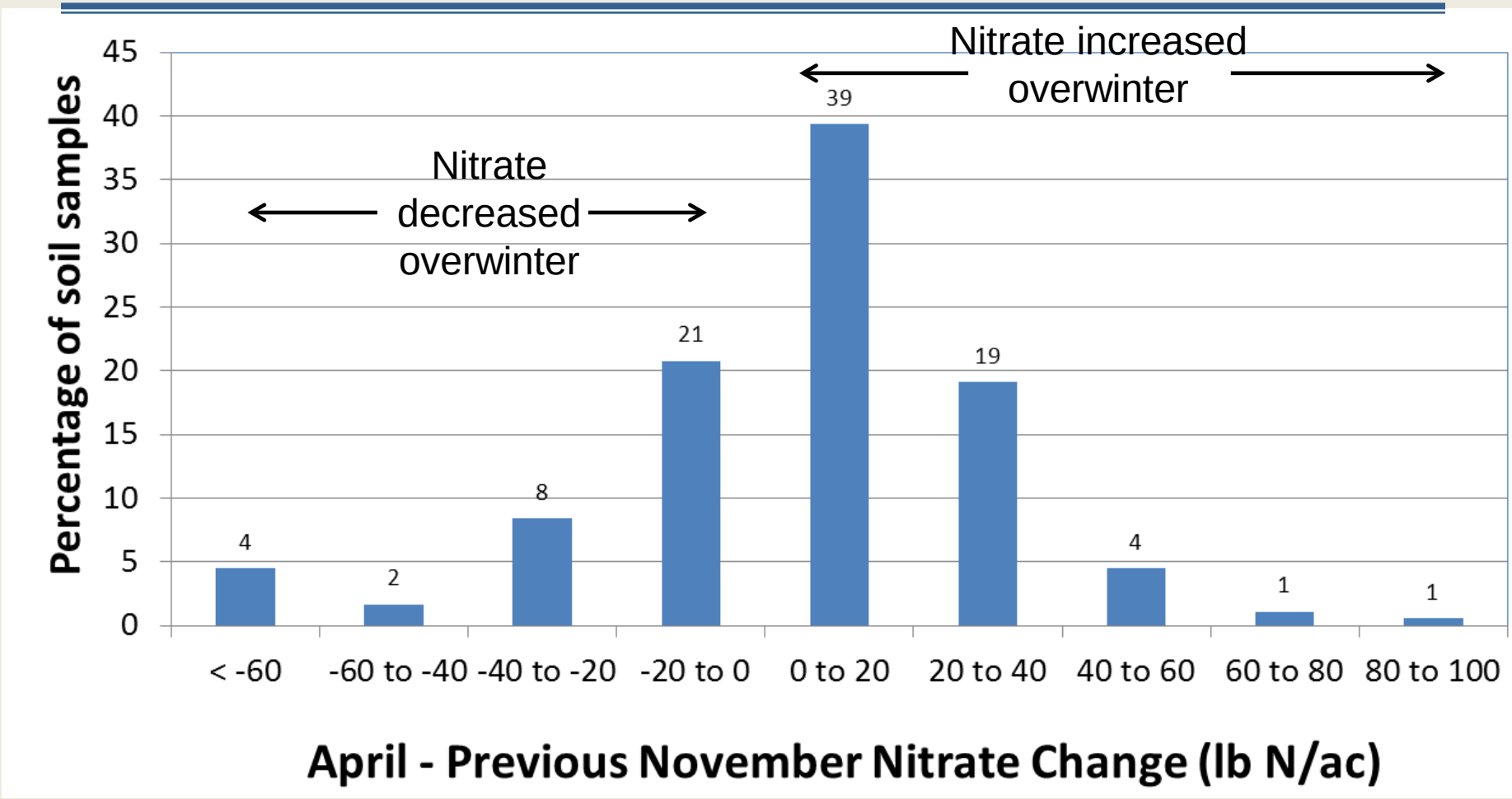
Based on 35 ‘clicker’ responses at MABA 2010 Convention, when asked when crop advisers do most of their soil sampling:

Why is this a potential problem?



# November to April nitrate changes

Montana data based on 180 samples (Jones et al. 2011)



# Soil sampling summary

- Nitrate levels change from late summer/fall to spring and are highly variable
- High nitrate levels on shallow coarse soils can be lost overwinter, resulting in under-fertilization
- Nitrate levels can increase overwinter, resulting in over-fertilization
- Sampling later will better represent growing season nitrate levels

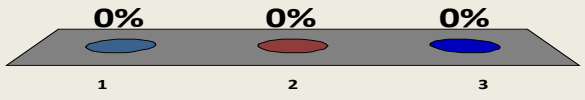
# Determining fertilizer N rate (cont'd)

Select fertilizer N rate based on soil N+ fertilizer N per bushel of yield goal OR use economic N rate calculator.

| Crop | MSU Fertilizer Guidelines | MT producers (based on survey) |
|---|---|---|
| Winter wheat | 2.6 lb N/bu | Guesses? (n = 64) |
| Spring wheat | 3.3 lb N/bu | Guesses? (n = 54) |

Do you think MT producers fertilizer wheat:

1. Less
2. About these amounts
3. More



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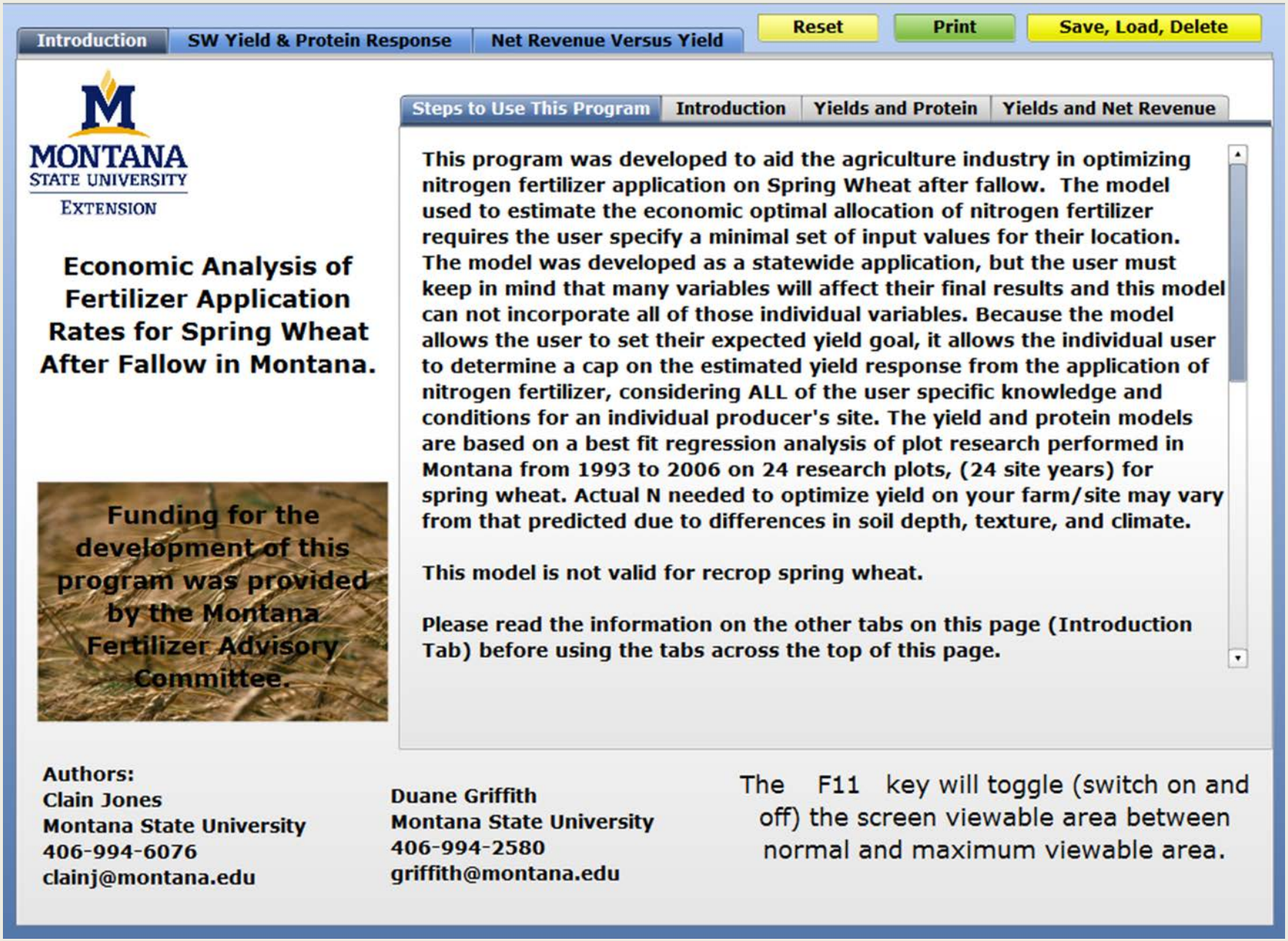
|---|---|---|
| Winter wheat | 2.6 lb N/bu | 2.3 lb N/bu |
| Spring wheat | 3.3 lb N/bu | 2.6 lb N/bu |

What is this under-fertilization costing MT spring wheat producers?

- in protein?
- in dollars?




http://www.montana.edu/softwaredownloads/software/SWFertilizerEconomics.swf

# Determining fertilizer N rate (cont'd)

What is this under-fertilization costing MT spring wheat producers?

~$25/acre compared to fertilizer guidelines
~$60/acre compared to economic calculator prediction

**Tens of millions of revenue dollars statewide?**

# Determining fertilizer N rate (cont'd)

Danger of aggressive N fertilization?

Hot dry season, low protein discounts, lower net returns, and higher leaching/volatilization N losses.

Strategy to avoid this possibility?

Use a conservative pre-plant N rate

Apply a 2nd application if needed

# QUESTIONS ON DETERMINING FERTILIZER N RATE?

# Split/In-season N Applications

1. By splitting N application, can better estimate yield potential based on precip to date

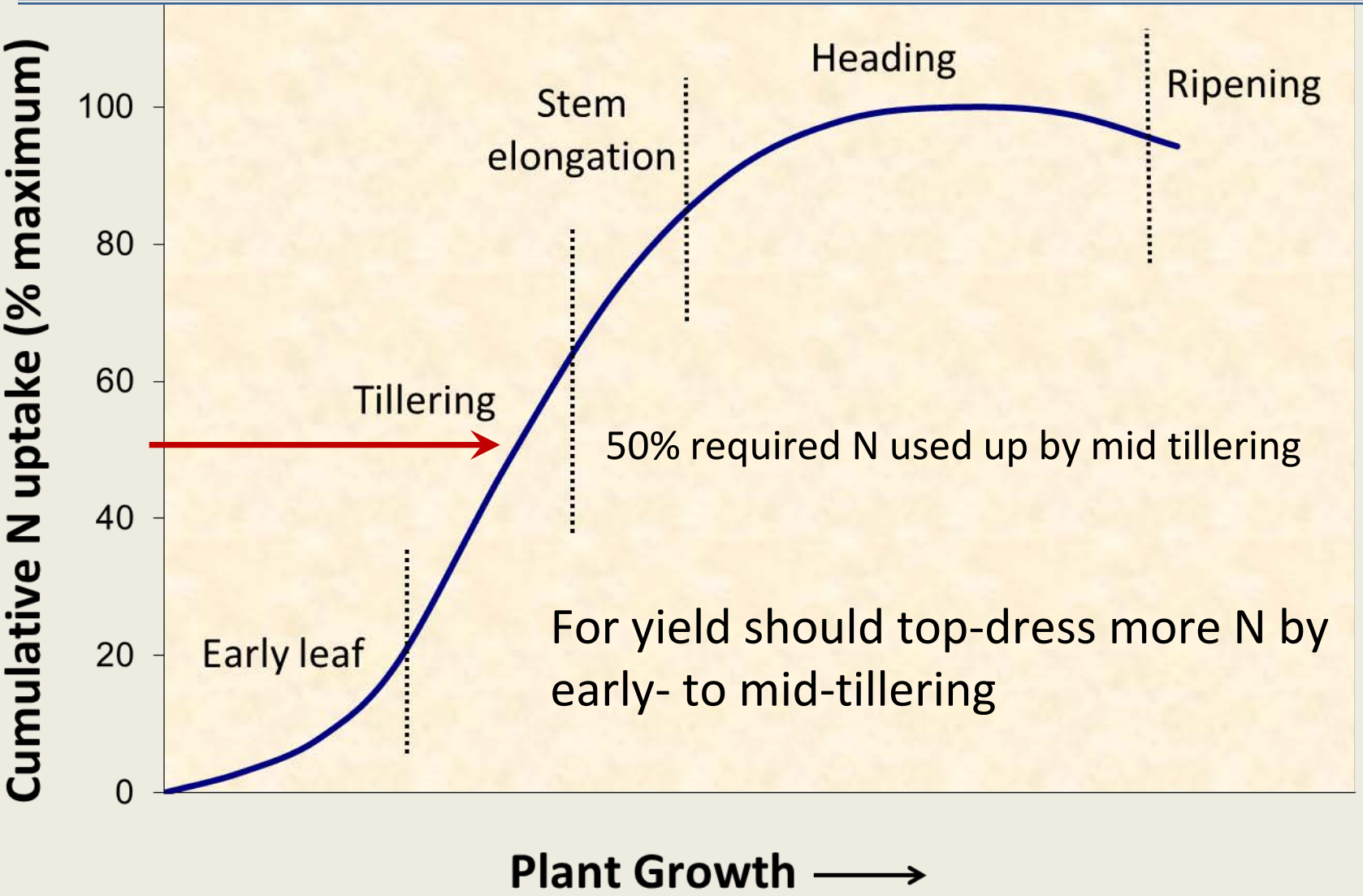
   - Don't apply 2nd application if dry

   - Apply large 2nd application if wet

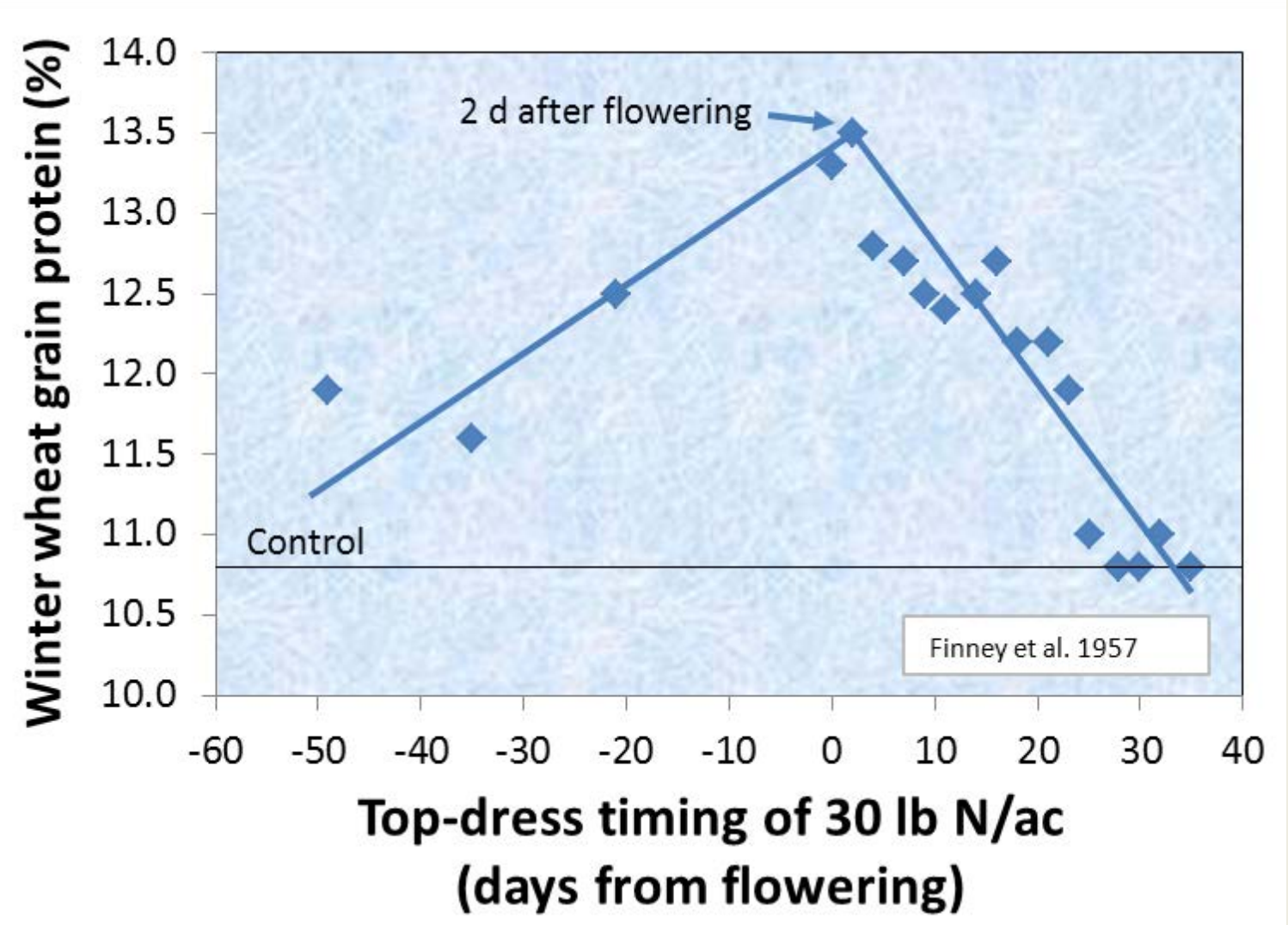
2. Later applications have less chance of causing lodging

3. Later applications have a better chance of making protein rather than yield

# Top-dress amount and timing based on wheat growth stage



# When should late-season N be applied to maximize grain protein?

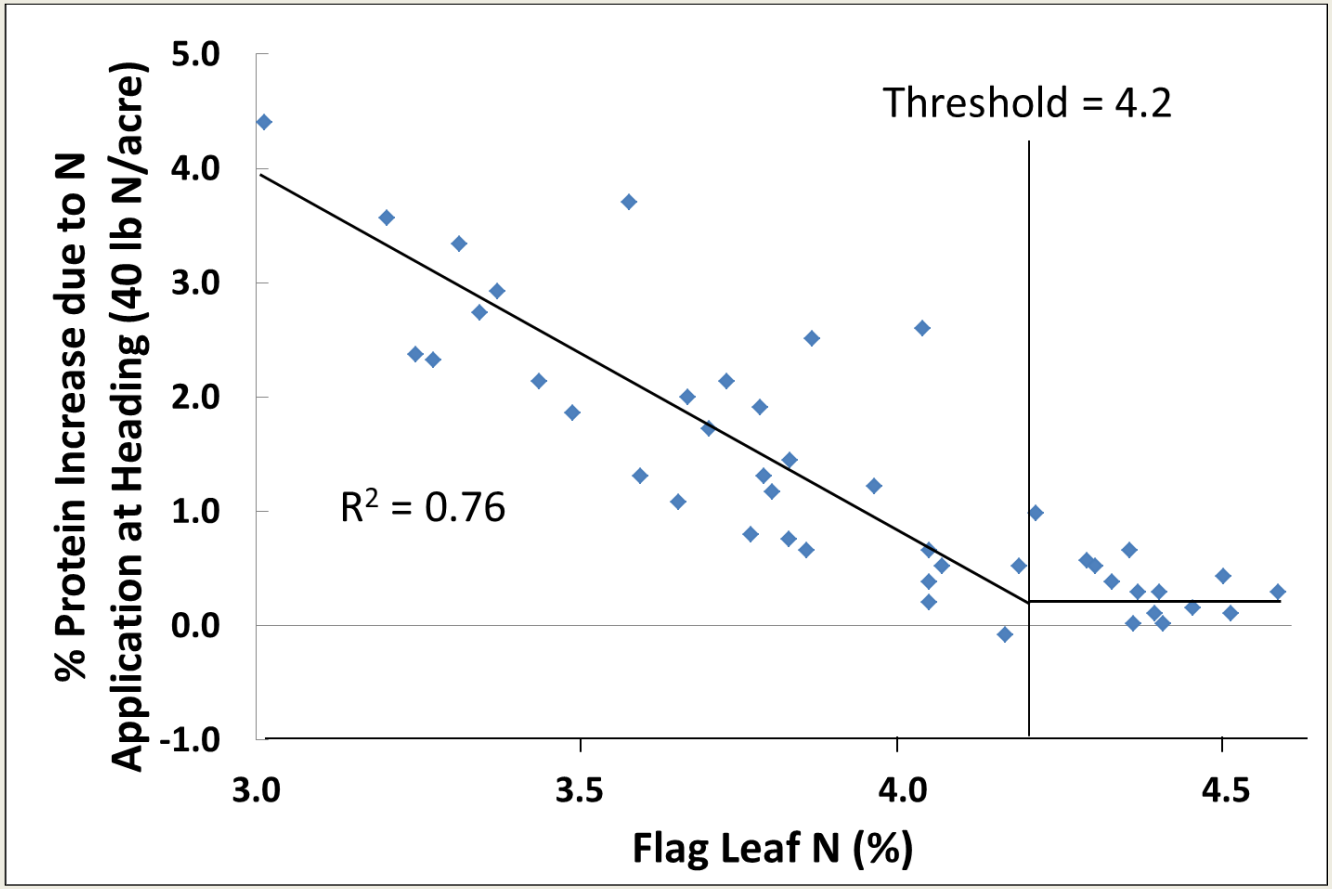


# How should you decide whether to apply late-season N?

Ask:

1. Do you have a way to apply N without severely damaging crop? (e.g. fertigation, high clearance weed sprayer, fly it on, etc.)
2. Are protein discounts sufficiently high to justify cost? (calculation will depend on expected % protein boost)
3. What is the flag leaf N concentration?

# Effect of top-dressing 40 lb N/acre at heading on spring wheat grain protein increase as affected by flag leaf N




Relationship between protein response to N top-dressed and flag leaf N in irrigated sw. Fertilizer Fact 12

# How much N should be top-dressed at flowering?

- Will depend on flag leaf N (if measured), protein discounts, and cost of application. About 20 to 30 lb N/ac is typical.
- No more than 30 lb N/ac of 28-0-0 and no more than 45 lb N/ac of liquid urea to minimize burn and yield loss (Brown and Long, 1988). Dilute 1:1 to reduce risk.
- If you make your own liquid urea (~15% N), beware that urea + water will lower temp to near freezing and thus not dissolve as much urea. Be patient.

# QUESTIONS ON SPLIT APPLICATIONS OR TOP-DRESSING?

See *Nutrient Uptake Timing by Crops: to assist with fertilizing decisions* (EB 0191)

# Minimizing N losses

- Potential losses:

  Volatilization

  Leaching (See MontGuide)

  Denitrification (nitrate → nitrogen gas)

  Erosion

  Immobilization (tie up by microbes-not a true loss)

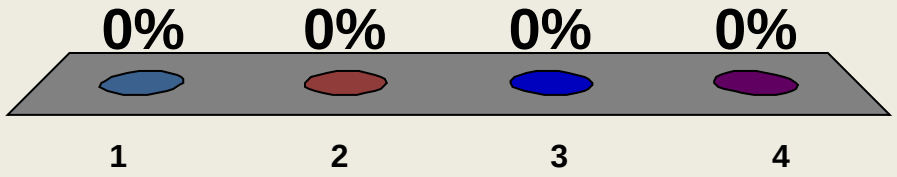
  Weed N uptake

- Largest loss in Montana?

  Likely volatilization

# In your opinion, urea volatilization losses are highest when applied:

1. On warm dry soil prior to extended dry period
2. On moist soil prior to extended dry period
3. On warm dry soil right before heavy precipitation
4. On snow covered or frozen ground

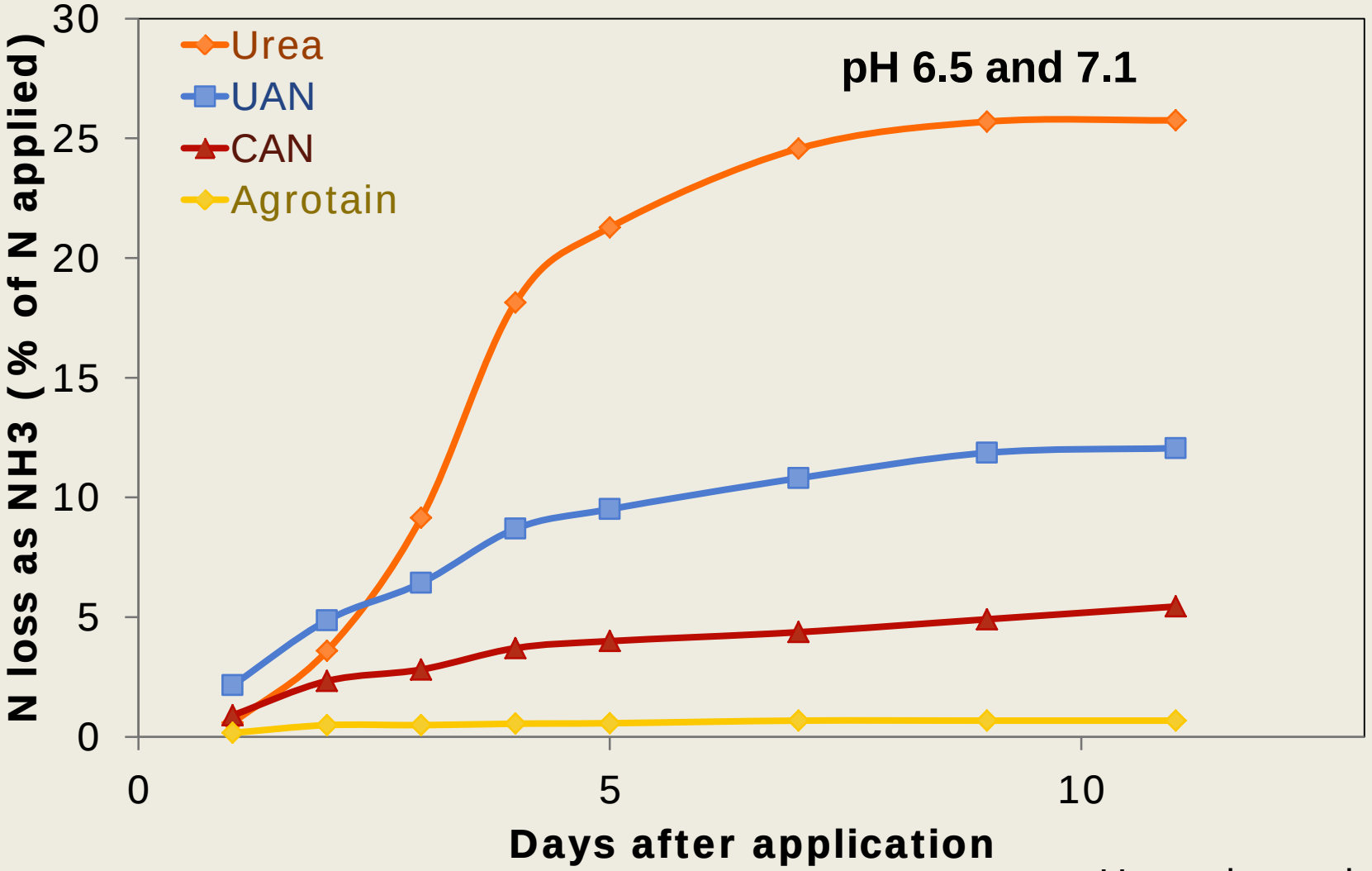


# N volatilization loss (%)

| Campaign | Fertilization date | Urea | Agrotain® |
|---|---|---|---|
| 1 | April 3, 2008 | 8.4 | 4.4 |
| 2 | Oct 8, 2008 | 3.1 | 1.4 |
| 3 | Nov 14, 2008 | 31.5 | 4.0 |
| 4 | March 25, 2009 | 35.6 | 18.0 |
| 5 | March 26, 2009 | 39.9 | 18.1 |
| 6 | Oct 6, 2009 | 10.7 | 3.3 |
| 7 | Oct 13, 2009 | 10.4 | 4.8 |
| 8 | Oct 19, 2009 | 15.7 | 3.4 |
| 9 | Jan 27, 2010 | 24.3 | 9.3 |
| 10 | Feb 26, 2010 | 44.1 | 11.9 |
| 11 | March 29, 2010 | 6.3 | 1.7 |
| 12 | April 20, 2010 | 14.7 | 1.4 |
| **Average** | | **20.4** | **6.8** |

***wide range in N loss amounts***

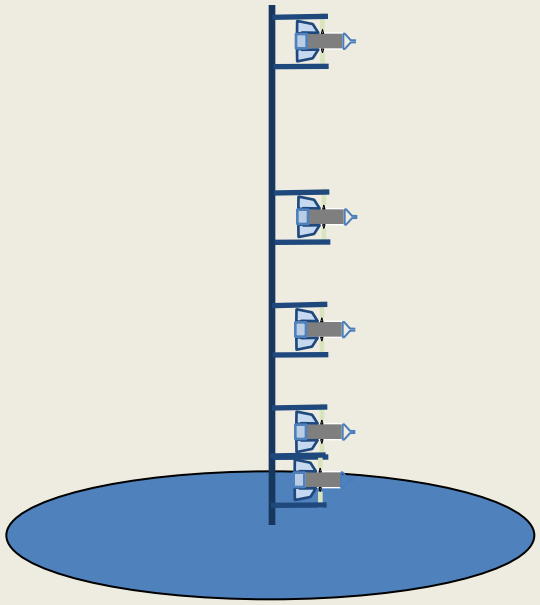
# Volatilization from grass
# Hermiston, Oregon (150 lb N/a)



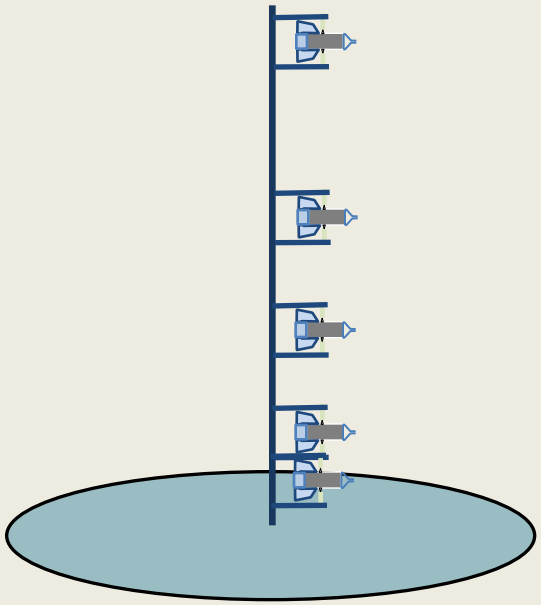

Horneck unpub data

# What about applying urea in front of air-drills?

## Fall Campaigns



***pre-plant urea***



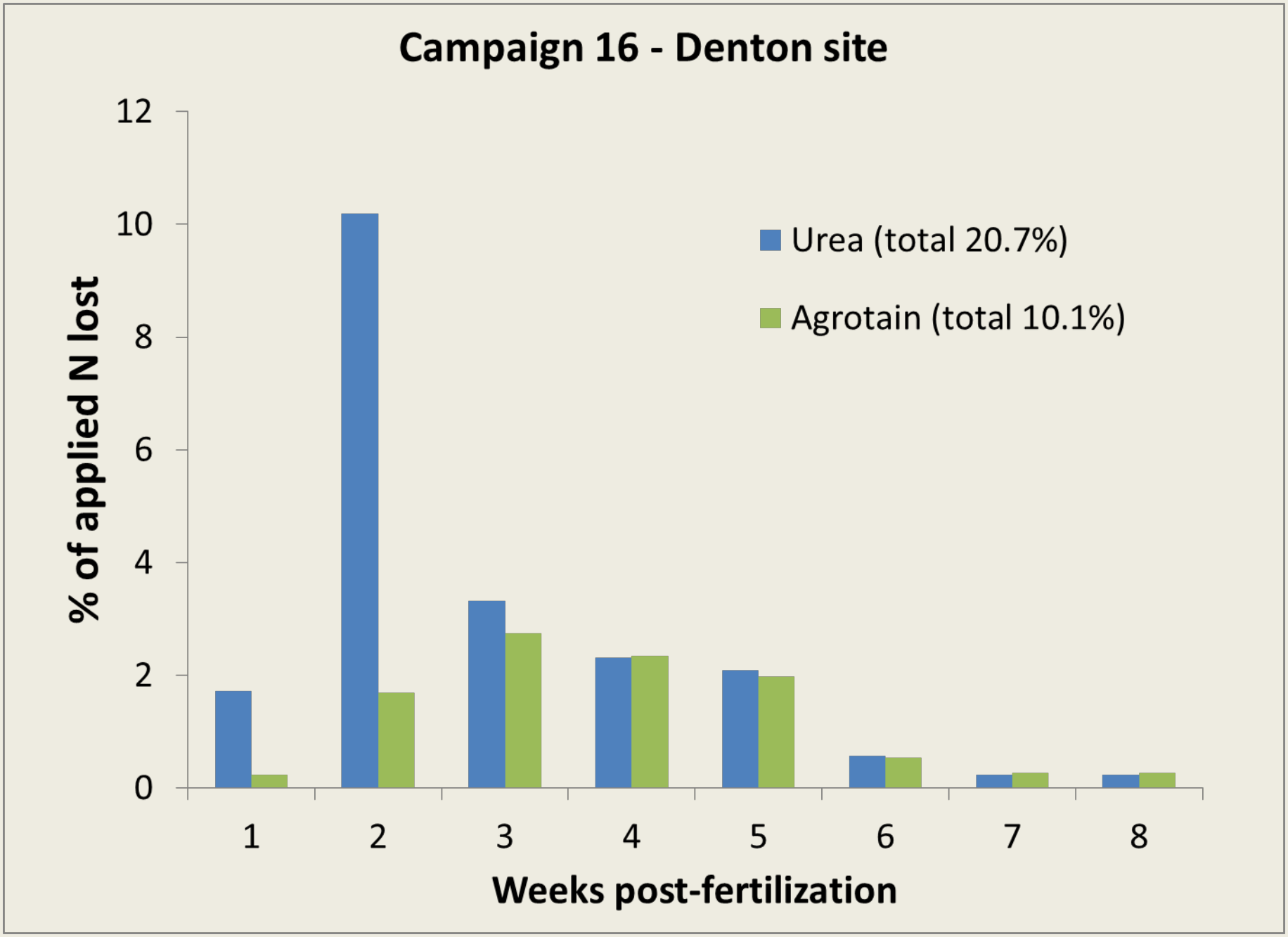
***post-plant urea***
***'control'***

# What about applying urea in front of air-drills?

## Three Campaigns last Fall

| Fertilization date | Cooperator | Pre-seeding | Post-seeding |
|---|---|---|---|
| September 15 | McIntosh- north Havre | 18.7% | 13.8% |
| September 27 | McCormick - Kremlin | 20.4% | 24.4% |
| October 7 | Peterson – Cottonwood | 4.1% | 5.2% |

# What about applying urea on snow? Denton – March 2 – fertilizer spread


Campaign 16 - Denton site
% of applied N lost
12
10
8
6
4
2
0
Urea (total 20.7%)
Agrotain (total 10.1%)
1
2
3
4
5
6
7
8
Weeks post-fertilization

# Denton-2 wk post-fertilization

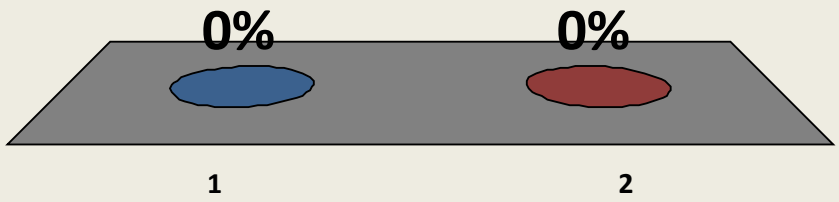
***snow -cover gone***

# What should you do to minimize volatilization?

1. Do not apply urea on moist ground UNLESS a snow or rainstorm is forecast to drop at least ½ inch of moisture in a day, preferably more (unlikely unfortunately!)
2. If irrigate, apply at least ½ inch of irrigation water after urea application
3. Apply urea below the surface – either in a midrow band, 2 inches from the seed or with the seed with a ‘protected’ product
4. Consider using Agrotain®, UAN, or ammonium nitrate (if available) if can’t apply during a low risk time

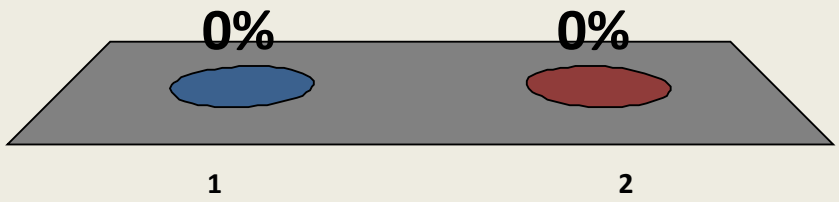
# Has this information increased your understanding of volatilization?

1. Yes
2. No



# Will you make a management change to reduce volatilization loss based on this information?

1. Yes
2. No



# QUESTIONS ON UREA VOLATILIZATION?

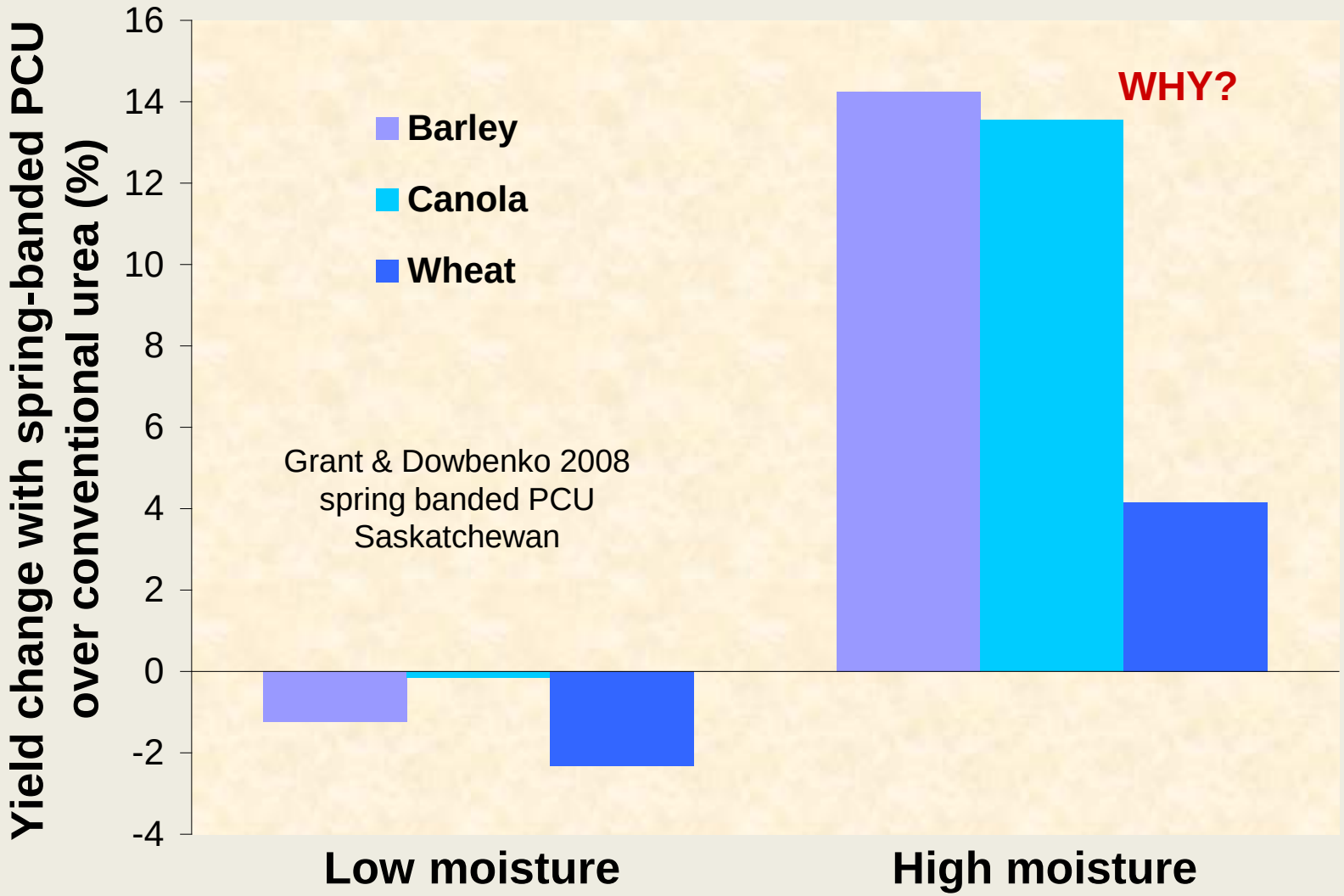
# Enhanced Efficiency Fertilizers
# EEFs

- Any fertilizer designed to:
  - Increase fertilizer availability
  - Decrease fertilizer losses
- 3 major methods of action
  - Stabilized - alter soil microbial or enzymatic reactions (e.g. Agrotain®= NBPT, NServe®)
  - Slow release - have additives which require chemical or biological decomposition to release nutrients (e.g. GP's Nitamin Nfusion® and foliar Nitamin® )
  - Controlled release - a semipermeable coating, usually a polymer, regulates release (e.g. Agrium's polymer coated ESN®)

# NBPT uses

- Can minimize urea volatilization for several weeks
- ‘Buys’ time for rainfall, irrigation or mechanical incorporation to protect urea
- Warm weather top-dressing
- Cool weather broadcast

# Effects of over-winter moisture conditions on effectiveness of PCU

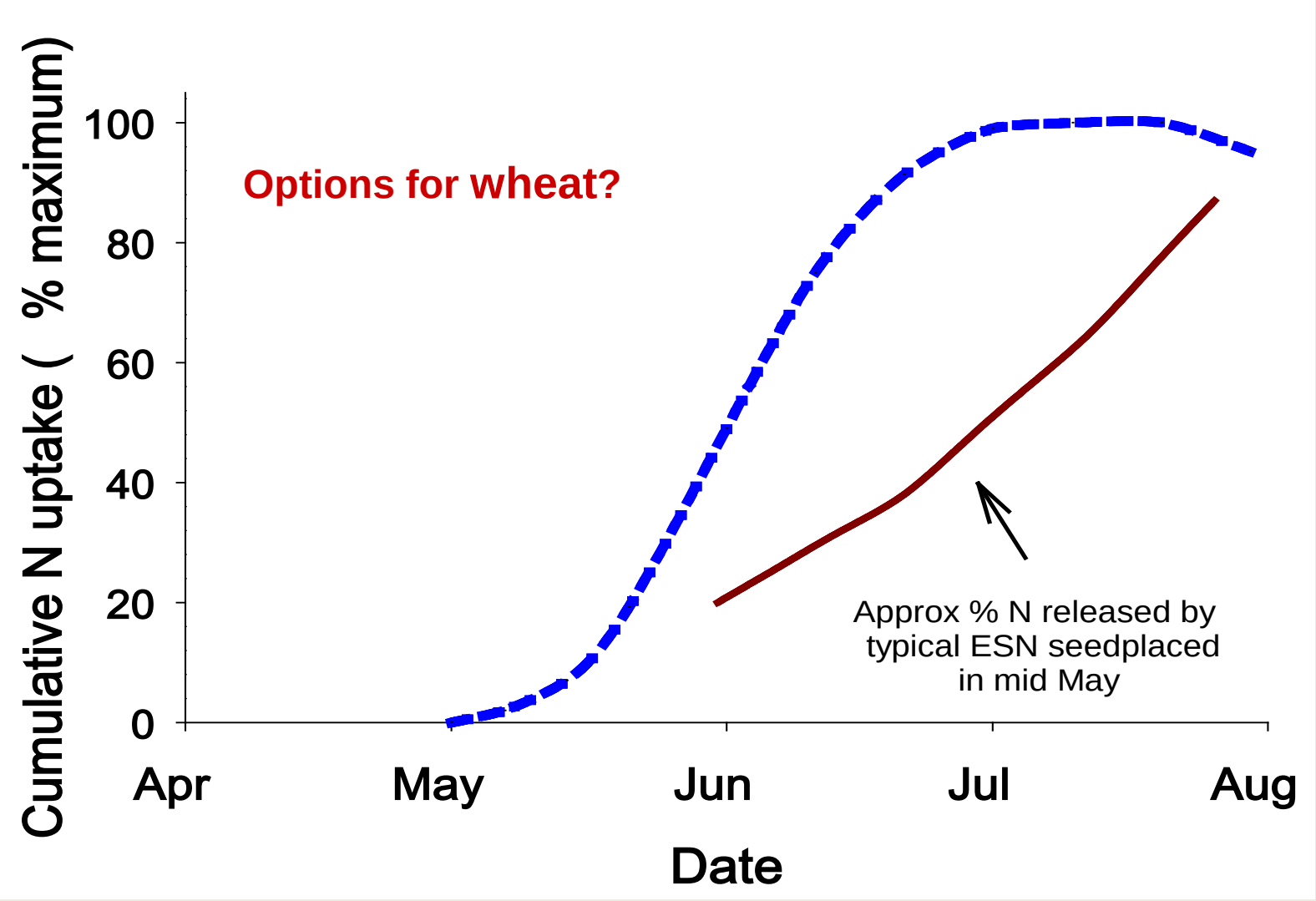


# What type of crops would you expect slow release to work better?

- Irrigated
- Warm season

What about dryland cool season crops?

# Timing of N uptake by wheat and ESN® N release



# How does PCU work for small grains?

- Fall/winter pre-plant works well. PCU is in soil long enough to dissolve in time for plant need.
- Late winter/spring broadcast PCU does not - may dry out, release is too slow.
- Incorporation is important, especially late winter/spring.
- Blending is recommended with late winter/spring surface applied PCU.
- Controlled and slow release should have best chance of boosting protein – results are variable

# Under what growing conditions would you expect EEFs to work better?

- High potential volatilization loss
  - **coarse soils**
  - **moist surface**
  - **warm temps**
  - **long time between application and incorporation**

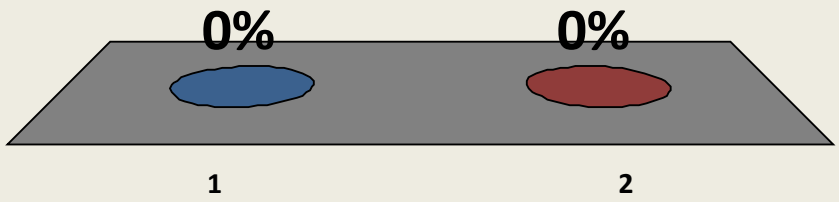
- High potential leaching
  - **coarse soils**
  - **high moisture content/irrigation/rainfall**

# QUESTIONS ON N ENHANCED EFFICIENCY FERTILIZERS?

See *Enhanced Efficiency Fertilizers* (EB0188) and/or request a copy of Dave Franzen's summary on N EEFs from me (has more data than EB0188)

# Do you include legumes in your rotation?

1. Yes
2. No

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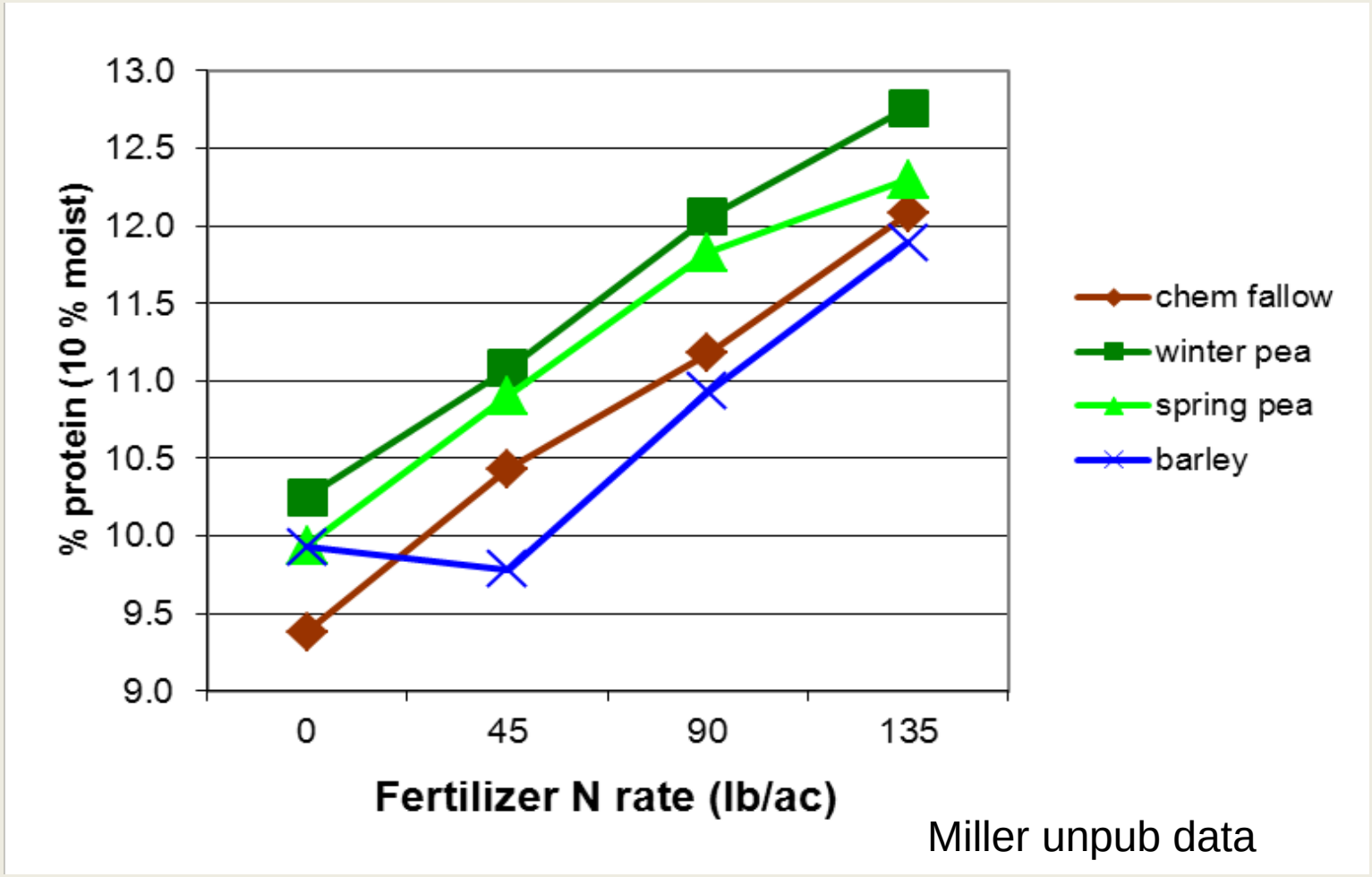
# Inclusion of legumes

- Legumes are excellent N scavengers – will use much of what is in soil before ‘fix’ N
- Since legumes don’t need N fertilizer, this leaves less nitrate in soil, especially in dry year when crops don’t remove much
- Legume residues are similar to ‘slow release N fertilizers’ which can lower N fertilizer needs in long run
- Beware of herbicides with high persistence

# Legumes in rotation w/ winter wheat to increase protein?




Legumes grown instead of a small grain or fallow can result in a protein increase similar to about 25 lb N/ac of fertilizer.

# Management practices to optimize N fertilizer use

- Use a conservative pre-plant N rate
- Add in-season N applications by mid tillering for yield, at flowering for protein
- Consider enhanced efficiency fertilizers
- Minimize N volatilization by incorporation or irrigation/rain
- Minimize N leaching with legumes, perennials and deep rooted crops in rotation

# Additional info in:

http://landresources.montana.edu/soilfertility

Fertilizer Facts and economic model:
go to “Fertilizer Information”

Other soil fertility publications:
go to “Extension Publications”

Ammonia volatilization taped presentation:
go to “Ammonia Volatilization”

This presentation: go to “Presentations”.


Questions?
Watrous, SK, 1920's