Practices to Increase Grain Protein and Revenue

Halloween 2012

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EXTENSION

Management practices to optimize grain protein

Soil Fertility Management

- Nitrogen

  Optimize total fertilizer N rate

  Split/in season N applications

  Minimize N losses

  Use an enhanced efficiency fertilizer?

  Use legumes in rotation?

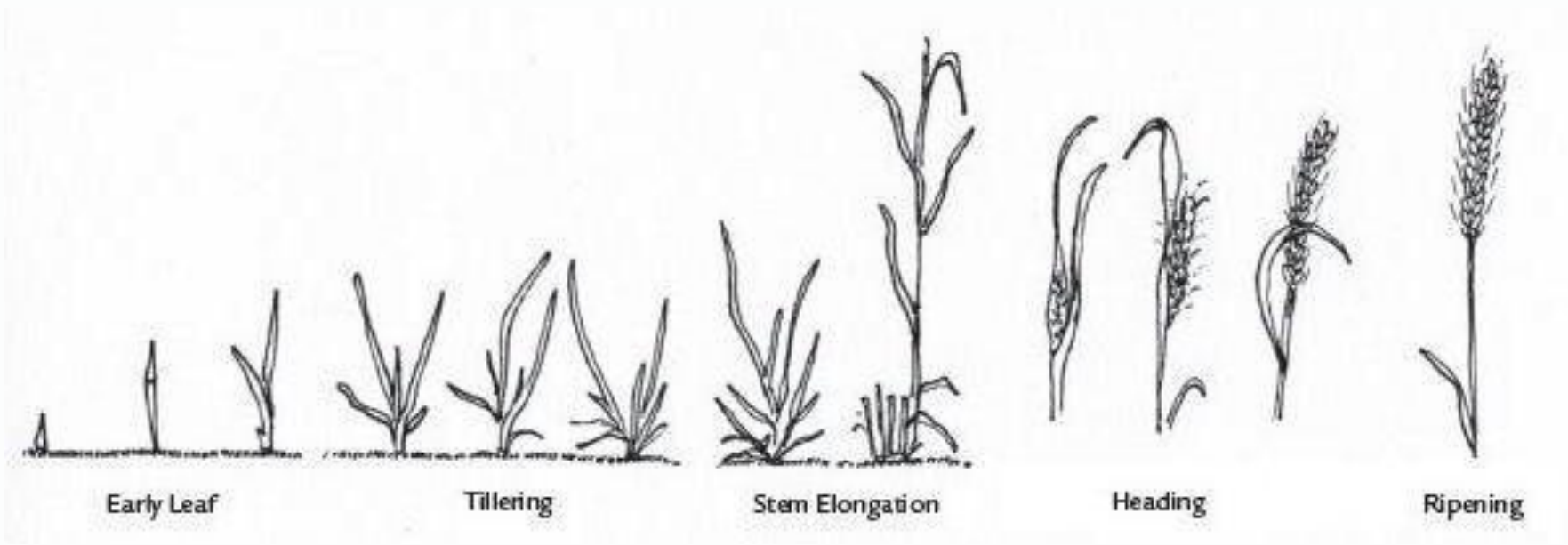
  Rotation and tillage

- Sulfur

N availability affects yield and protein

Added N increases no. tillers and kernels per head
Grain will use N from stems/leaves to make protein

Added N goes to protein



Optimize fertilizer N rate

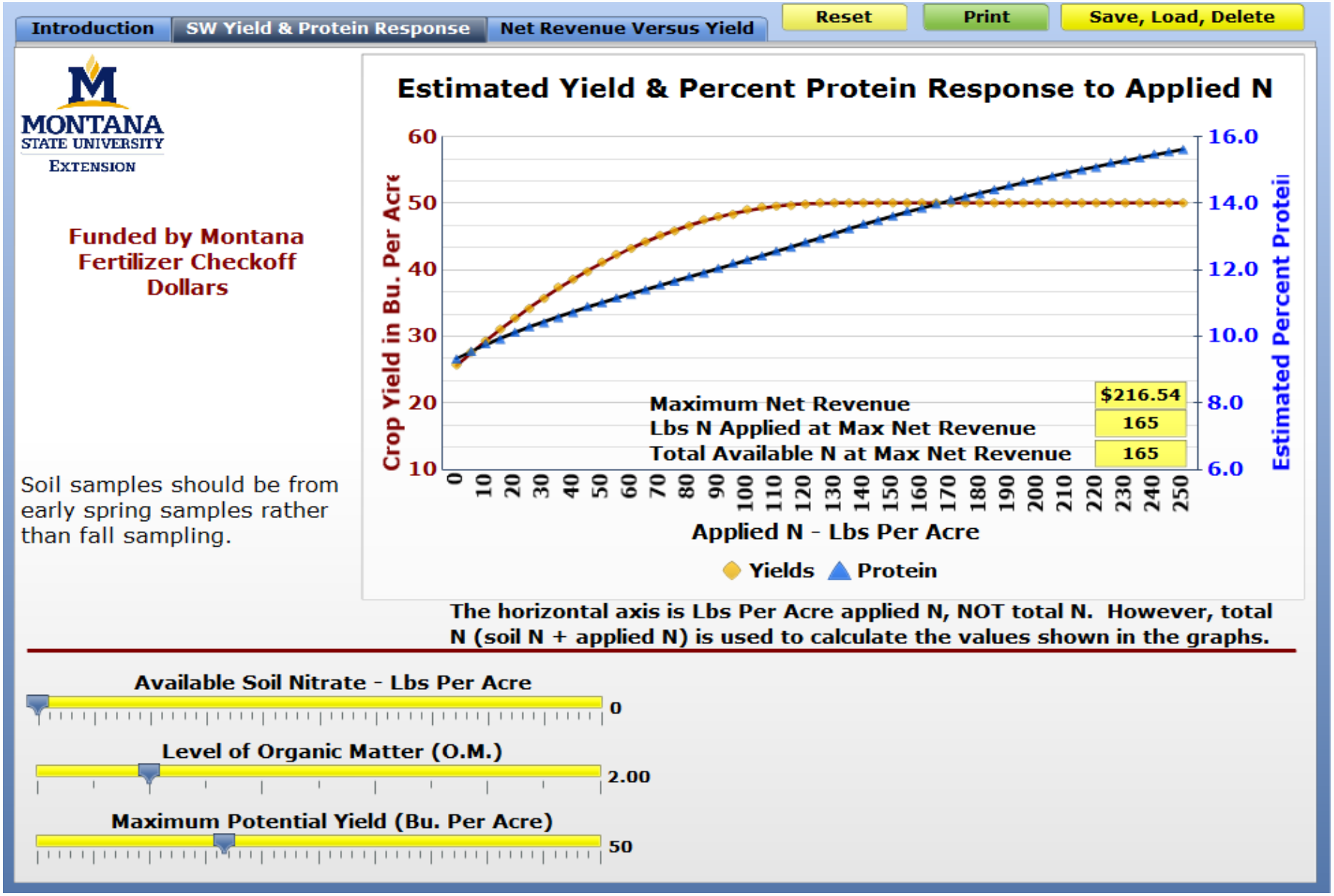
How?

- Use a conservative pre-plant N rate based on:
  spring soil sample
  realistic yield potential
  economic rate calculator

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

- Apply a 2nd application if needed

Economic rate calculator



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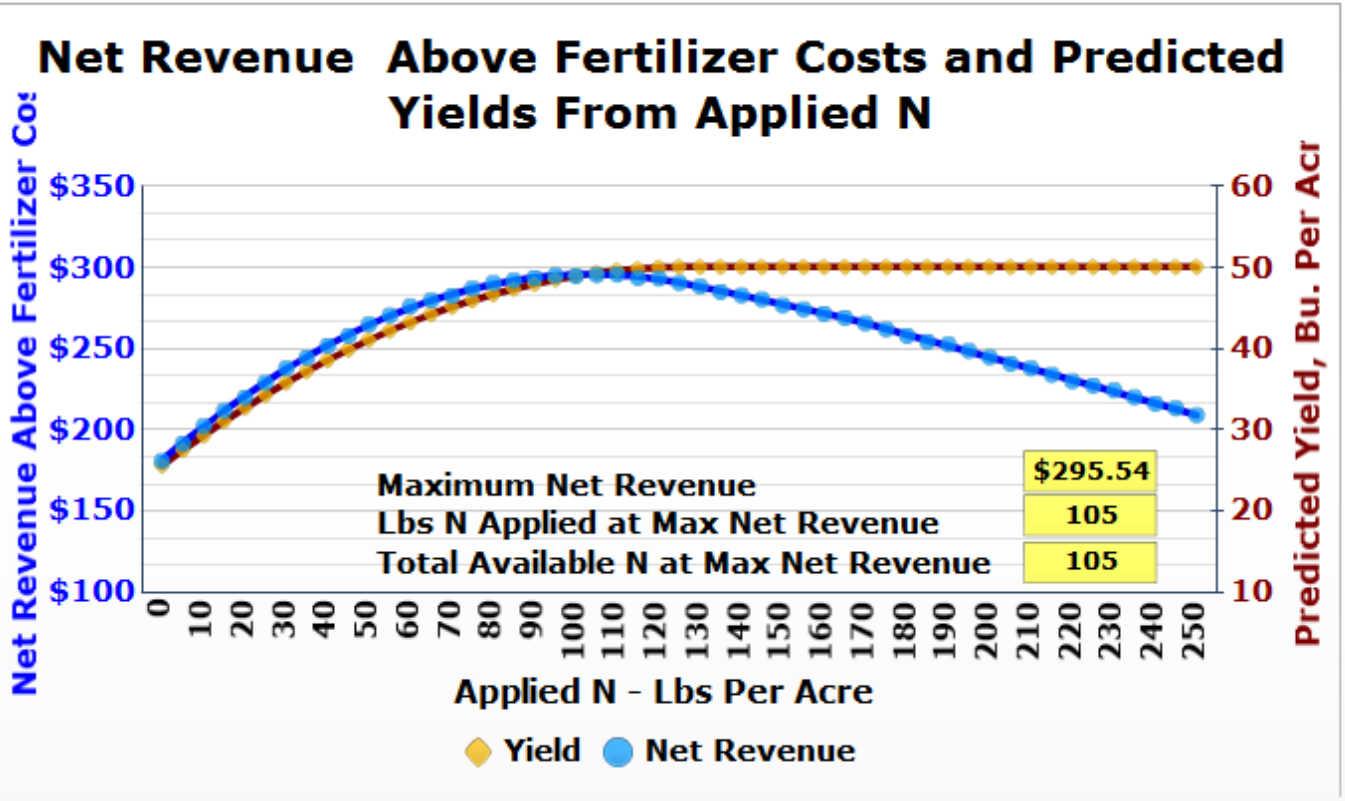
The buttons below are toggles that display or hide a graph. They are initially set to hide the graph. Click once to display the graph and click again to hide the graph.

Net Revenue Only Graph Off/On

Yield Only Graph Off/On



The horizontal axis is Lbs Per Acre applied N, NOT total N. However, total N (soil N + applied N) is used to calculate the values shown in the graphs.

Available Soil Nitrate - Lbs Per Acre: 0

Level of Organic Matter (O.M.): 2.00

Maximum Potential Yield (Bu. Per Acre): 50

Wheat Price for 14% Protein Spring Wheat: $8.02

Nitrogen Price Per Pound of Active Ingredient: $0.80

Protein Discount Per One Quarter Point: $0.050

Low protein discount and premium

Protein Premium Per One Quarter Point, Max 17%: $0.025

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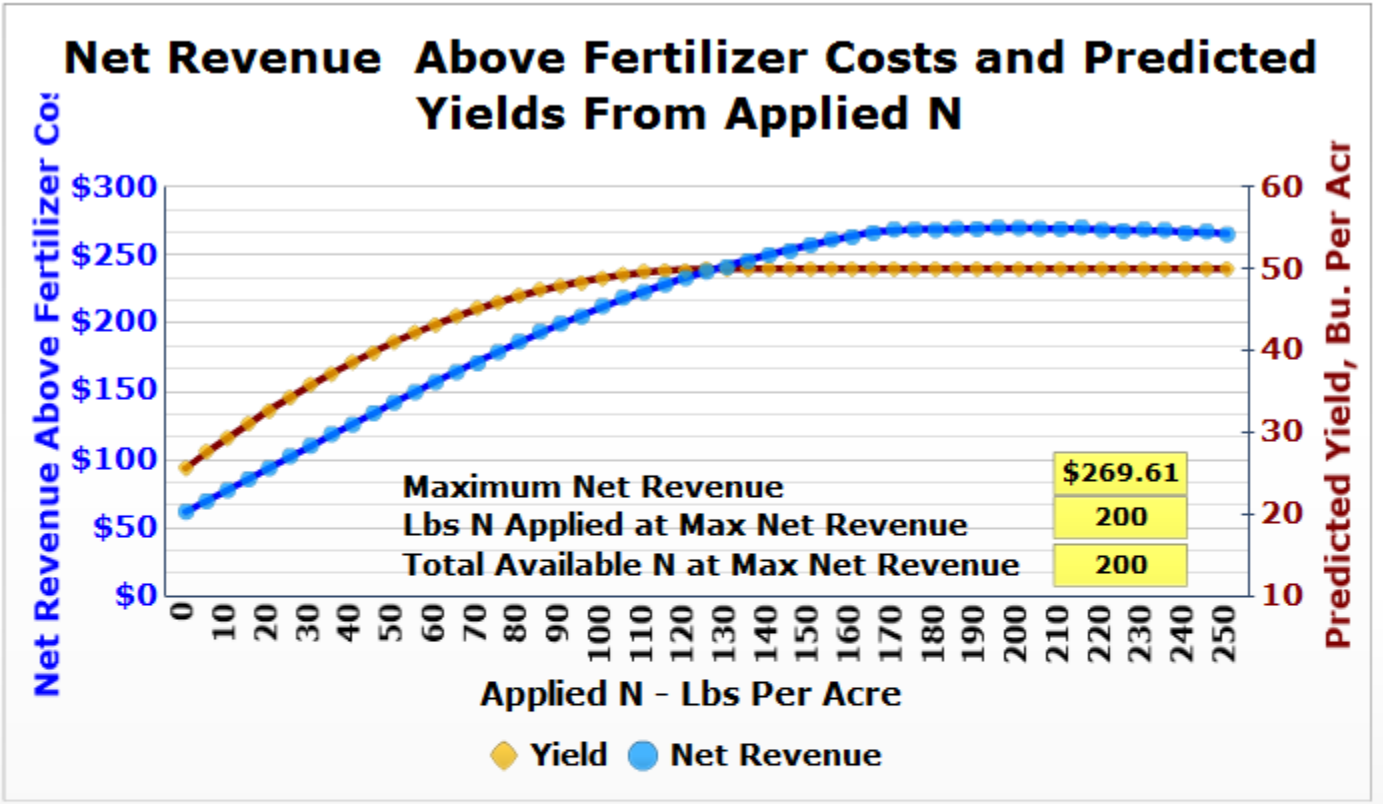

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Available Soil Nitrate - Lbs Per Acre: 0

Level of Organic Matter (O.M.): 2.00

Maximum Potential Yield (Bu. Per Acre): 50

Wheat Price for 14% Protein Spring Wheat: $8.02

Nitrogen Price Per Pound of Active Ingredient: $0.80

Protein Discount Per One Quarter Point: $0.300

High protein discount and premium

Protein Premium Per One Quarter Point, Max 17%: $0.200

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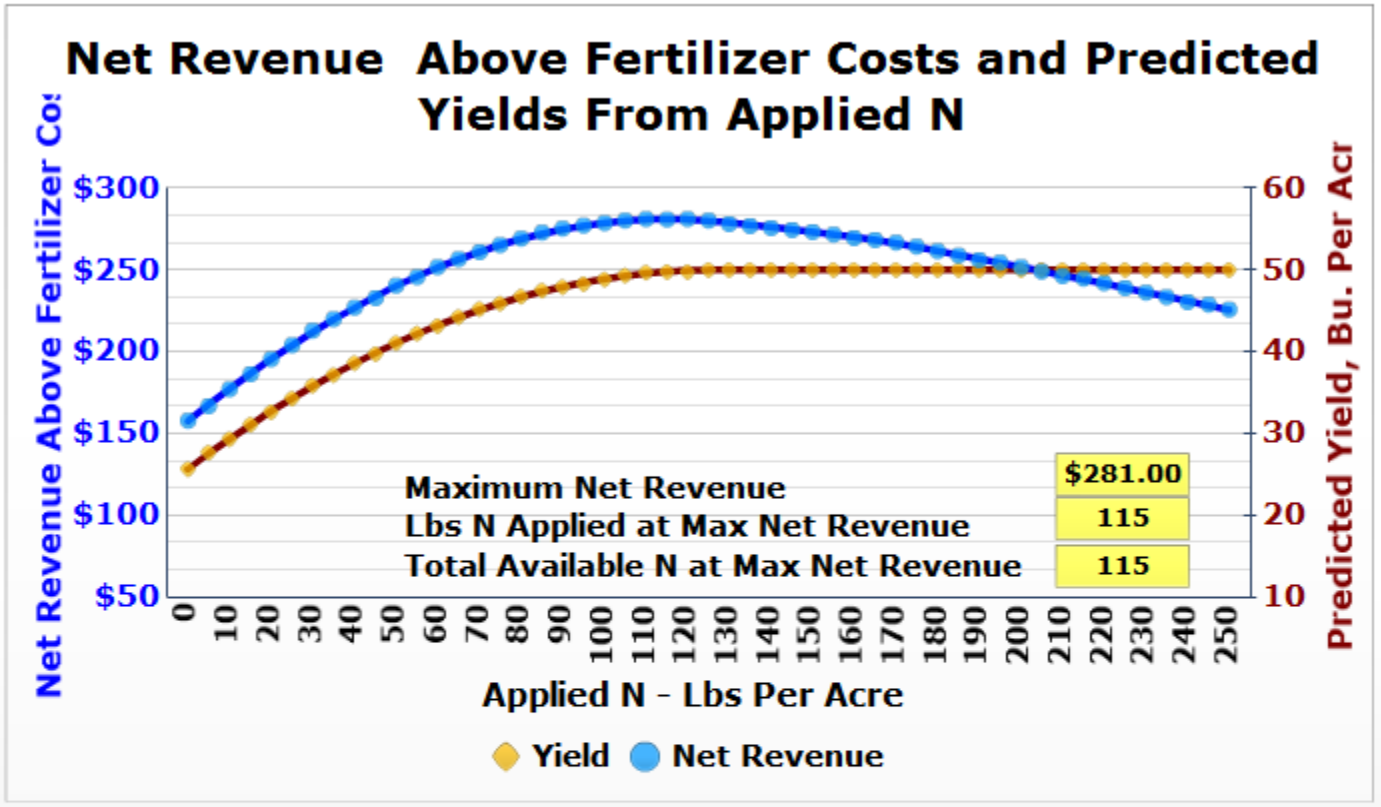

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Level of Organic Matter (O.M.): 2.00

Maximum Potential Yield (Bu. Per Acre): 50

Wheat Price for 14% Protein Spring Wheat: $8.02

Nitrogen Price Per Pound of Active Ingredient: $0.80

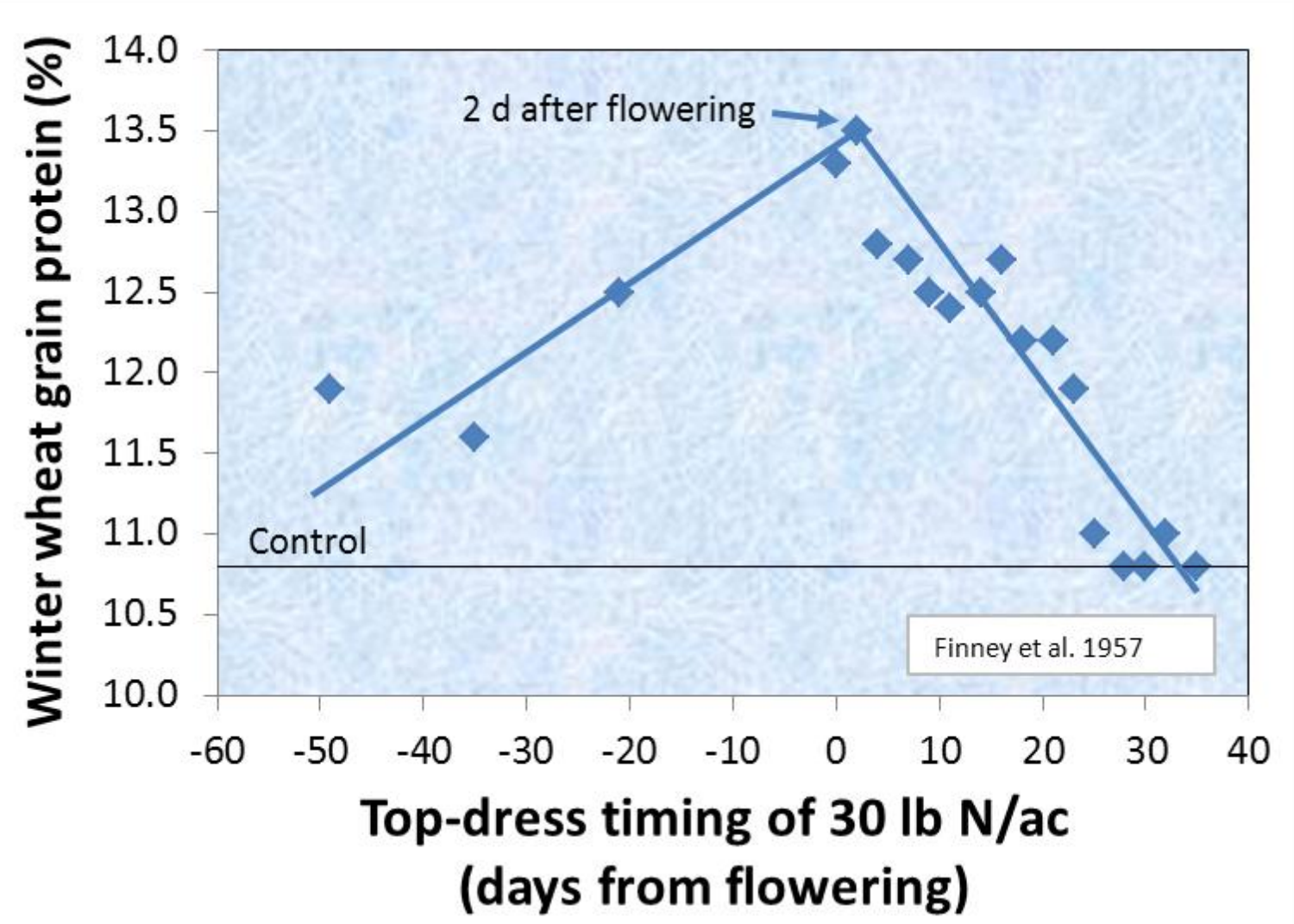
Protein Discount Per One Quarter Point: $0.100

1999-2011 average protein discount and premium

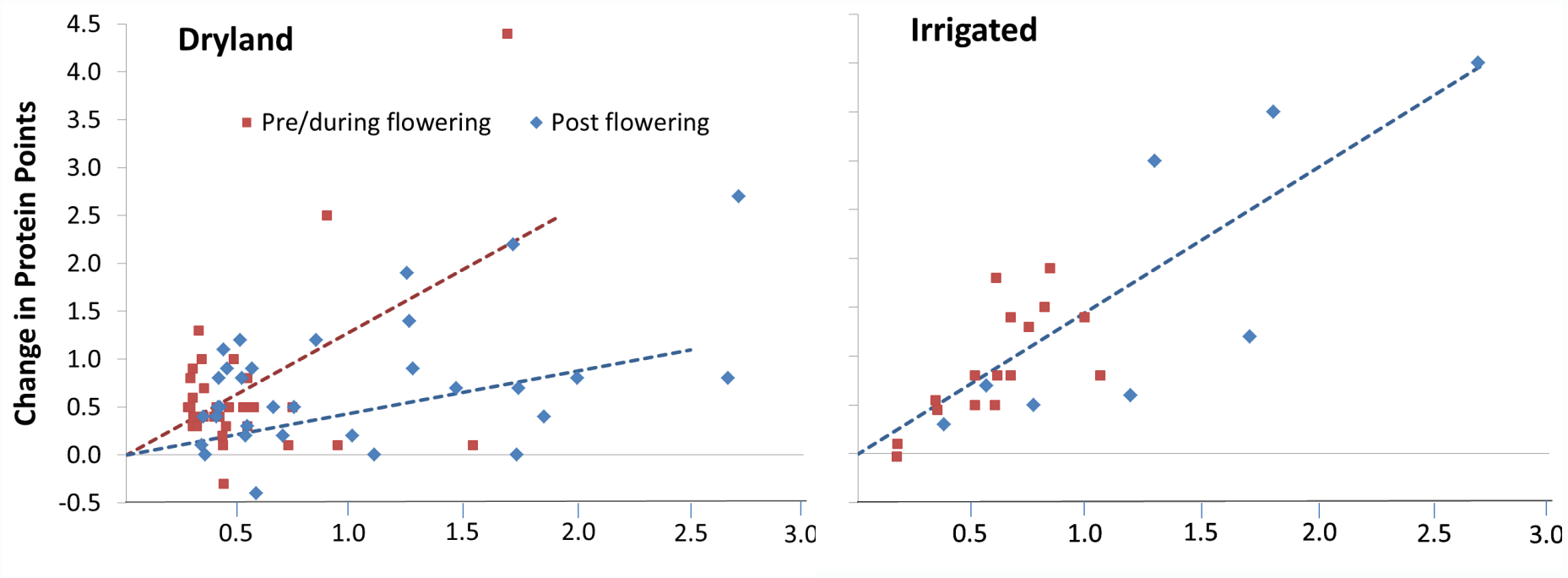
Protein Premium Per One Quarter Point, Max 17%: $0.075

QUESTIONS ON OPTIMIZING FERTILIZER N RATE?

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



In-season N rate, timing, and dryland vs irrigation affects protein boost



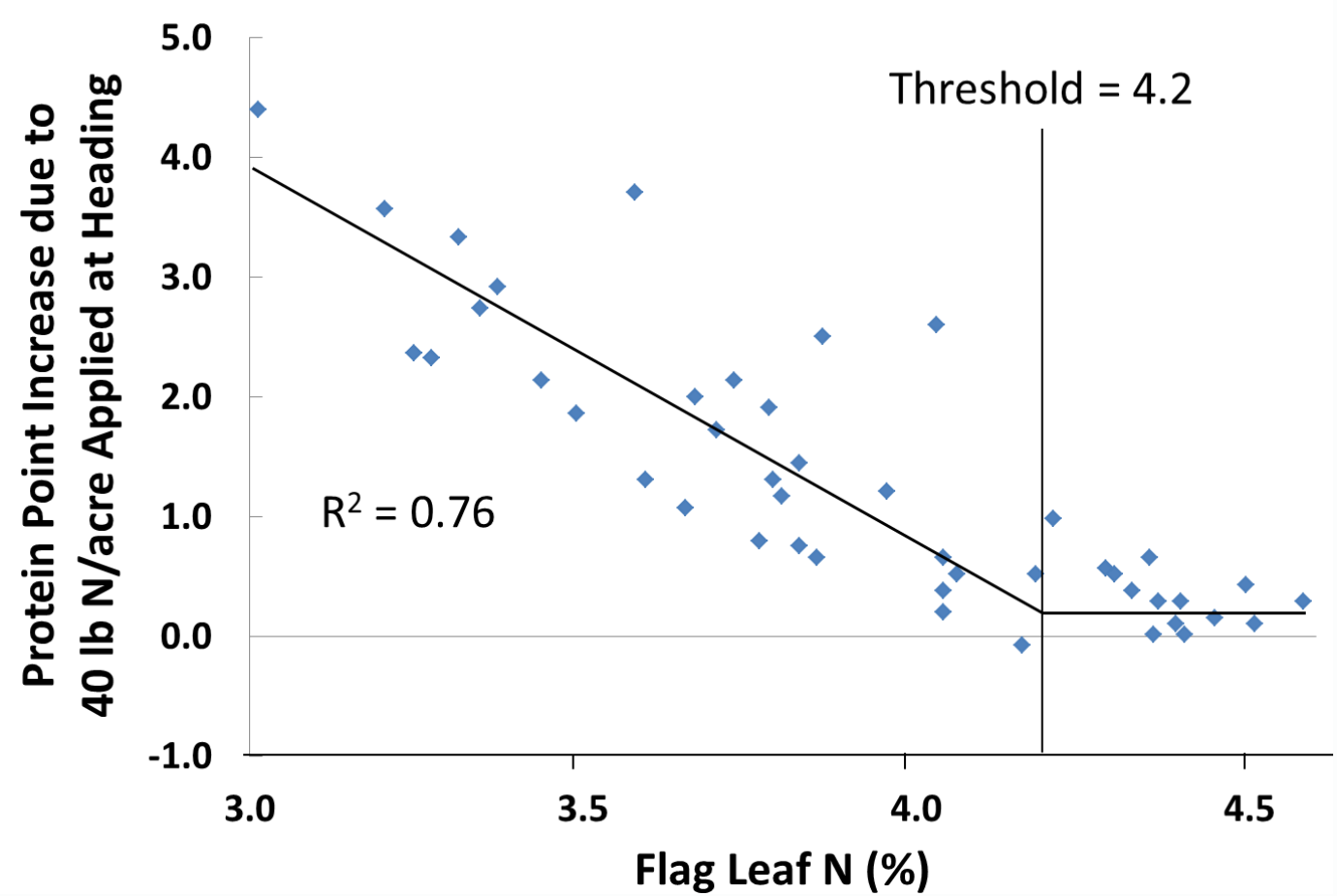
Ability to incorporate with rain or irrigation more important than exact timing at flowering

How should a grower decide whether to apply late-season N?

Ask:

1. Does grower have a way to apply N without severely damaging crop? (e.g. fertigation, high clearance weed sprayer, fly it on)
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

What is the ‘critical flag leaf N’?

- Critical FLN = FLN below which should top-dress N to maximize profit (and above which should result in a loss).
- Critical FLN = 4.2 – 13.33(N cost in $/lb N)/((protein discount per point)(expected yield))

  -13.33 is application rate (40 lb N/ac) divided by slope of response on previous figure (-3)
- Example 1: If ratio of N cost to discount = 1.5 (May 2012) and yield = 50 bu/ac, critical FLN = 3.85%.
- Example 2: If ratio of N cost to discount = 6 (current) and yield = 50 bu/ac, critical FLN = 2.65% (rarely this low).
- Bottom line: need far lower FLN to justify top-dressing for protein IF ratio of fertilizer cost to discount is high.

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 UAN (b/c of burn)
- If determined that should add N, then add as much as possible w/o burning for best economic rate (b/c 'dilutes' cost of application)

Foliar N

- Only 1-16% of foliar N taken up through leaf
- Apply with ½ inch water to move into soil
- If scab risk, do not irrigate within 5 days of flower
- No more than 45 lb N/ac of liquid urea to minimize burn and yield loss (Brown and Long, 1988)
- Leaf damage increased with:

  Surfactant + more than 20 lb N/ac of 28-0-0 UAN

  Urea + Agrotain®

QUESTIONS ON SPLIT APPLICATIONS OR TOP-DRESSING?

Effect of N source and timing on volatilization losses and protein

Cool season broadcast urea volatilization study – by Engel

- 19 trials to date
- On farm studies
- Focus on NT winter wheat

mast and shuttles ➡

N volatilization loss (%)

Season	No. trials	Fertilization dates	Urea	Agrotain®
Fall	6	Oct 6 – Nov 29	3.1 – 31.3	1.4 – 5.9
Winter	5	Dec 30 – March 5	13.0 – 44.1	4.1 – 11.9
Spring	6	March 25 - April 24	6.1 – 39.9	1.7 – 18.1
Average			**18.8**	**6.7**

wide range in N loss amounts

Engel et al. 2011

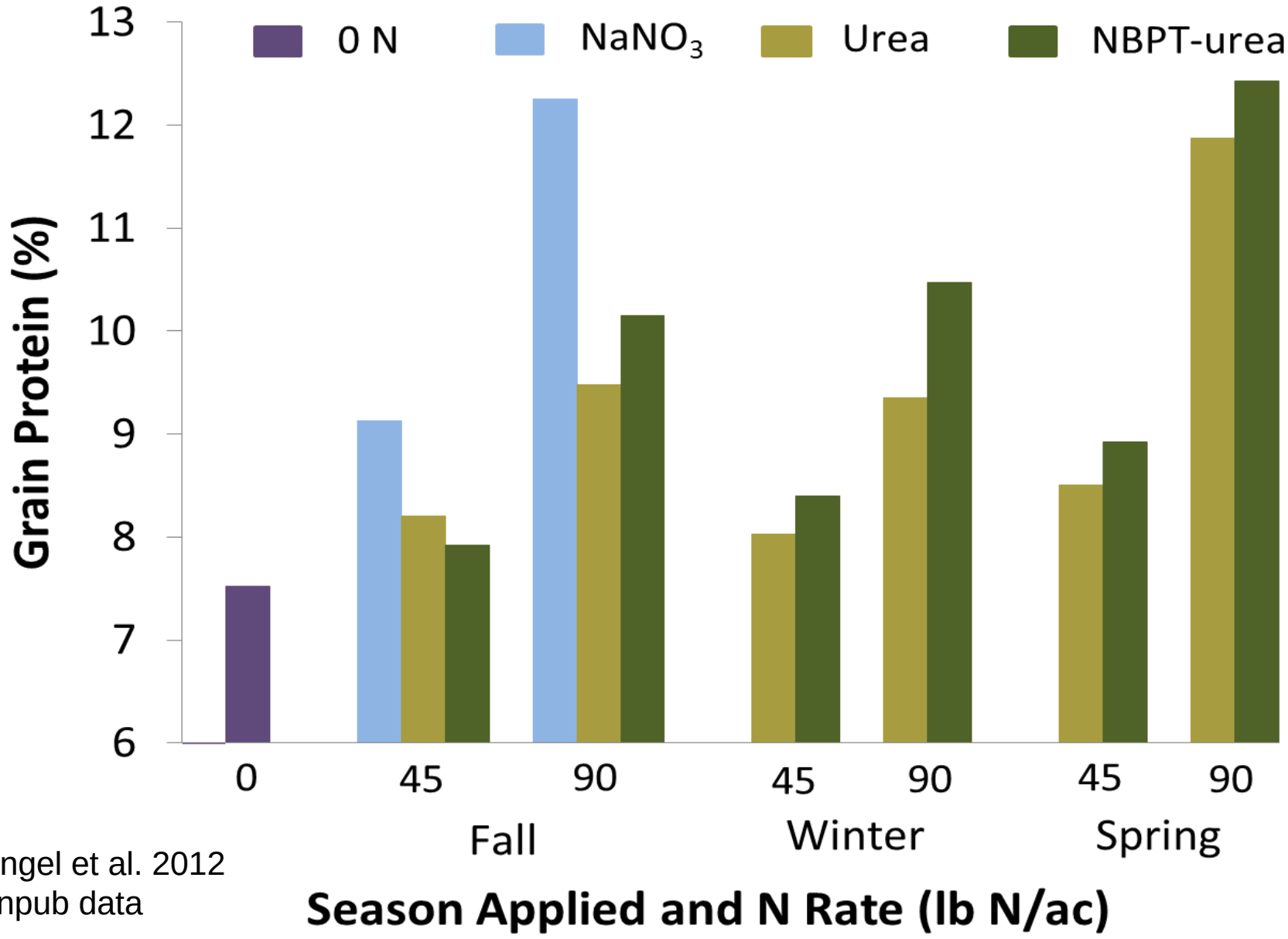
Are yield and protein affected by volatilization loss?

- Location: Central MT (Coffee Creek)
- On the same field, compared:

  Timing: Fall, winter, spring
  Source: Urea vs. NBPT–urea (Agrotain®) vs. $NaNO_3$ (doesn't volatilize)

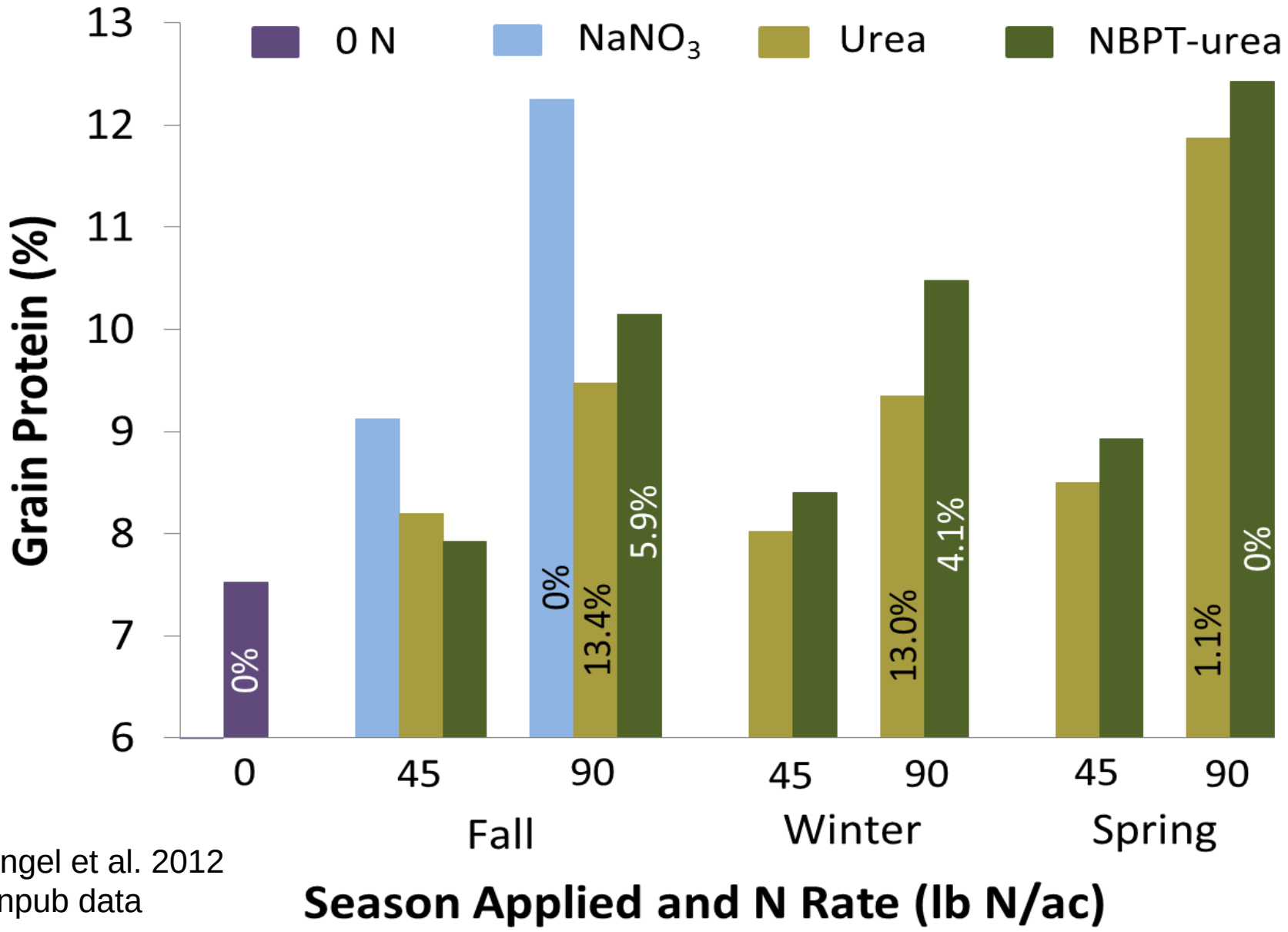
- Measured in plots:
  Winter wheat grain yield
  Grain protein

Source, application rate and timing affect protein



Engel et al. 2012
unpub data

Volatilization affects protein

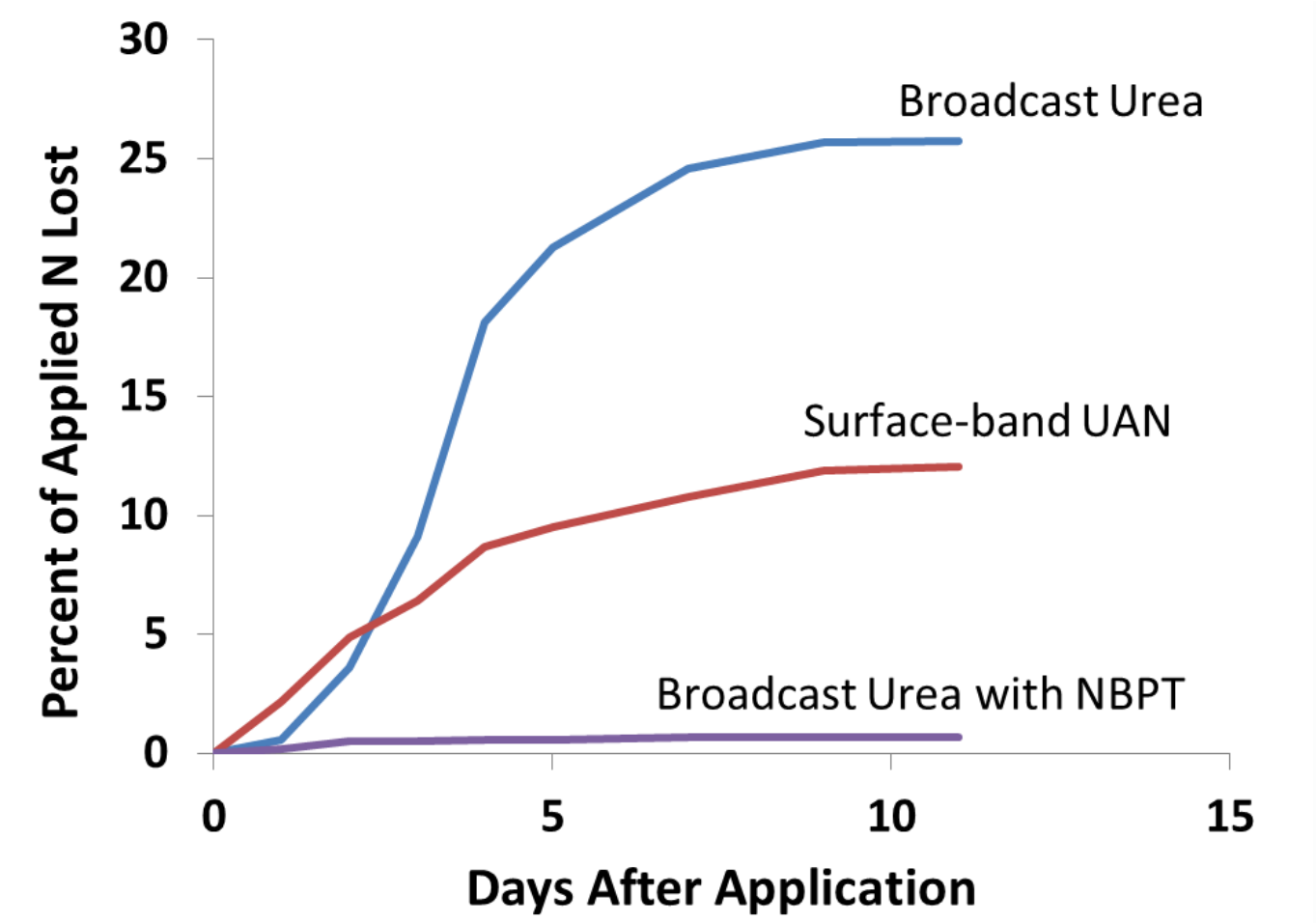


Engel et al. 2012
unpub data

Timing and source affect volatilization, yield and protein

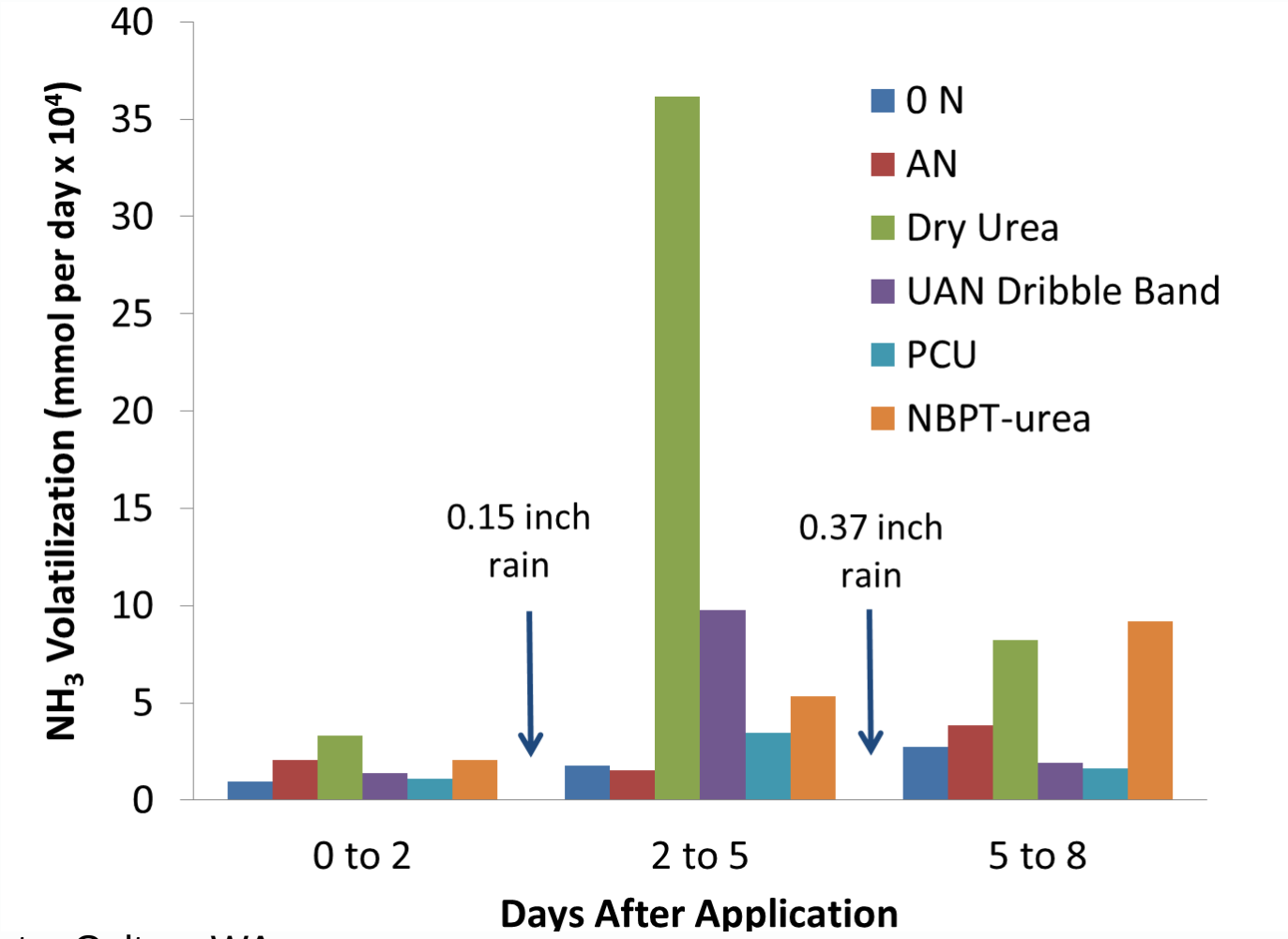
- Yield and protein both higher from spring application
- Spring application produced highest protein - had lowest volatilization loss (1%) probably because rained ¾ inch shortly after application
- NBPT increased protein by reducing volatilization N losses
- NBPT did not affect yield (water may have limited grain yield more than N due to dry summer)

Volatilization from different sources



Spring application 150 lb N/ac on newly seeded field irrigated before application. Hermiston, Oregon. Horneck unpub. data

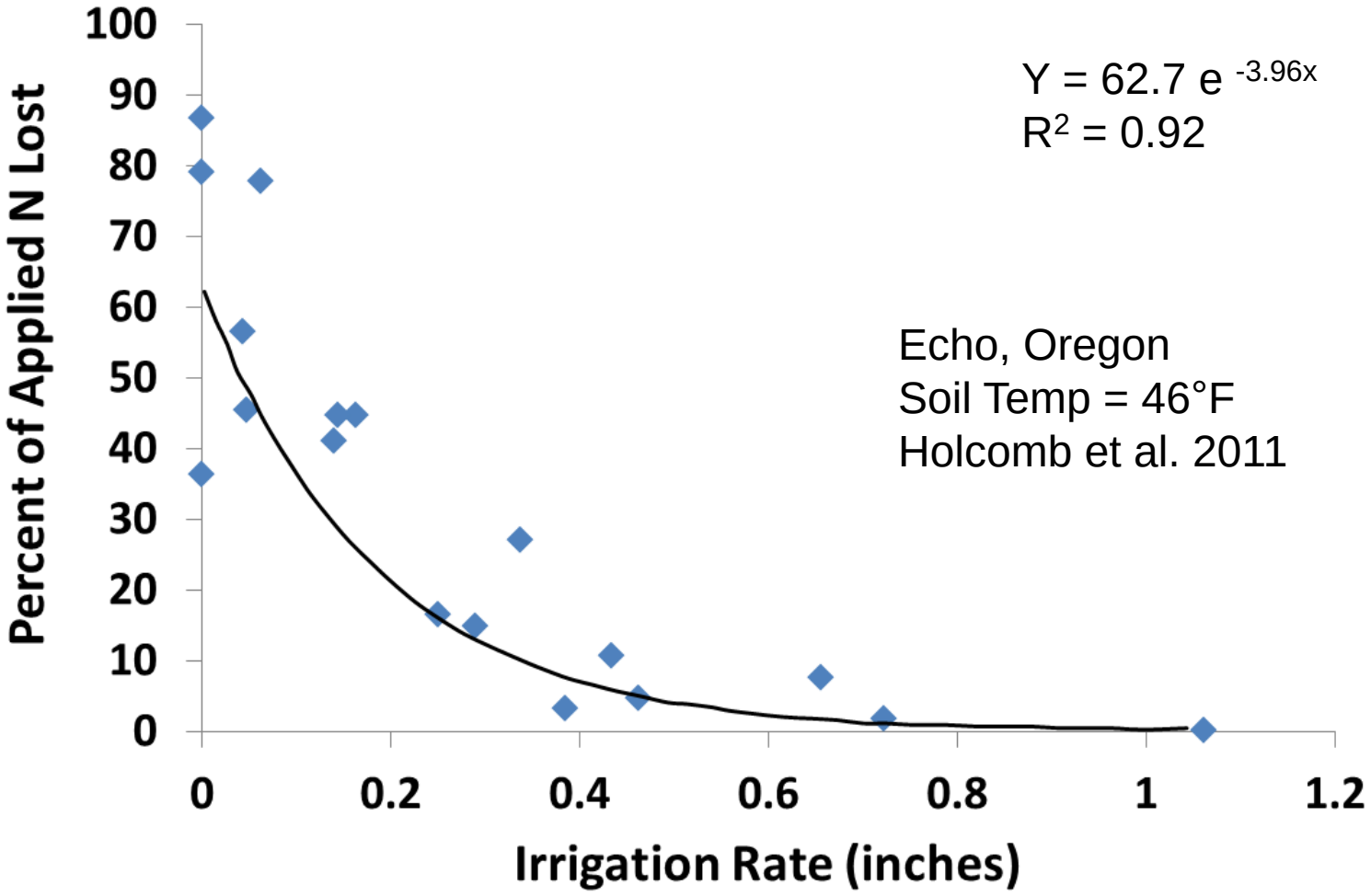
Volatilization from different sources



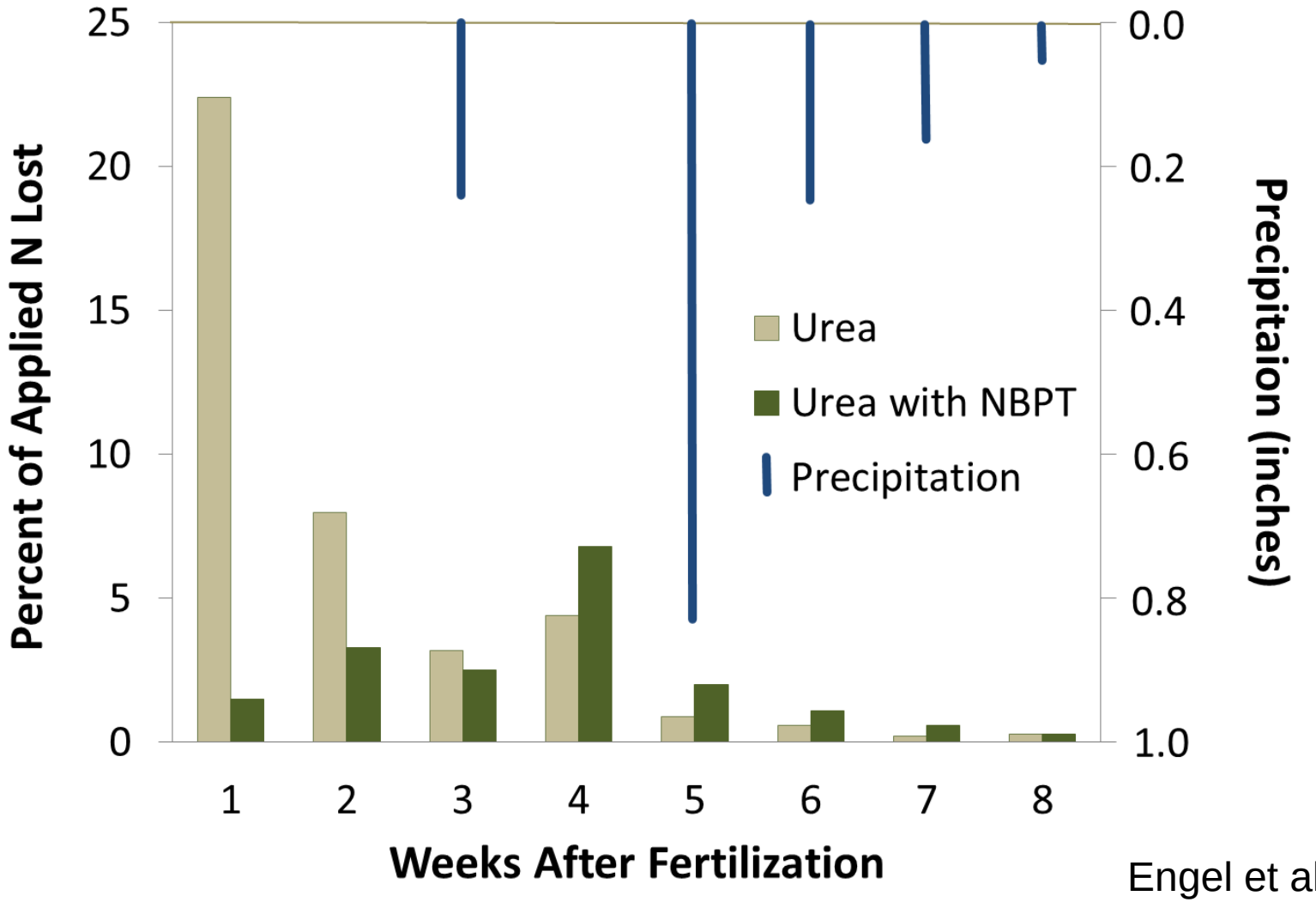
Koenig unpub. data, Colton, WA

150 lb N/acre base rate applied late Sept post grass seed harvest

Effect of irrigation rate on urea volatilization

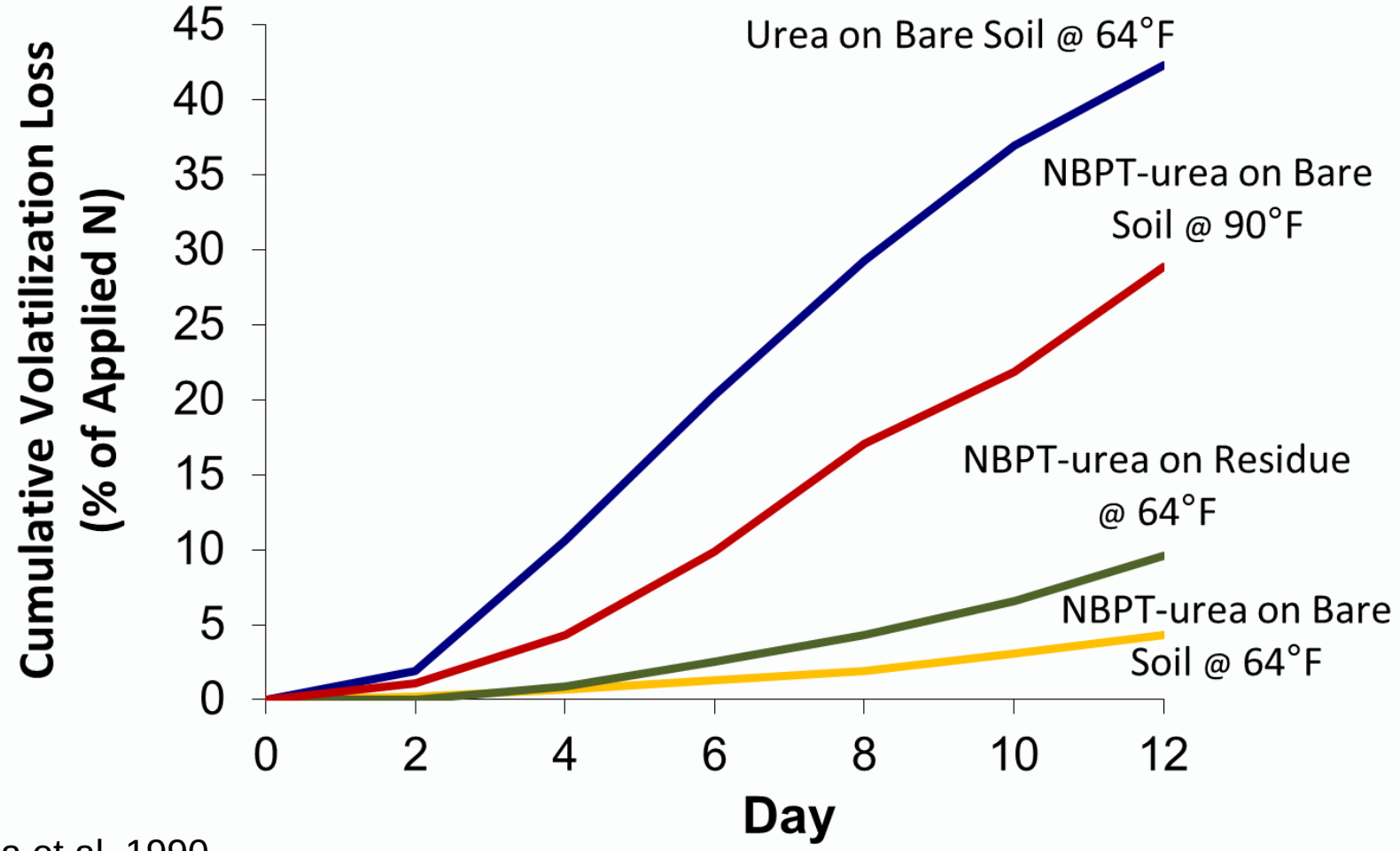


Effect of rainfall on urea volatilization



Engel et al. 2011

Plant residue and temperature effect on volatilization



Carmona et al. 1990
Lab conditions

High risk conditions for urea volatilization

- Moist soil or heavy dew
- High soil pH (>7.0)
- High soil temperature (>70 °F) or frozen soil
- Crop residue, perennial thatch or sod
- Low cation exchange capacity soil (sandy)
- Poorly buffered soils (low soil organic matter, low bicarbonate content)

The risk of volatilization increases as the number of high risk conditions increase, with soil moisture likely being the most important.

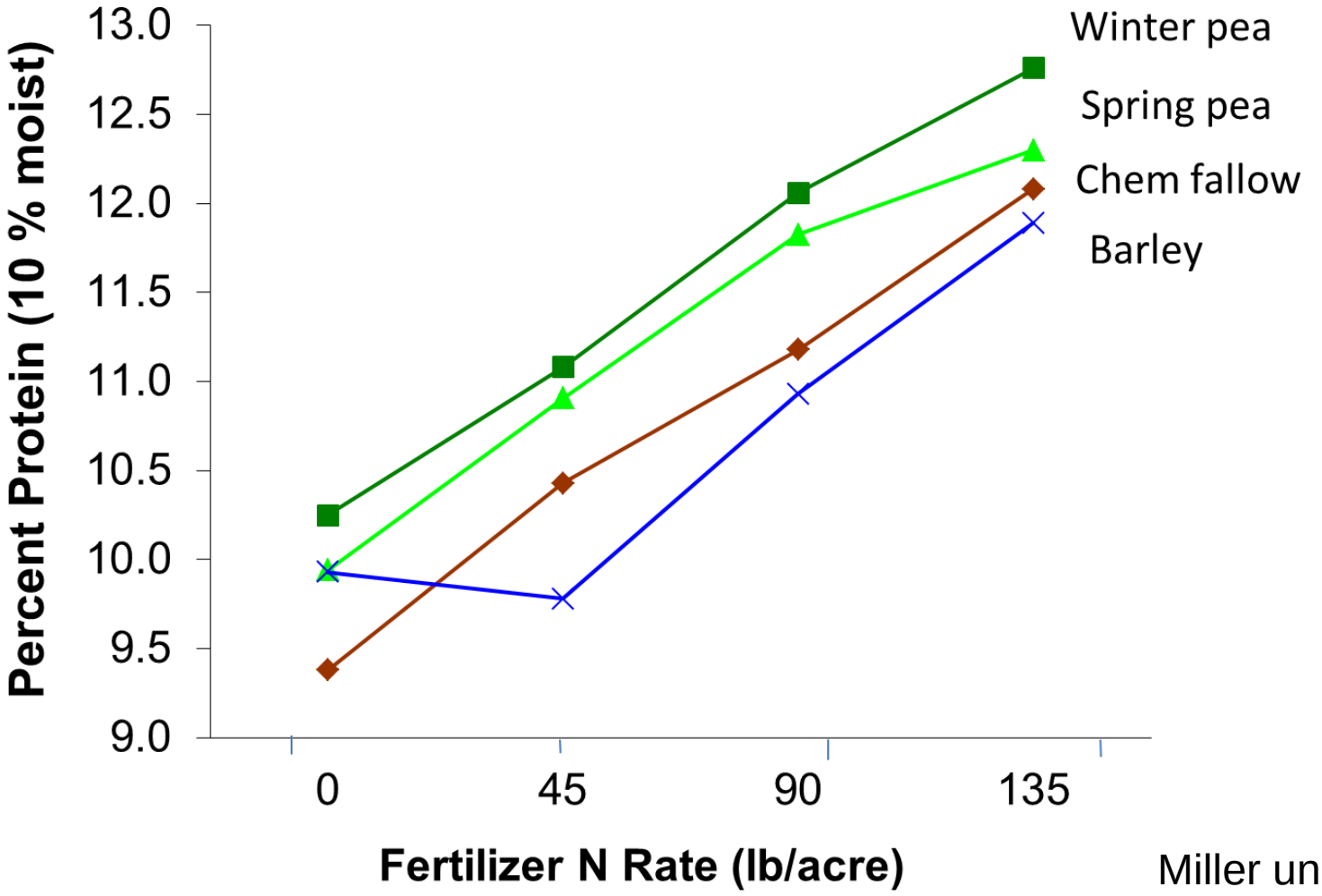
What should growers do to minimize volatilization?

Goal is to get urea 2” below surface and dispersed to not concentrate urea (which causes large pH increase/loss)

1. Do not apply urea on moist ground UNLESS a large snow or rainstorm is forecast (> ½ inch of moisture in a day, preferably more. Unlikely!)
2. Incorporate – mechanical or with water (> ½ inch)
3. Apply urea > 2” below the surface – either in a midrow band, 2 inches from the seed or with the seed with a ‘protected’ product
4. Consider using NBPT (Agrotain®), UAN, PCU, ammonium nitrate (if available) or calcium ammonium nitrate

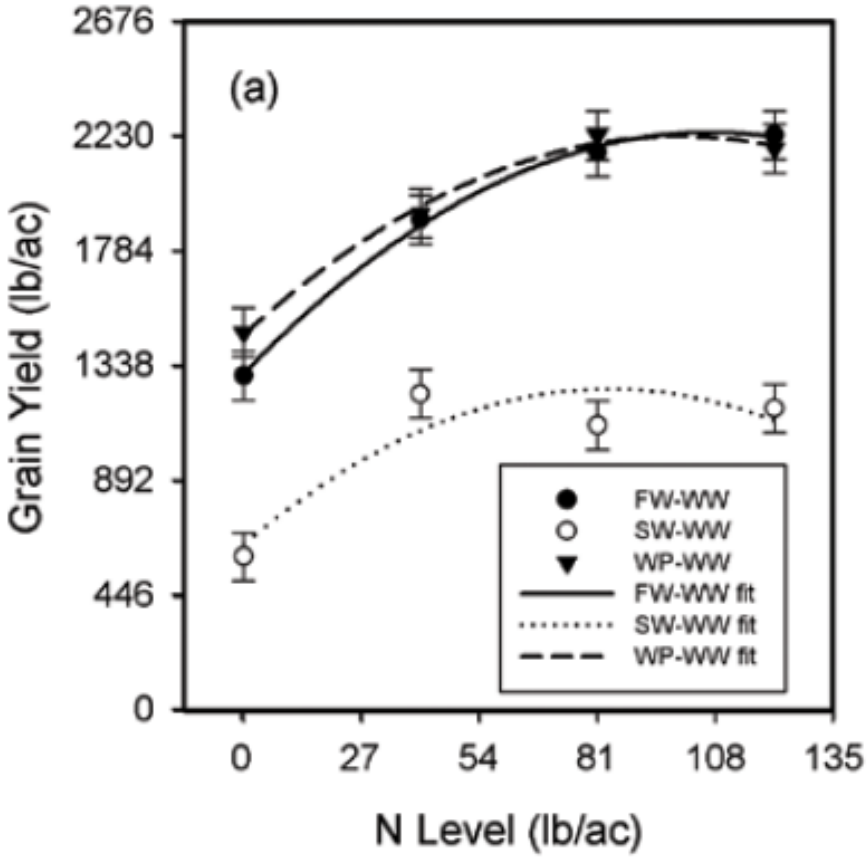
QUESTIONS ON UREA VOLATILIZATION?

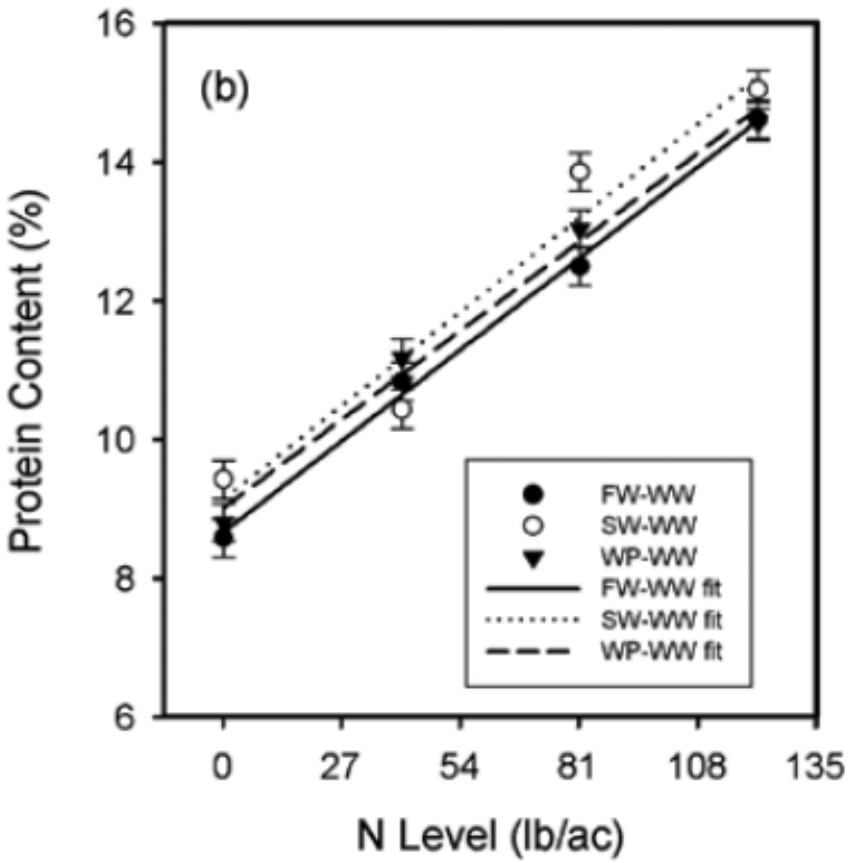
Legumes in rotation with winter wheat?



Miller unpub data

Legumes in rotation with wheat?

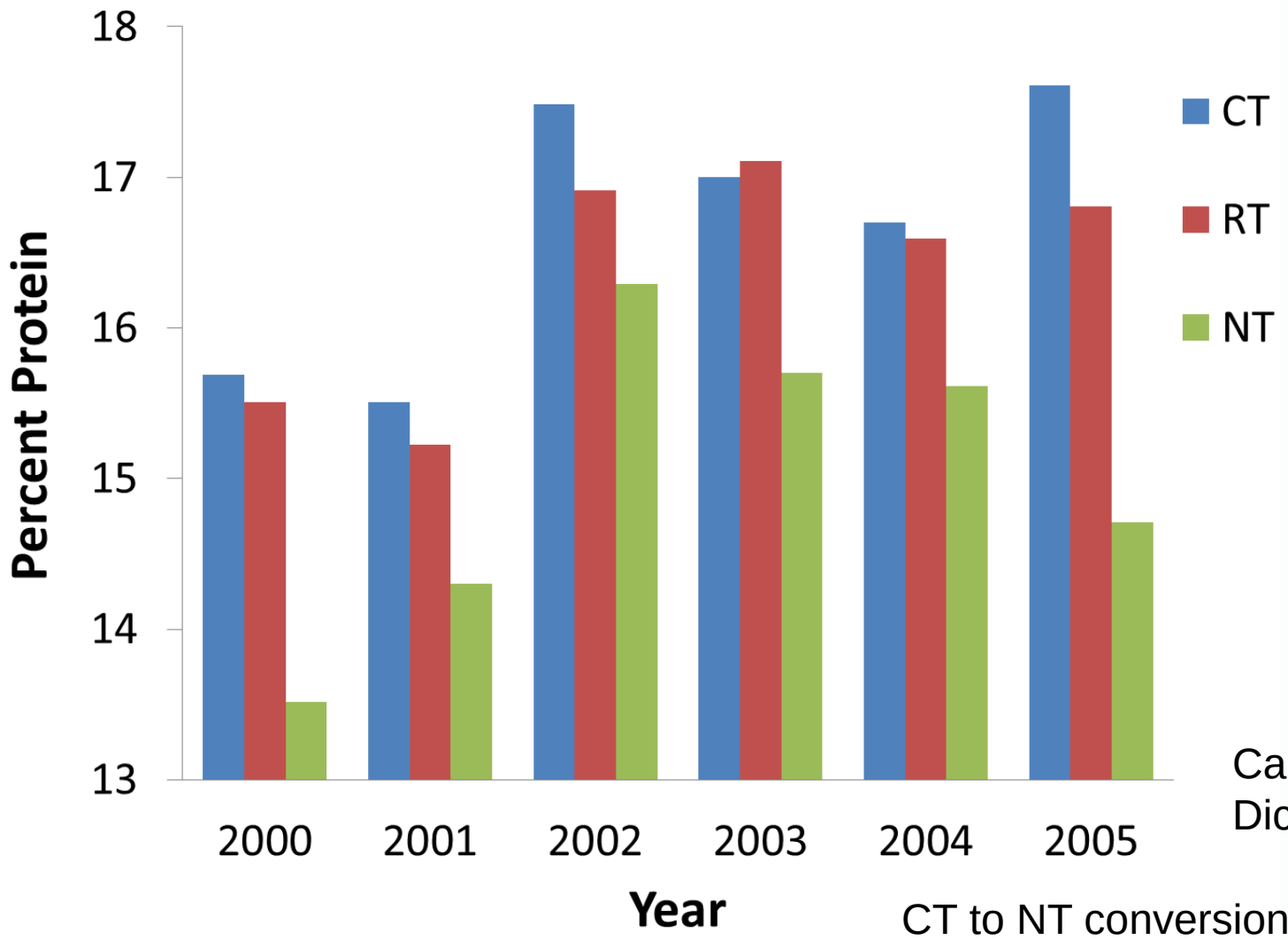




Chen et al. 2012, central MT

Winter wheat following fallow, spring wheat or winter pea for hay

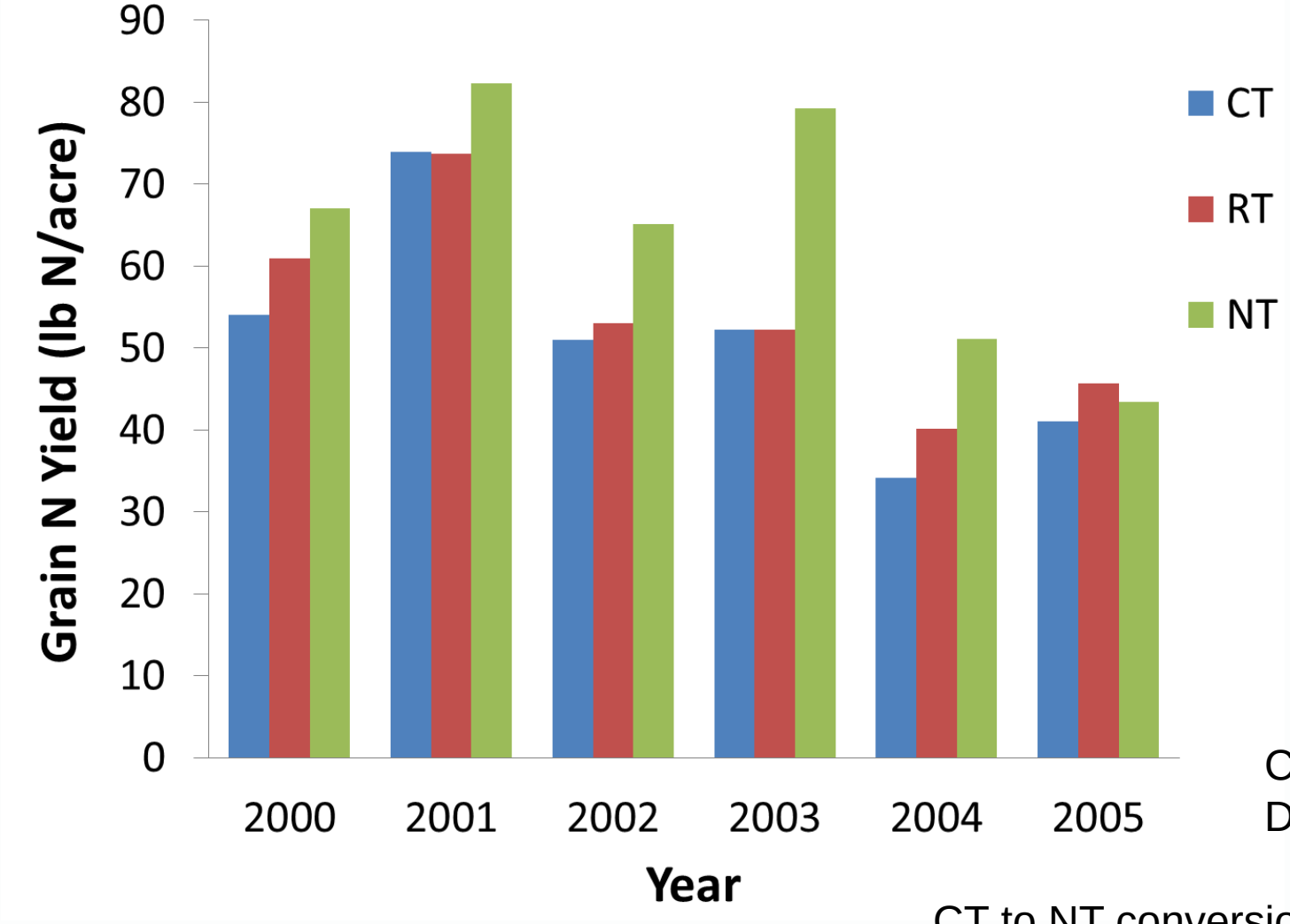
Tillage system on wheat protein



Carr 2008
Dickinson, ND

CT to NT conversion in 1995

Tillage system on grain N yield (yield x N content)



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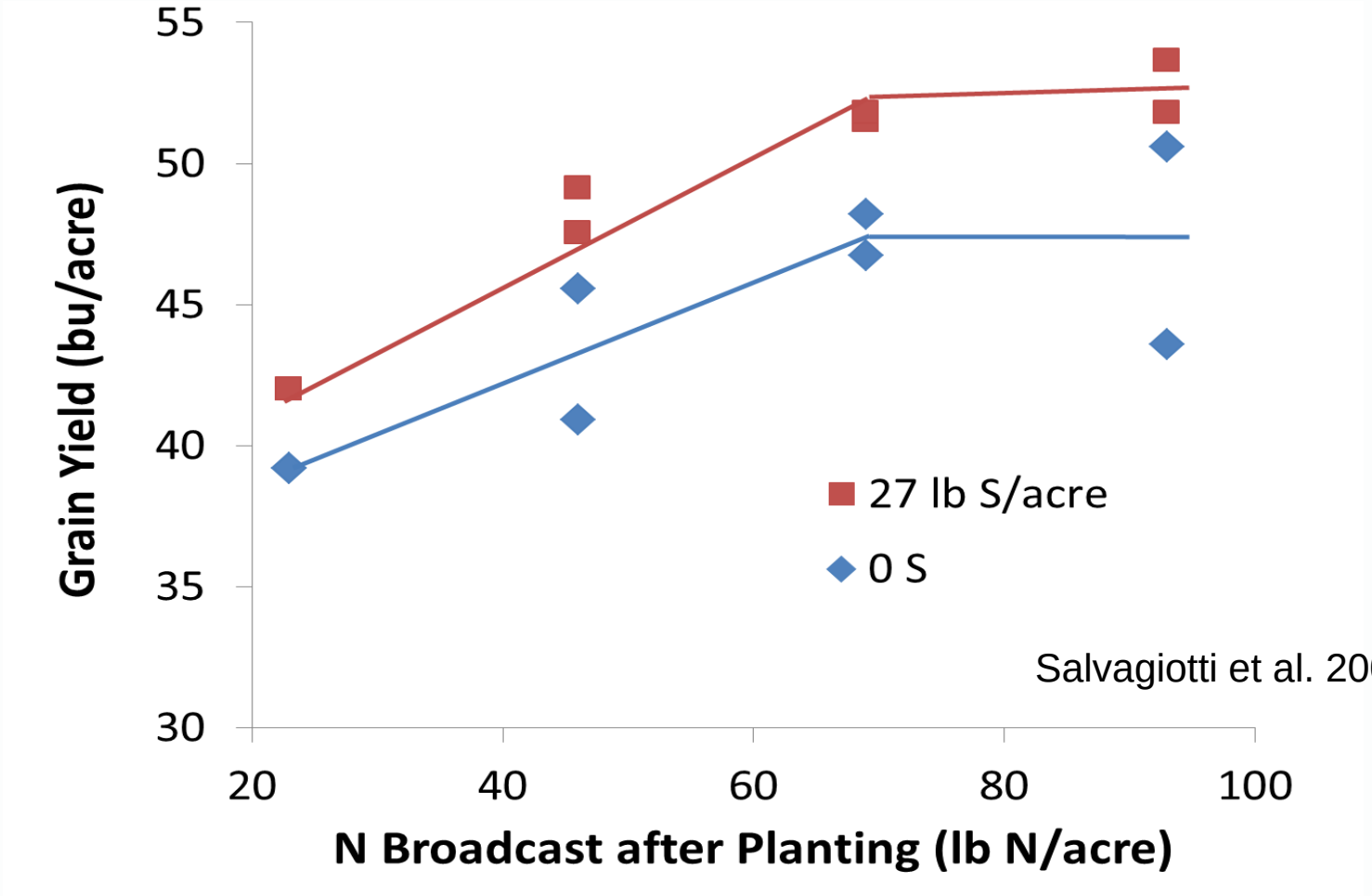
Other nutrients? Sulfur



S increased total N uptake, but not protein concentration

Conclusions

- Supplying sufficient pre-plant N and top-dressing at flowering are the two most consistent strategies to boost grain protein.
- Minimizing N losses and growing wheat after annual legumes should in general both increase protein.
- Enhanced efficiency products may or may not increase grain protein and should be used cautiously given additional expense.
- Legumes rather than fallow or continuous small grain in rotation *may* increase protein similar to about 25 lb N/ac of fertilizer.

QUESTIONS?

Additional info at:
http://landresources.montana.edu/soilfertility

Practices to Increase Wheat Grain Protein (bulletin)
Ammonia Volatilization (2 bulletins coming soon)
Other soil fertility publications
Go to “Extension Publications”

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

Ammonia volatilization taped presentation:
Go to “Ammonia Volatilization”

This presentation: Go to “Presentations”