Managing Nitrogen with Cover Crops

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Sustainable Agricultural Systems

Legumes

- Growth not limited by soil N
- High tissue N concentration (3-4% N)
    - C:N ratio < 20
- Rapid N mineralization during decomposition
- Not very good at reducing N leaching

Legumes

When compared to:

1. Mineral fertilizers
   - Slower release rates
   - Lower energy use
   - Renewable resource

2. Animal Waste
   - No new P
   - No transport costs
   - Low volatility

Hairy vetch (*Vicia villosa*)

- Winter annual legume
- Seed at 20-30 lb/ac; 0.5-1.5” deep
- High biomass producer (4000-7000 lb/ac)
- Produce more than 150 lb N/ac
- Good weed control
- Disease suppression in vegetables

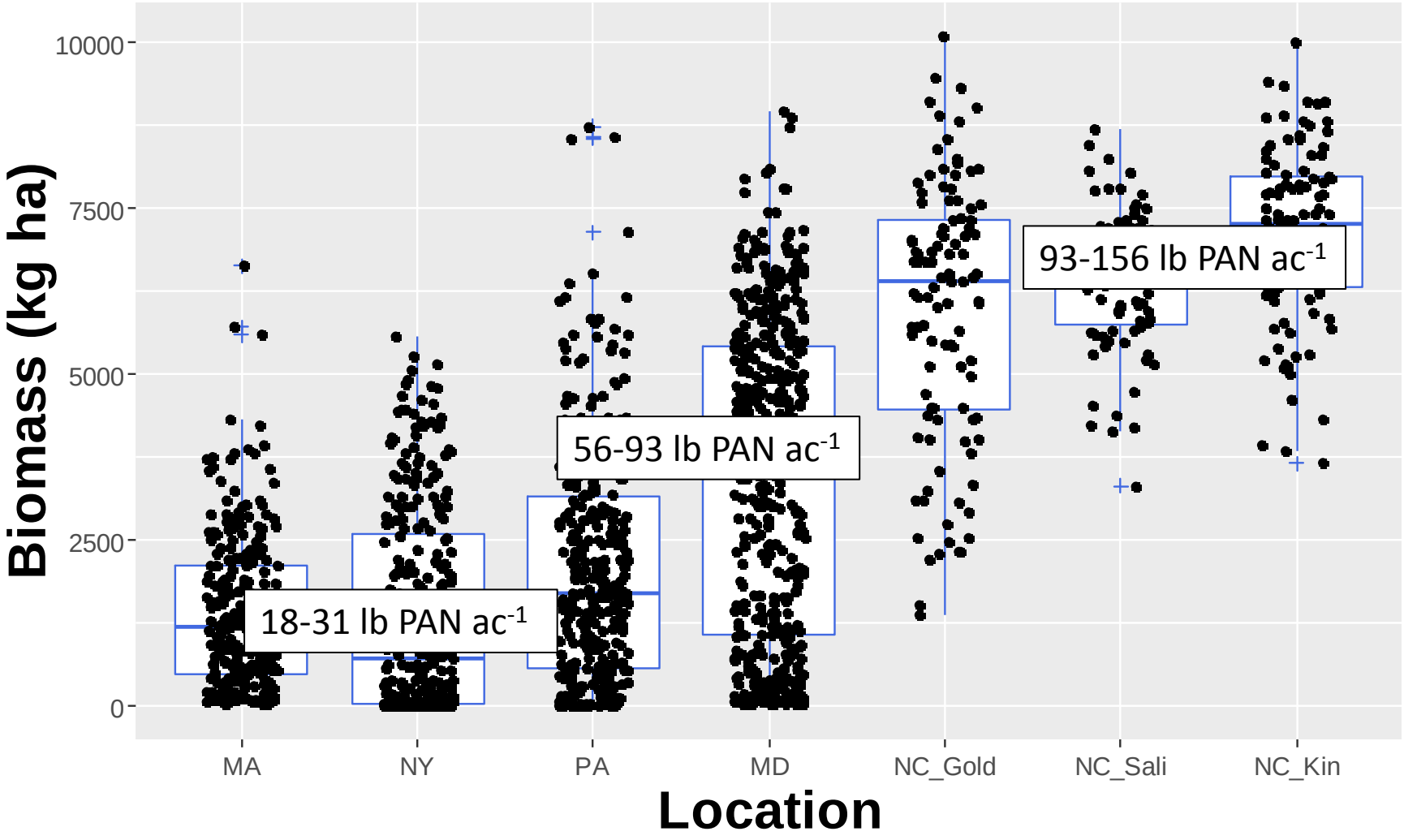
Crimson clover (*Trifolium incarnatum*)

- Winter annual legume
- Seed at 8-15 lb/ac; 0.25-0.5” deep
- Biomass (1000-3500 lb/ac)
- Produce more than 130 lb N/ac
- Improves soil structure

Austrian winter peas (*Pisum sativum*)

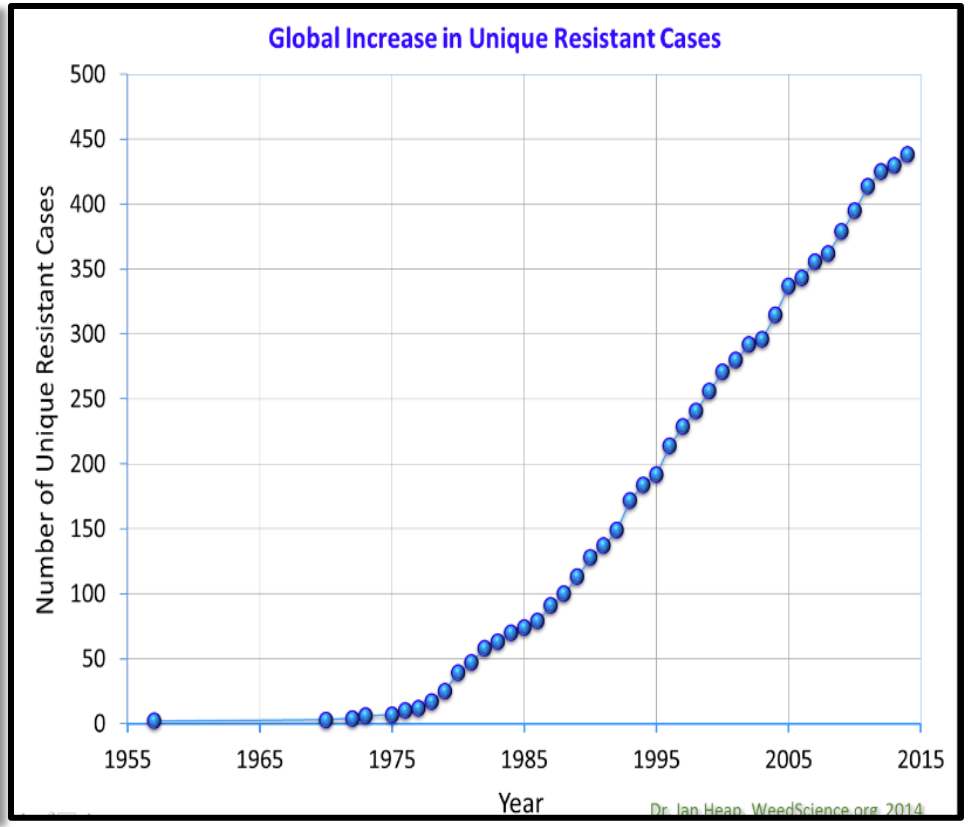
- Winter and spring annual
- Seed at 50-80 lb/ac; 1-2” deep
- Biomass (1000-3500 lb/ac)
- Produce more than 130 lb N/ac
- Improves soil structure/reduces compaction

Total above ground plant available nitrogen from hairy vetch (lb PAN ac^{-1})



Need covers for multiple functions

- No-till has soil conservation benefits
- Successful due to herbicides/herbicide resistant crops



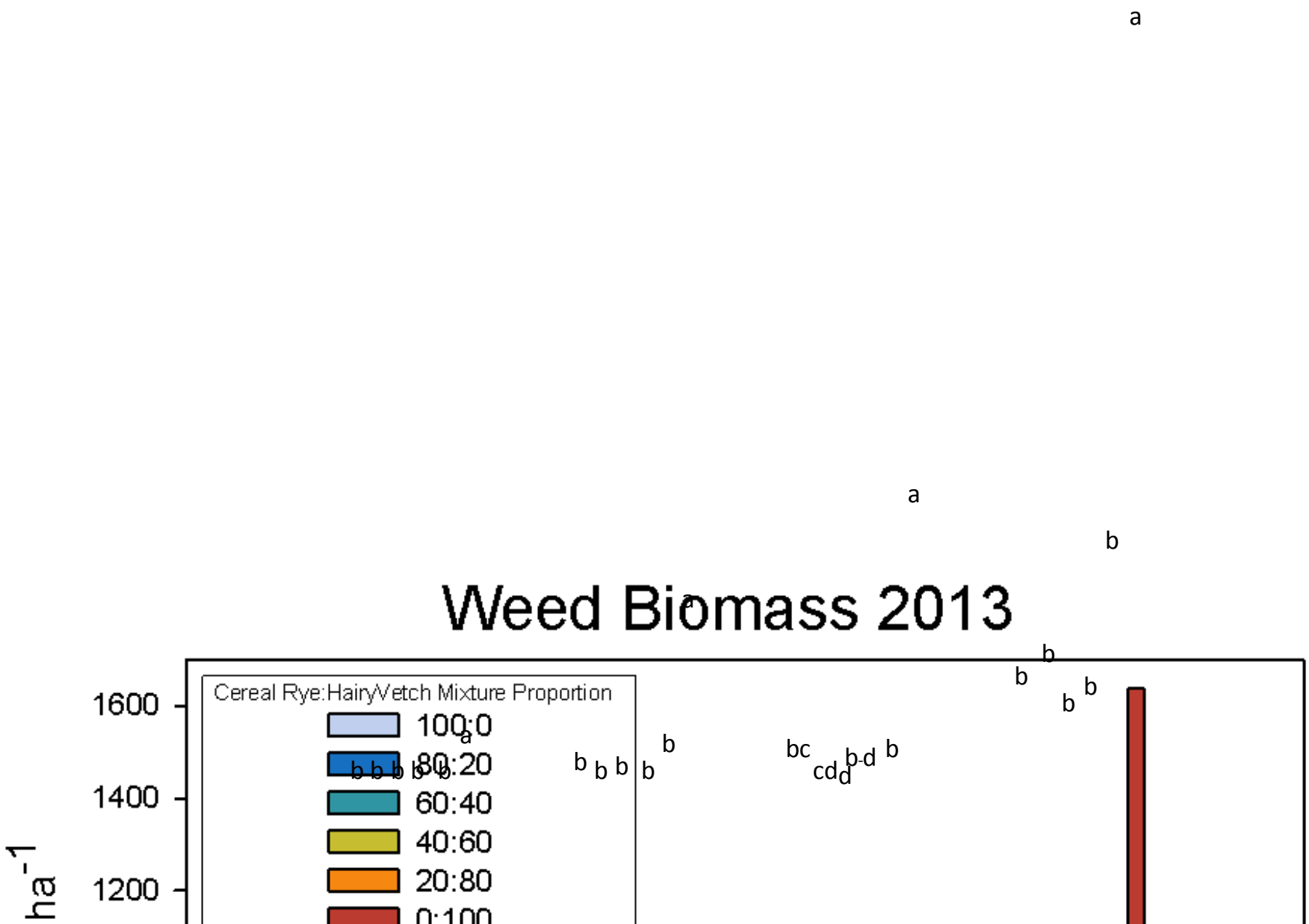
Nutrient supply vs. weed control

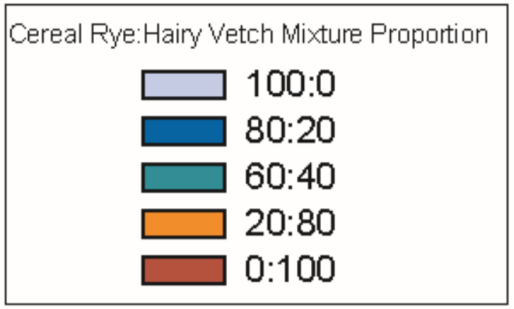
- Grasses: High weed suppression, low N supply

Cereal rye
(*Secale cereale* L.)

- Legumes: Low weed suppression, high N supply

Hairy vetch
(*Vicia villosa* Roth*)*


Weed Biomass 2013
Cereal Rye:HairyVetch Mixture Proportion
100:0
80:20
60:40
40:60
20:80
0:100
1600
1400
1200
ha-1
a
b
bc
cd
d
b-d



a

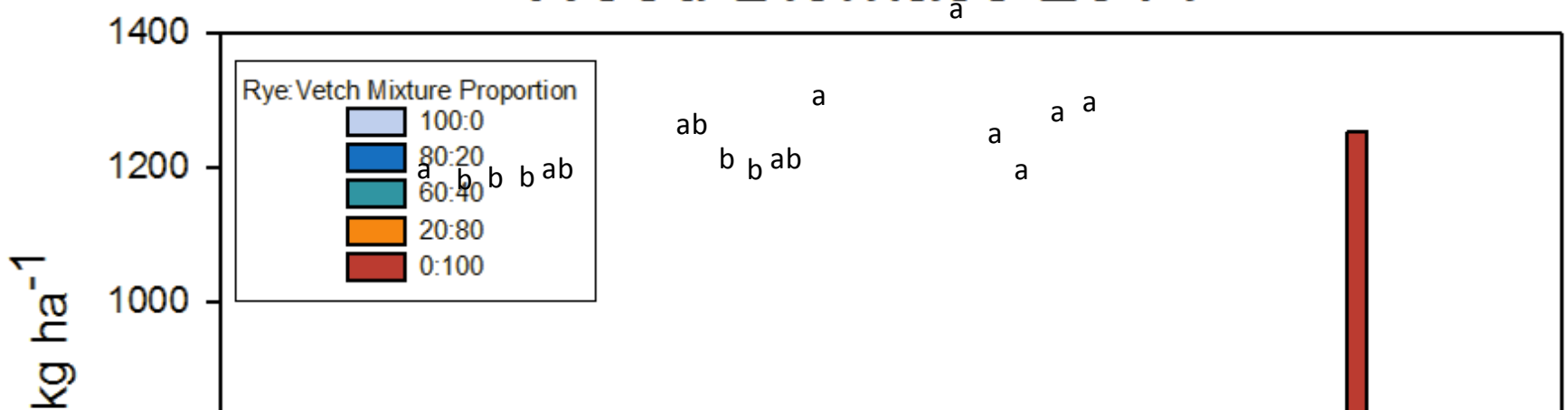
b b

b

b

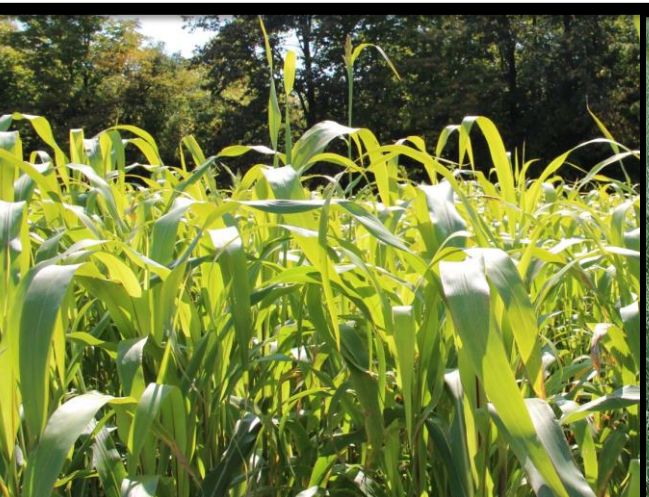
a

Weed Biomass 2014

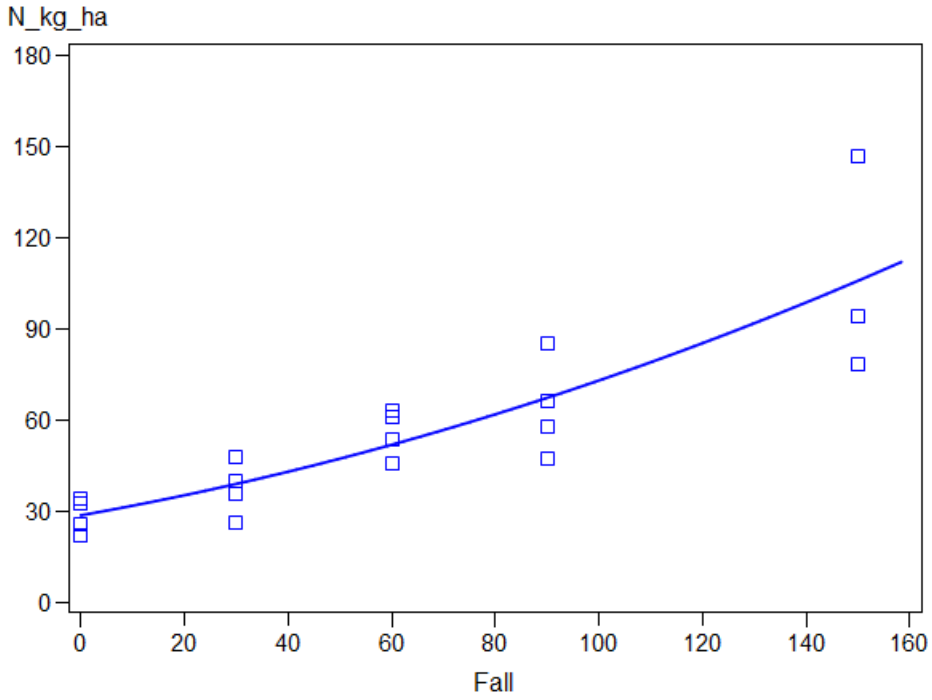


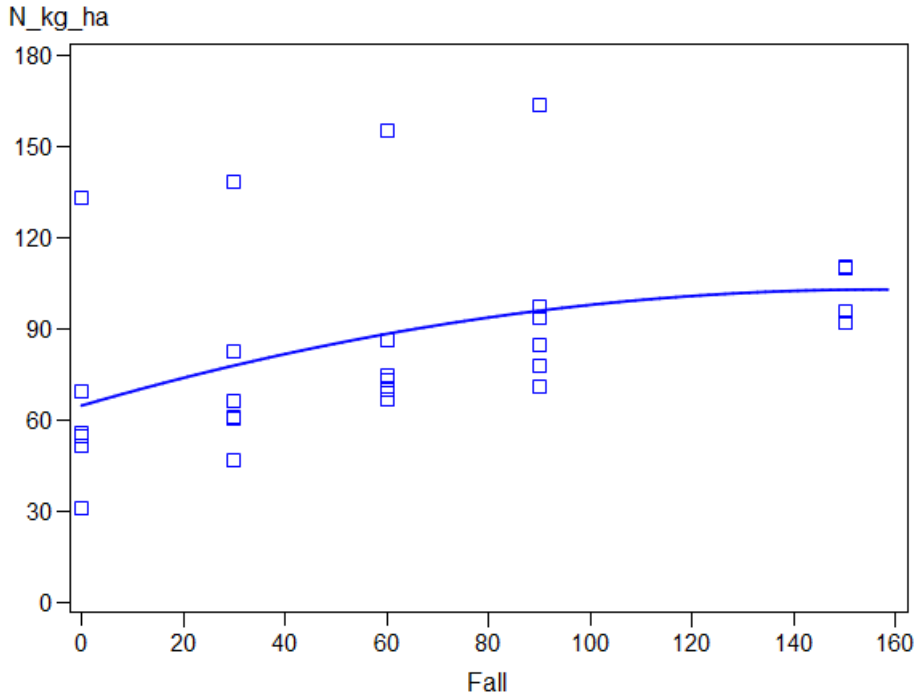
Grasses

- Tremendous N scavenging
- Erosion control
- Weed suppression as a mulch
- Growth limited by soil N
- Lower tissue N concentration (1-2%)
  - C:N ratio > 25
- Possible N immobilization during decomposition
- Excellent at reducing N leaching



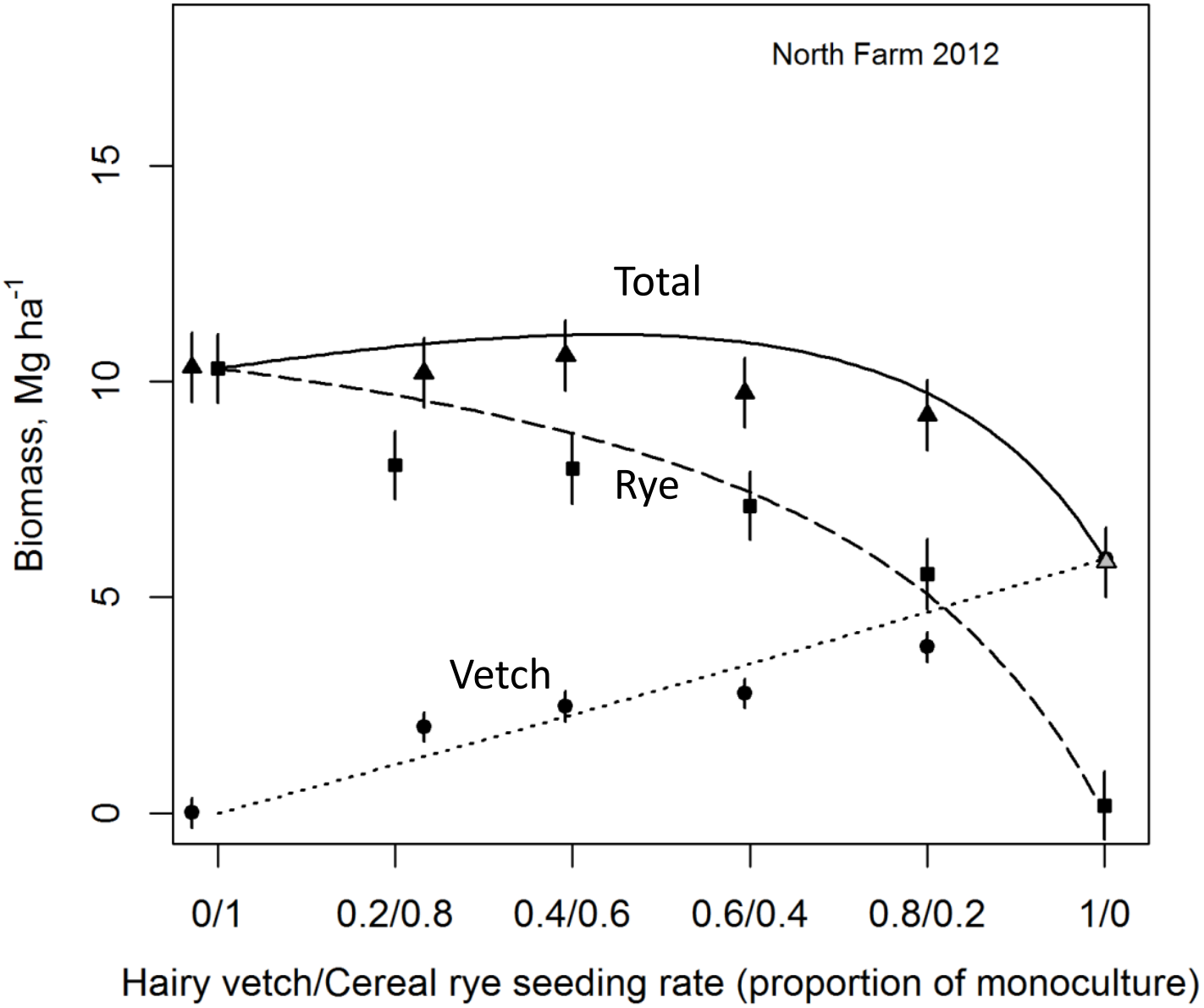
Cereal rye nitrogen content across a fall fertilizer gradient





Fall nitrogen application rate (kg ha^{-1})

Cover crop biomass across mixture proportions



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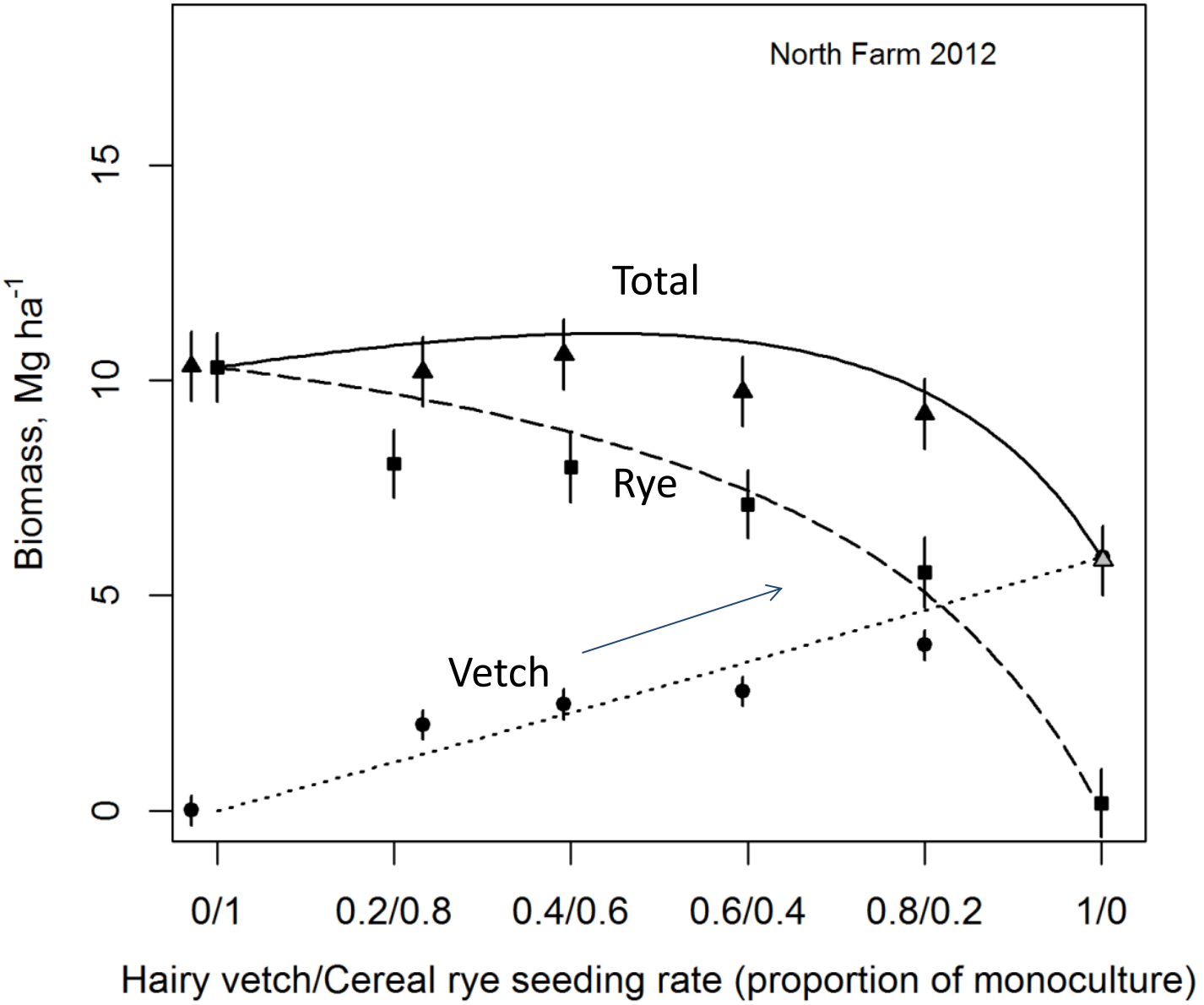

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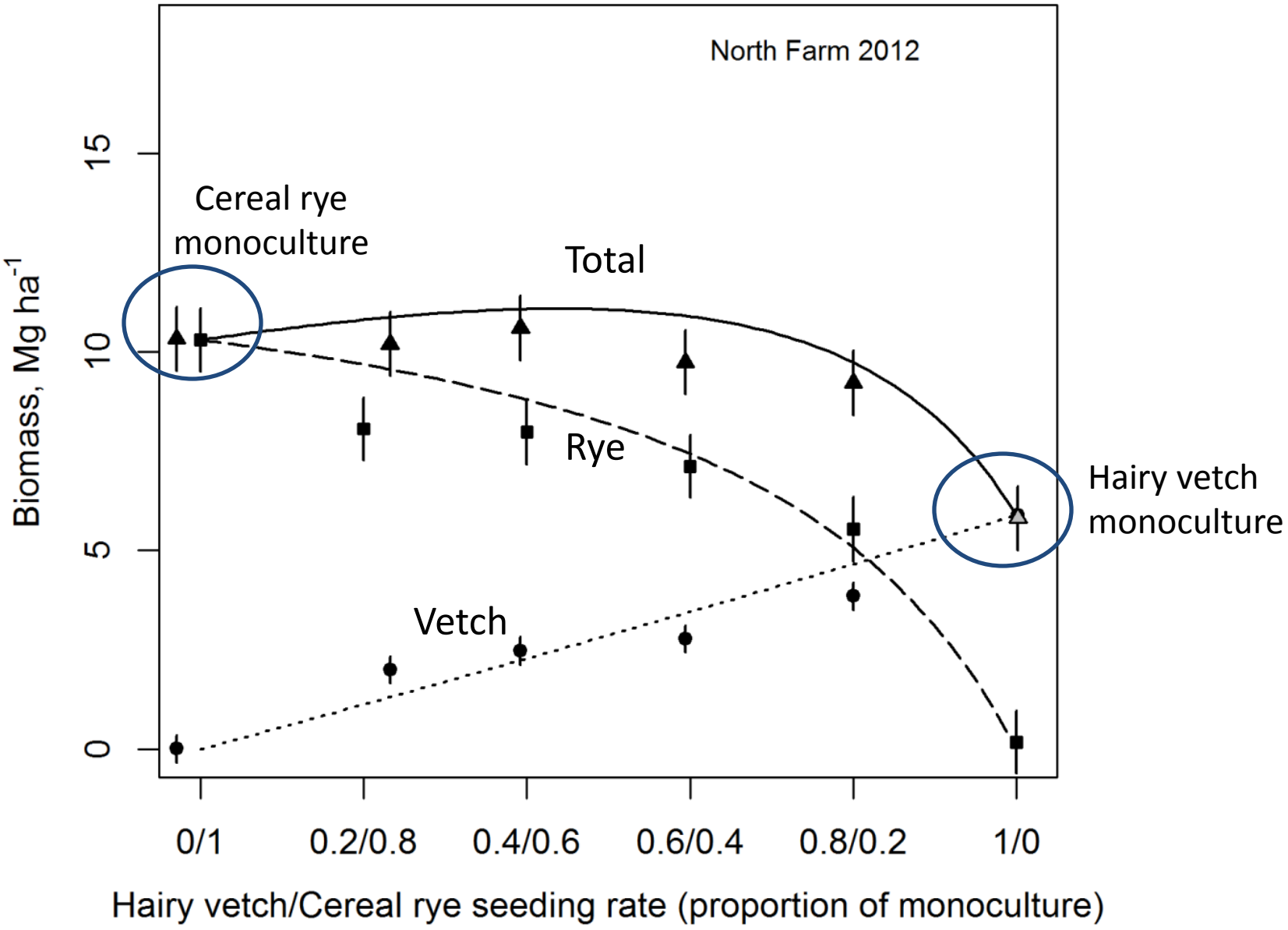

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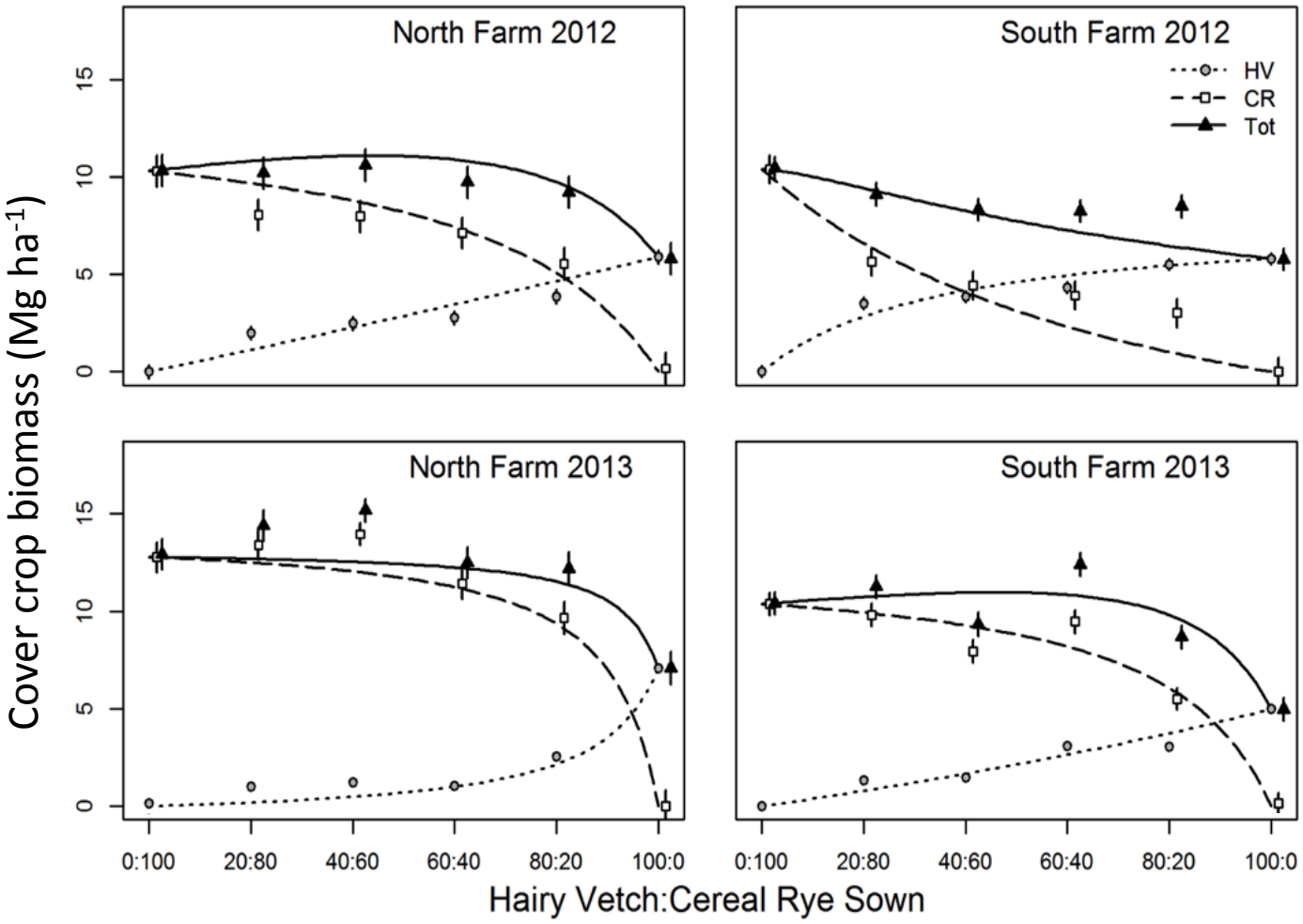


Meta-analysis
(Poffenbarger et al. 2014)
Mixture
vs.
monocultures

- > biomass
- = 50% legume content equivalent to pure legume
- Drivers for over yielding: proportion, seed applied, and GDD

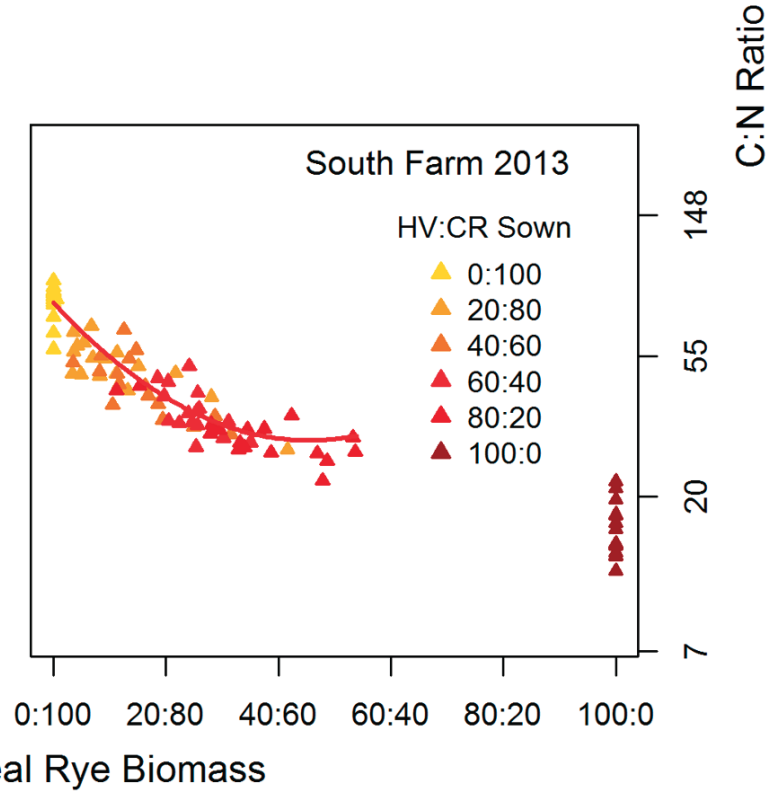
C:N ratio of hairy vetch monocultures and mixtures

C:N ratios:

Hairy vetch (16:1)

Cereal rye (83:1)

50:50 = 25-30:1;
N immobilization/ mineralization threshold



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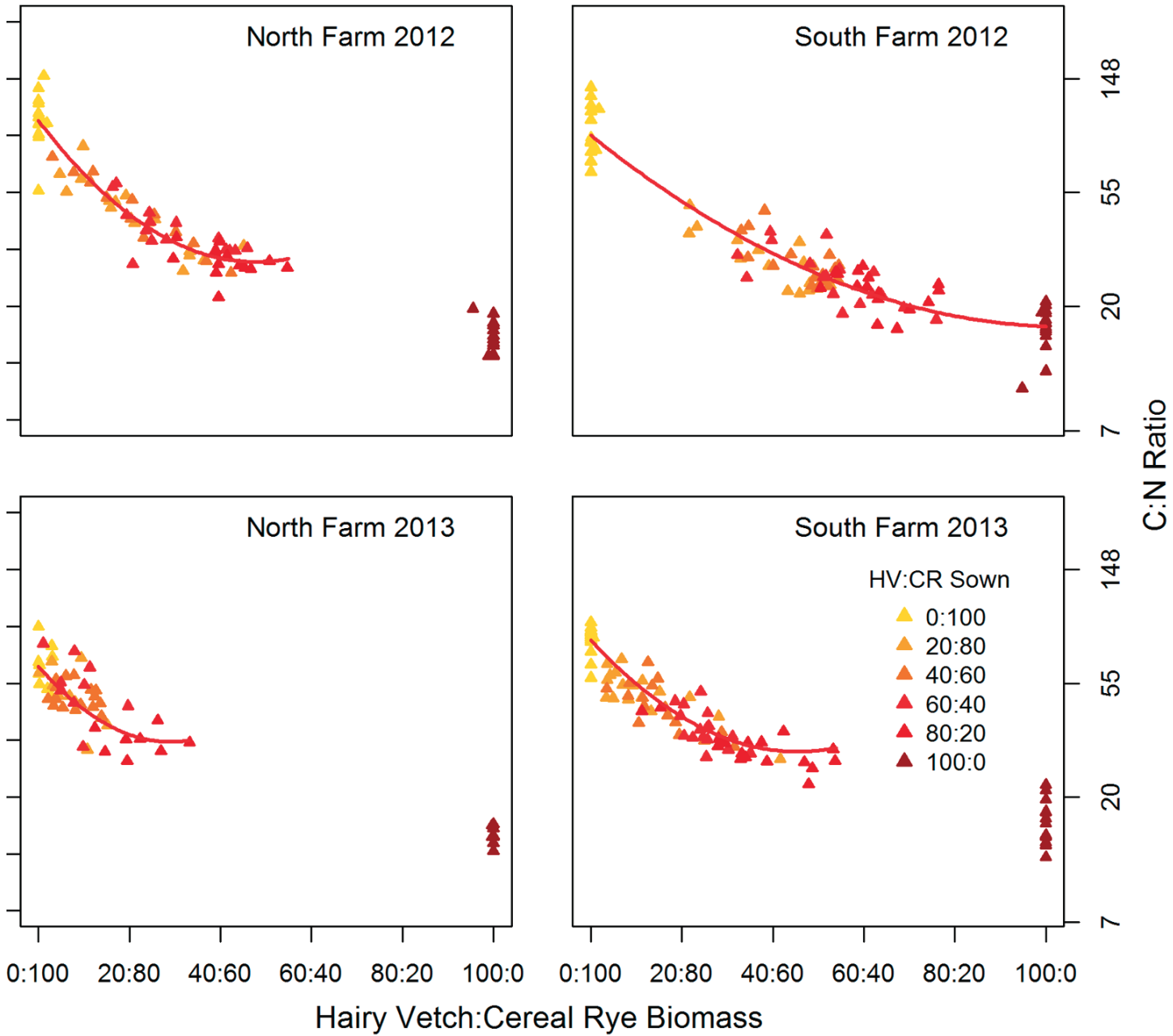
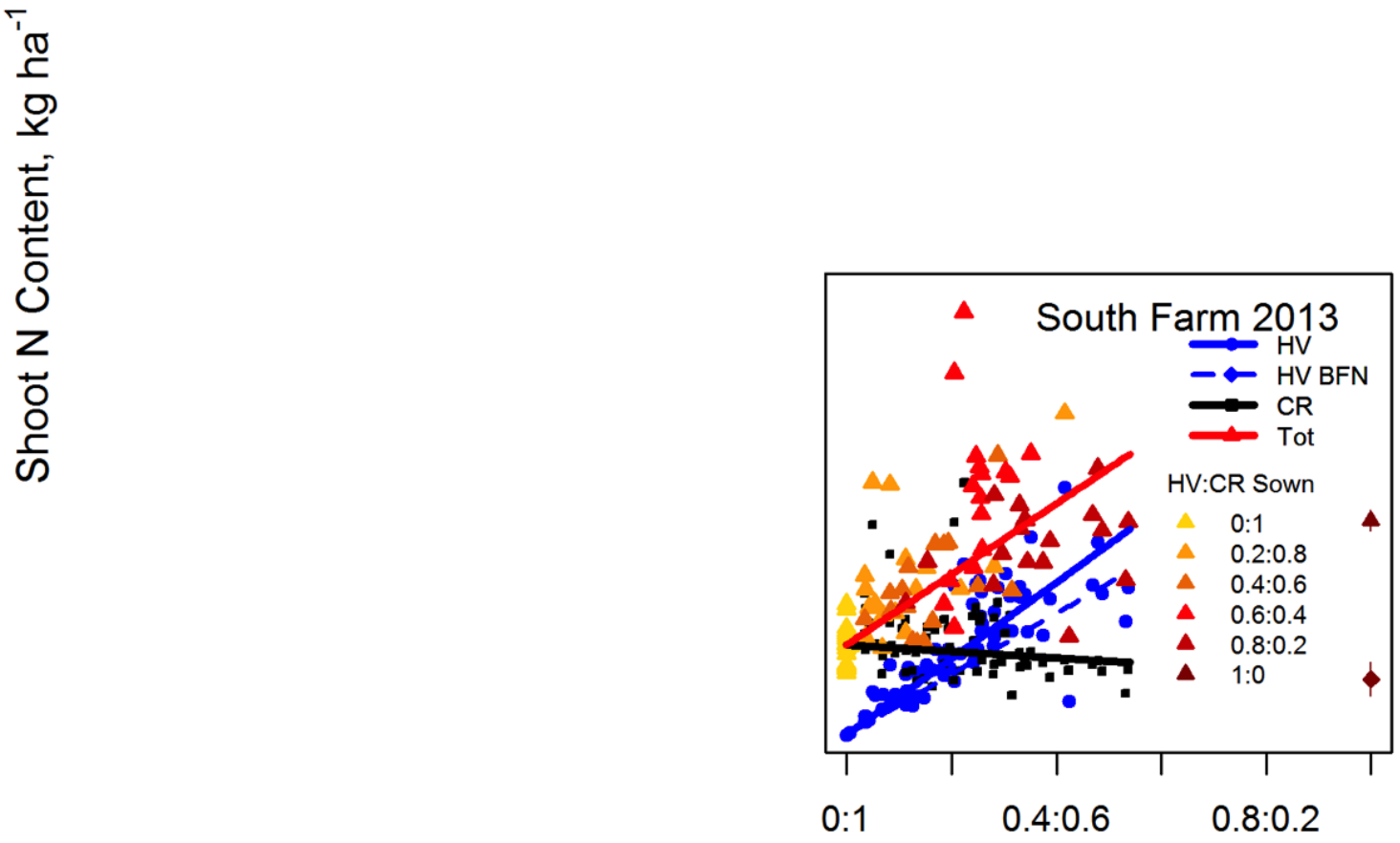


Cereal rye and hairy vetch monoculture and mixture N content



Poffenbarger et al.

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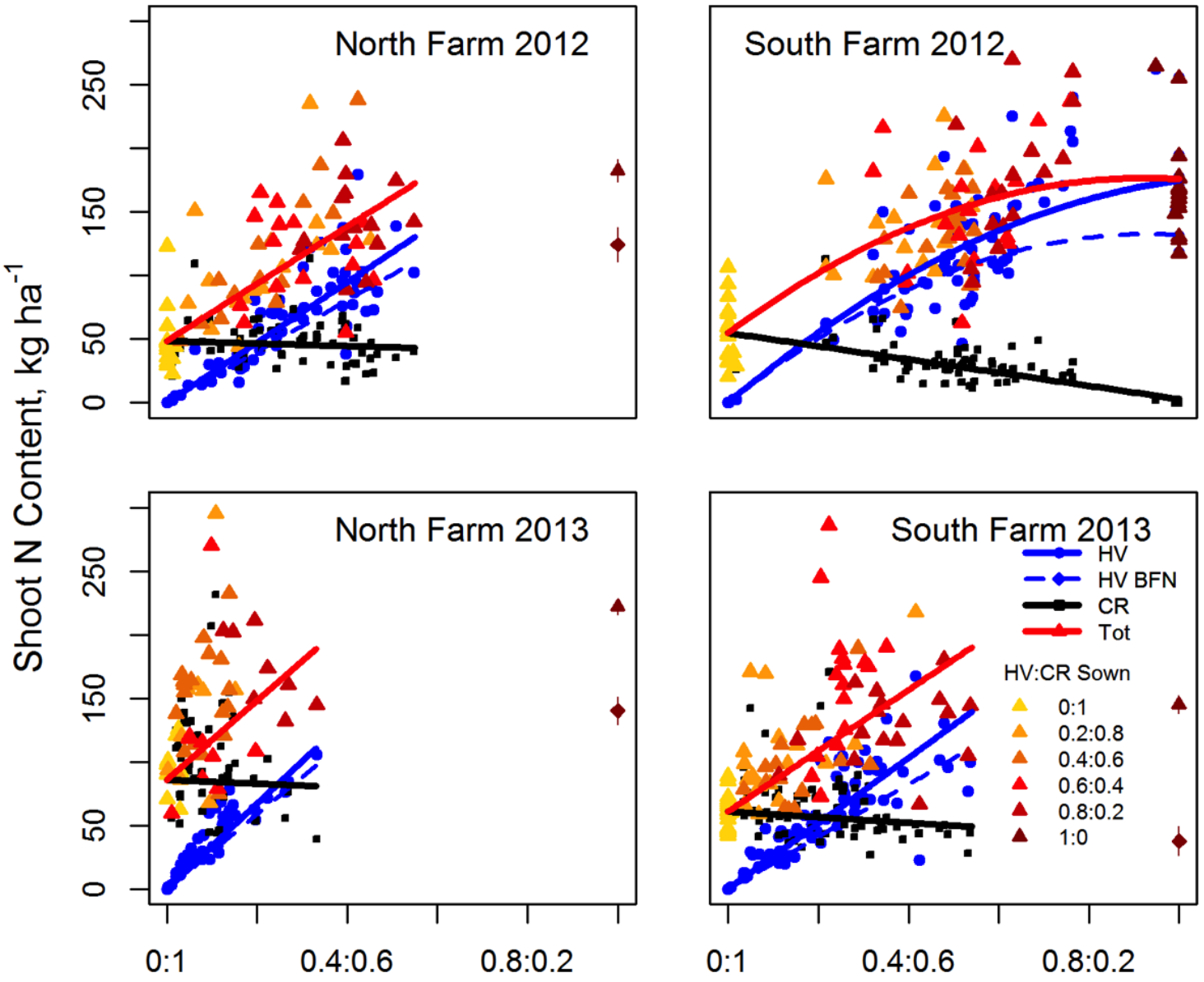
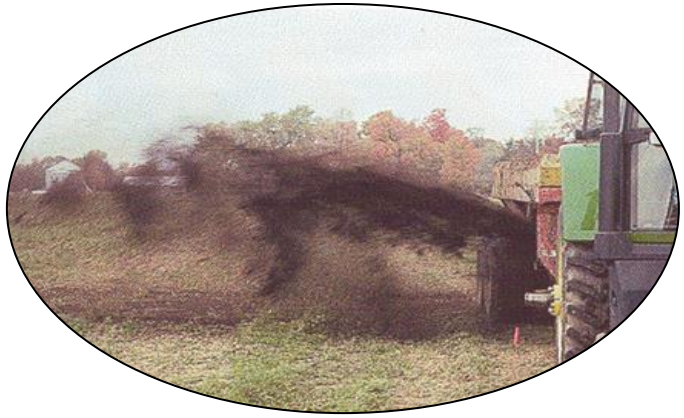


Poffenbarger et al.

Nutrient management

Determine the right:

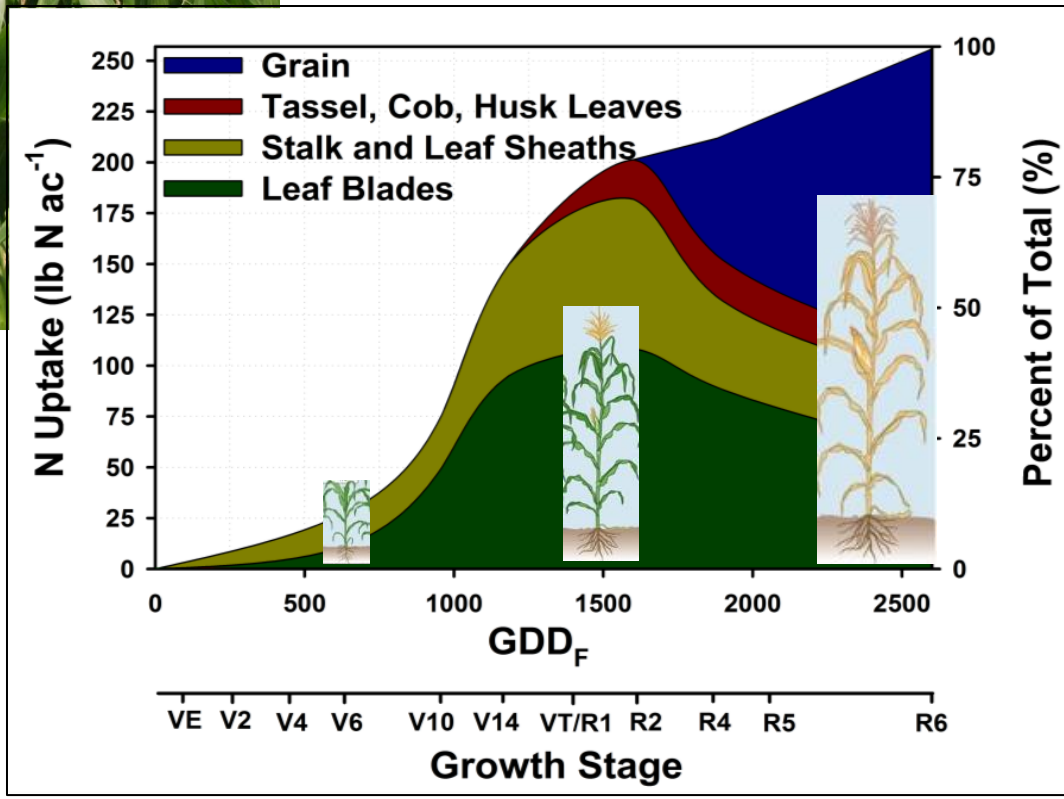
rate, source, time, and placement



- Focus is on reducing potential for losses:
  - Leaching
  - Erosion
  - Volatilization

- Increasing use efficiency
  - lowers cost of production and conserves natural resources

Improving nitrogen mgmt. in corn

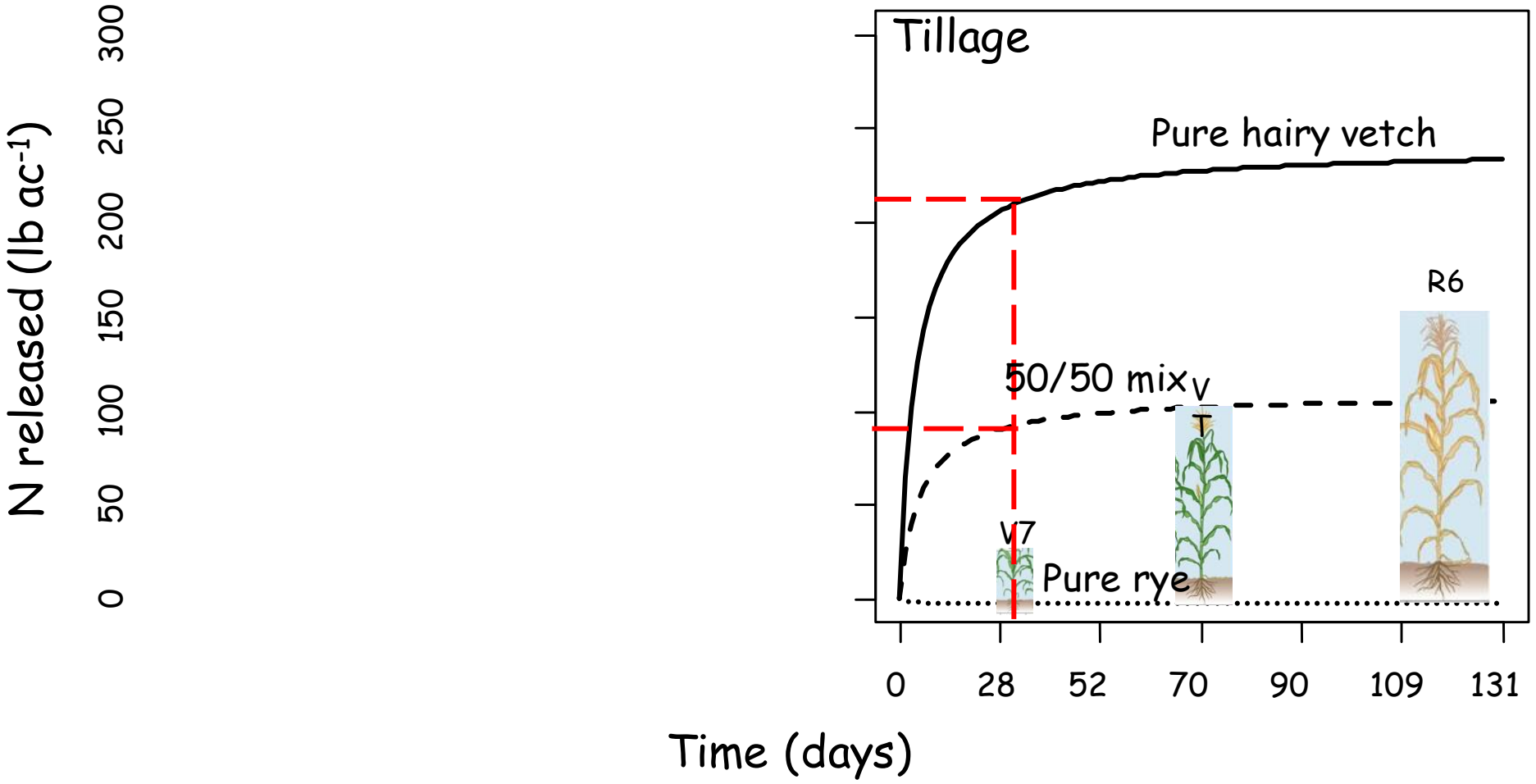


V6: Period of greatest N uptake

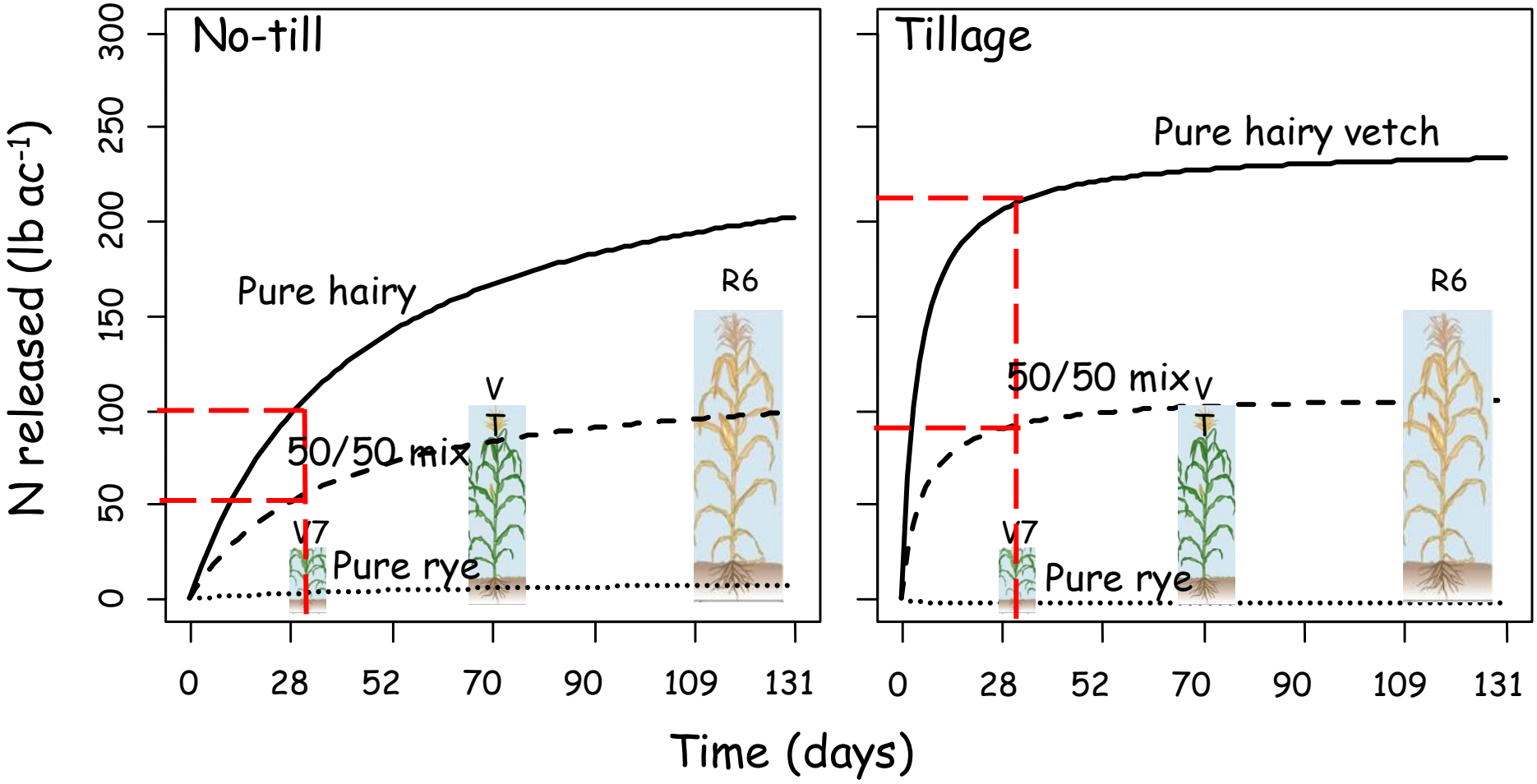
University of Illinois

Cover crop decomposition and N release

Nitrogen release over time



Nitrogen release over time

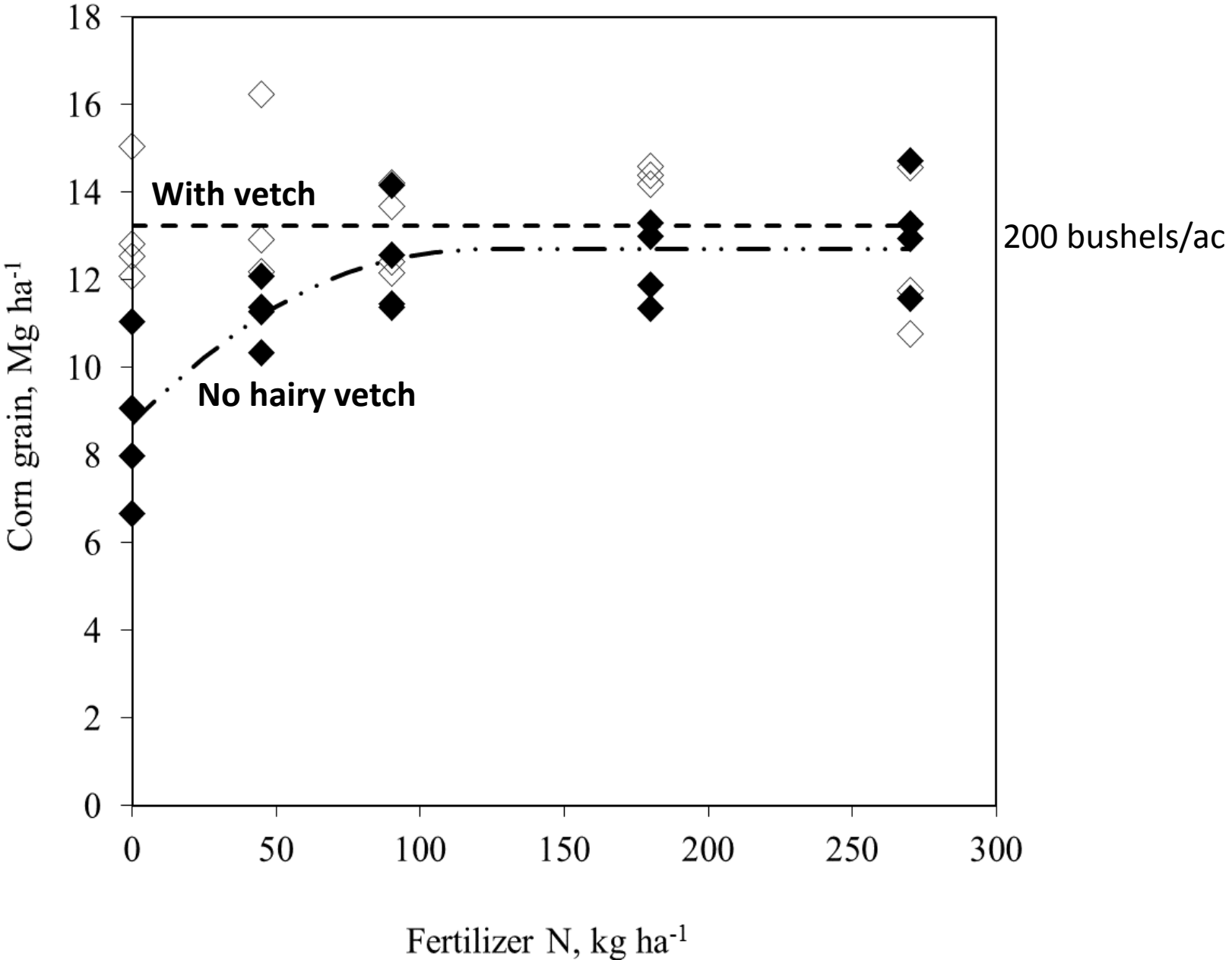


Moving beyond C:N ratios to quality

(decision support tools for growers; water and nitrogen)

Call for farmers to participate

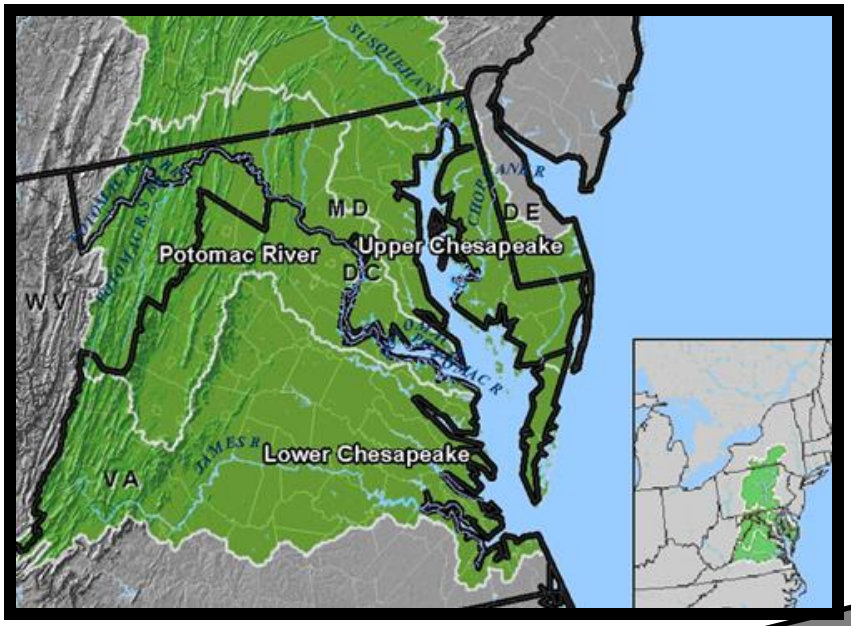
Effects of hairy vetch and mineral fertilizer on corn yield

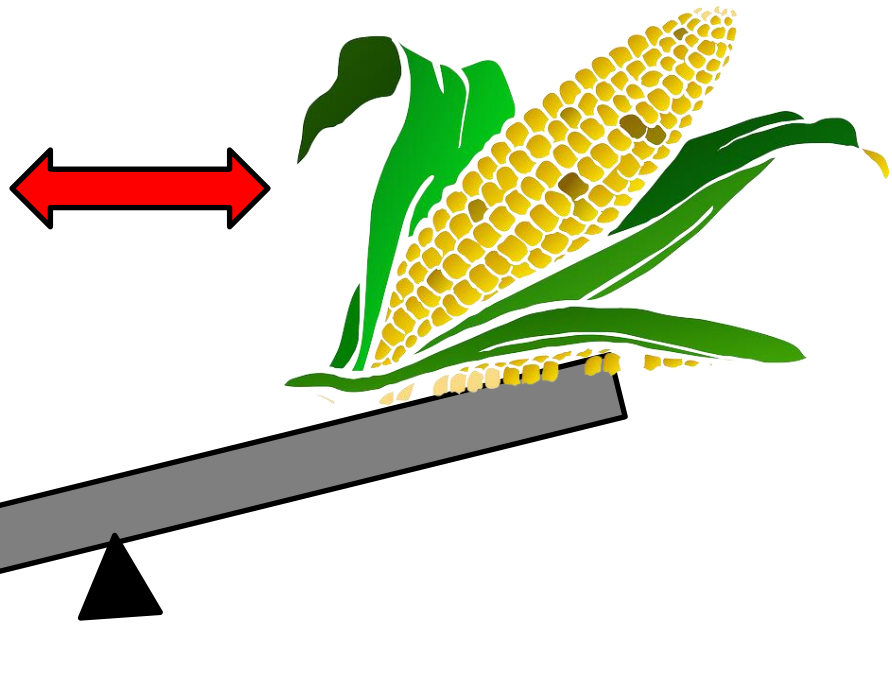


Managing N in cereal covers

(may need to adjust split application rates)

N and P Management





<u>Balancing N needs with P concerns</u>

-legume cover crops + organic amendments

-apply amendments at P removal rates

- soil reserves as “buffer”

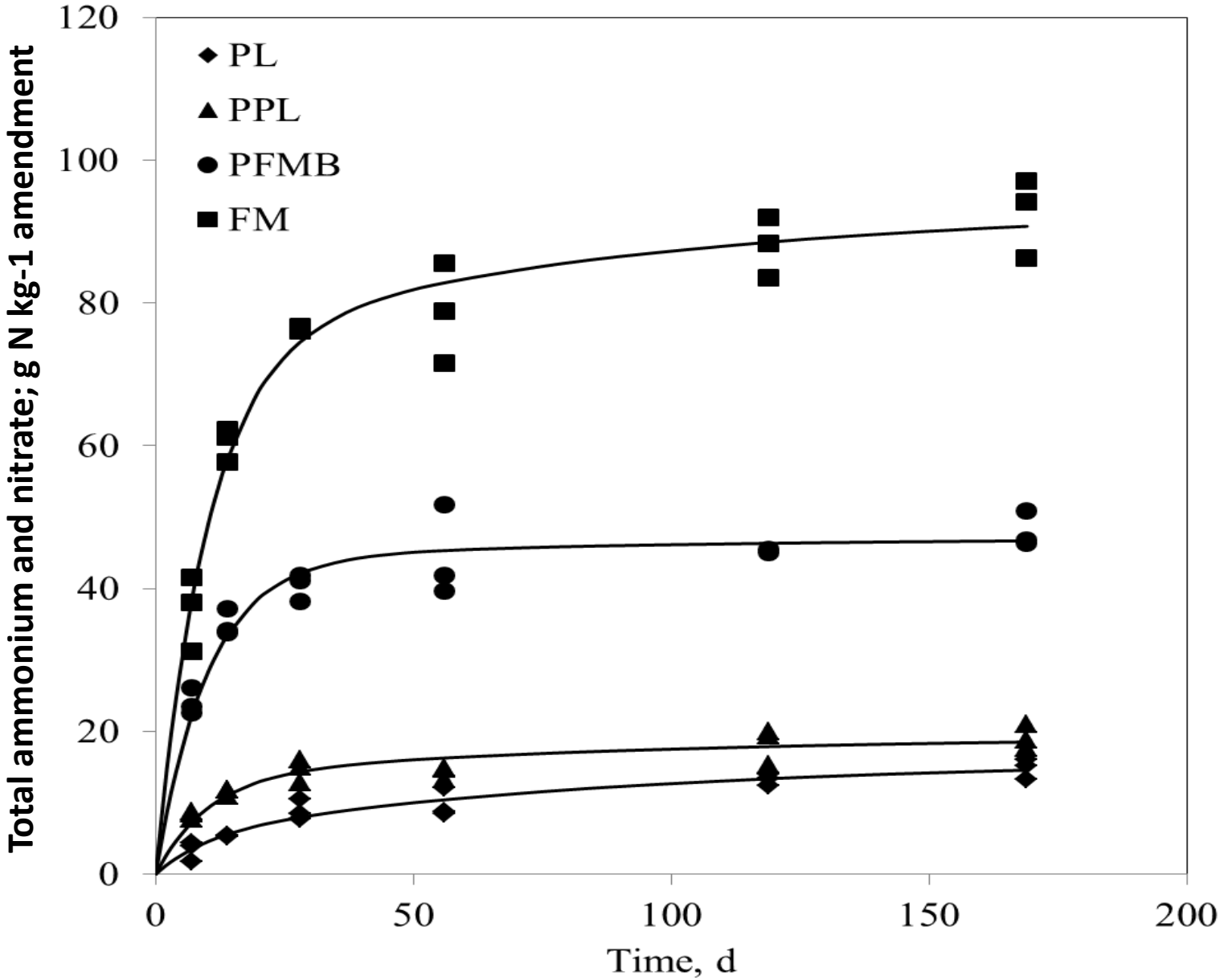
Poultry litter nutrient properties

Nutrient pool	lbs/ton
Total N	60
NH4-N	14
Org-N	46
PAN	**42**
P_2O_5	**58**
K_2O	**52**

Van Devender et al. 2004. Utilizing Dry Poultry Litter: An Overview.

- N-based rate: Need ~3 tons/acre to supply 140 lbs PAN/acre
  - 174 lbs P_2O_5/acre
  - 156 lbs K_2O/acre
- P-based rate: Need ~1.5 tons/acre to supply 85 lbs P_2O_5/acre
  - 63 lbs PAN/acre
  - 78 lbs K_2O/acre

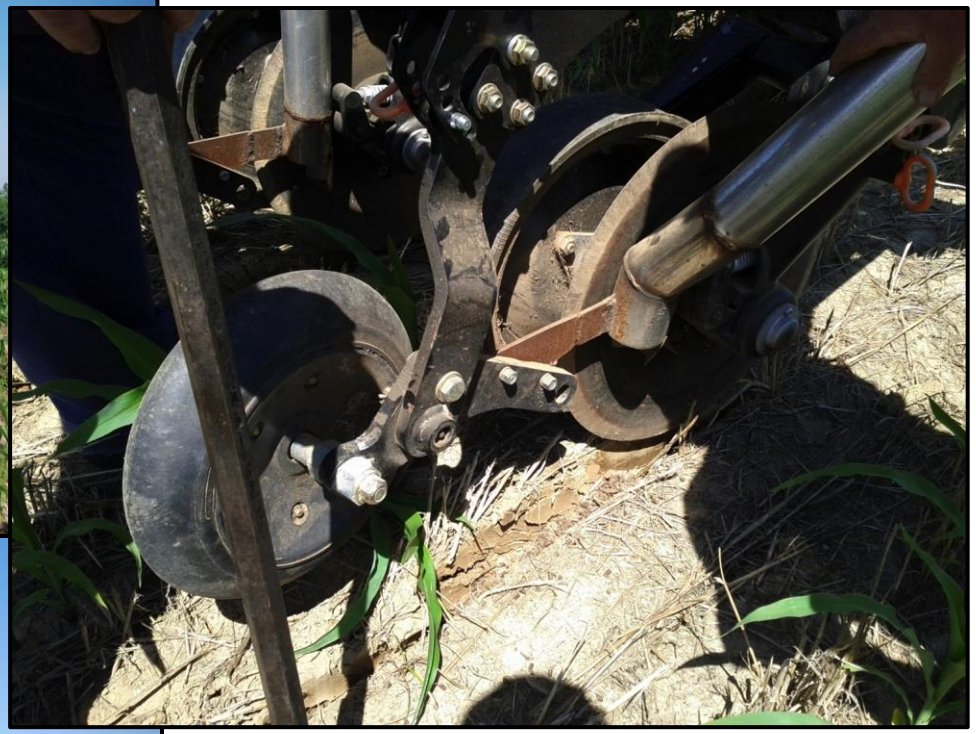
Poultry litter N availability over time



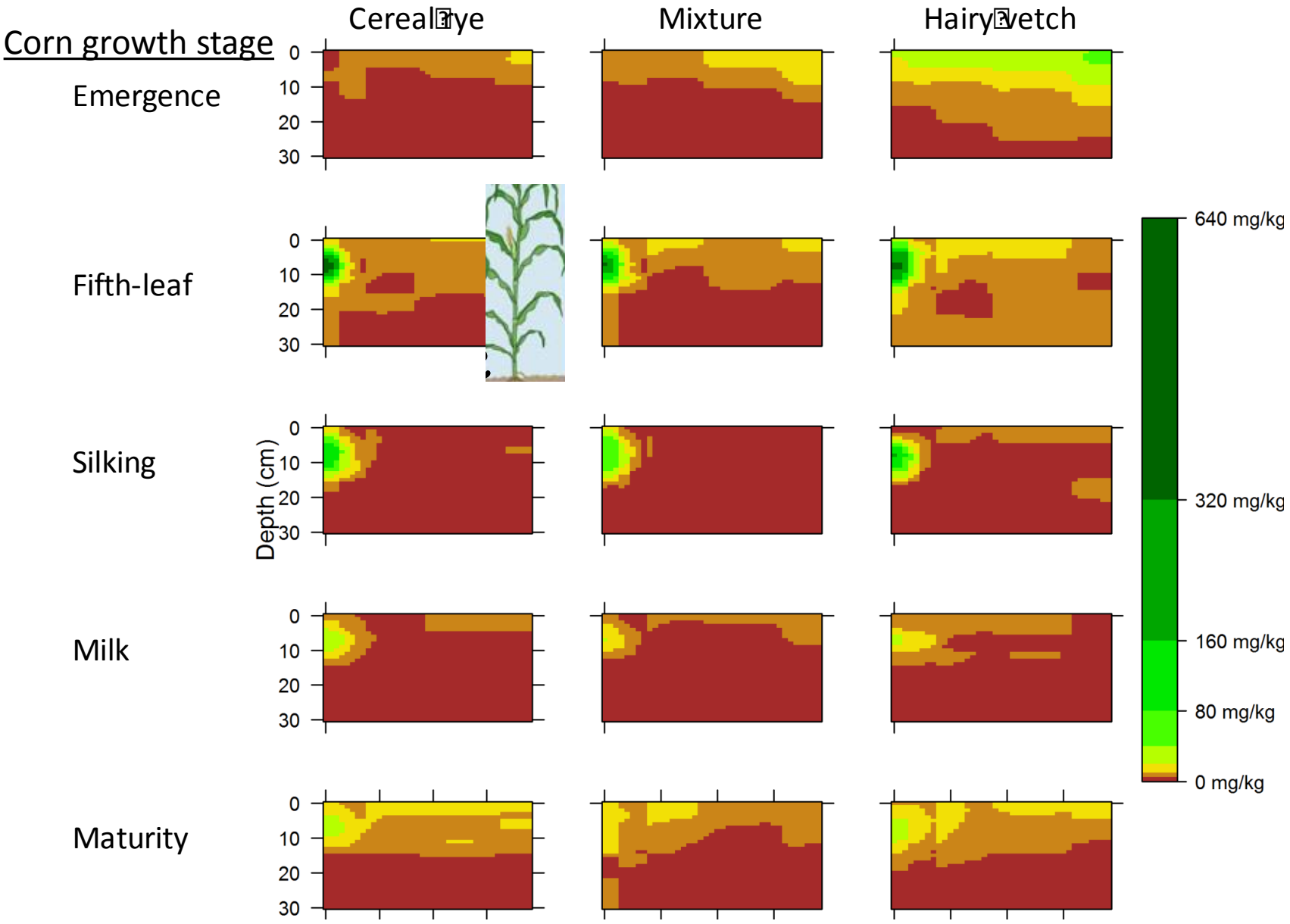
- N losses to atmosphere (~50% of NH_4-N lost)
- Nutrient losses in run-off

John Deere.com

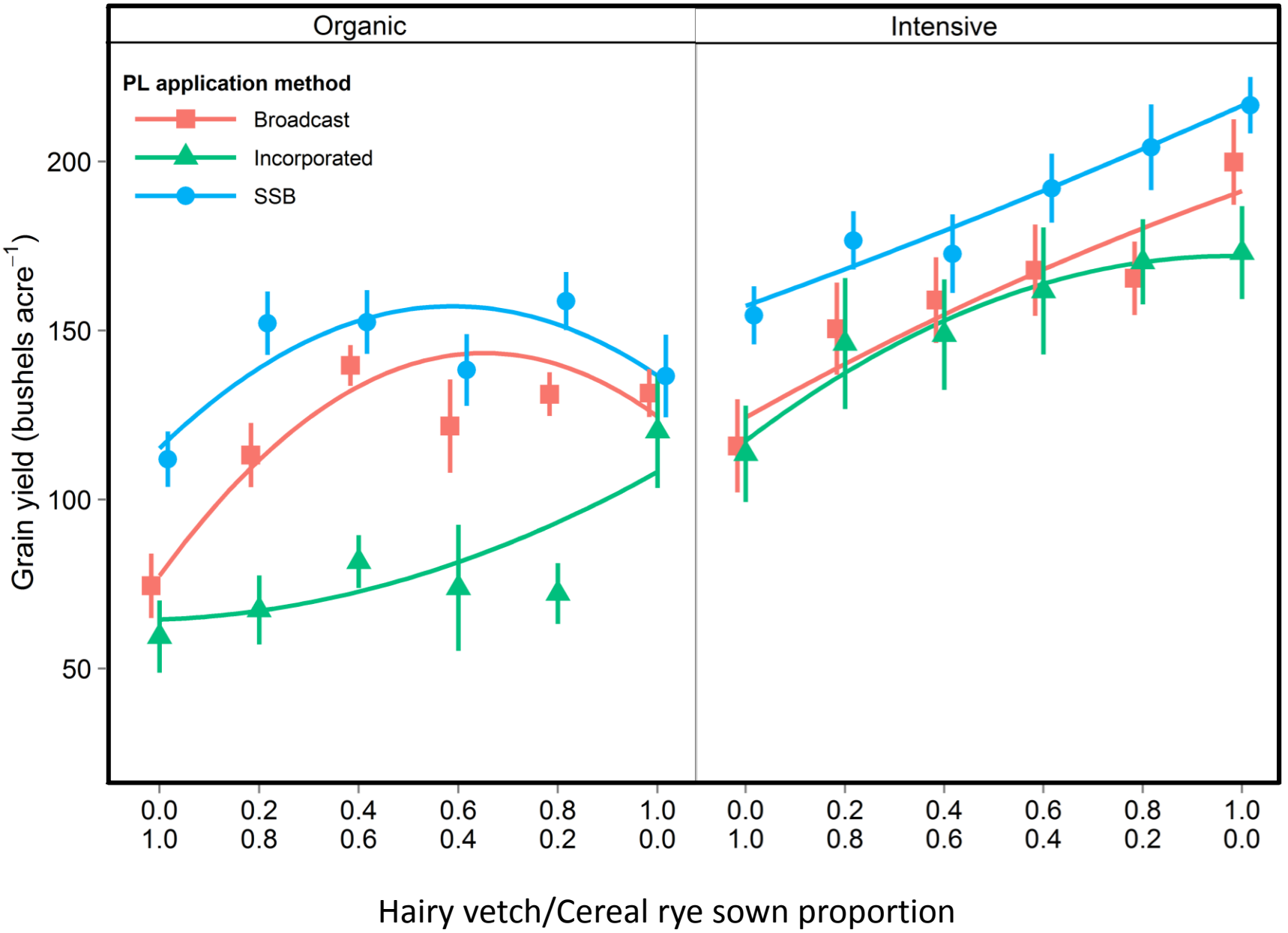
Manure subsurface band applicator



Soil inorganic N in grass/legume cover crops over time



Effect of cover crop and poultry litter application method on corn yield



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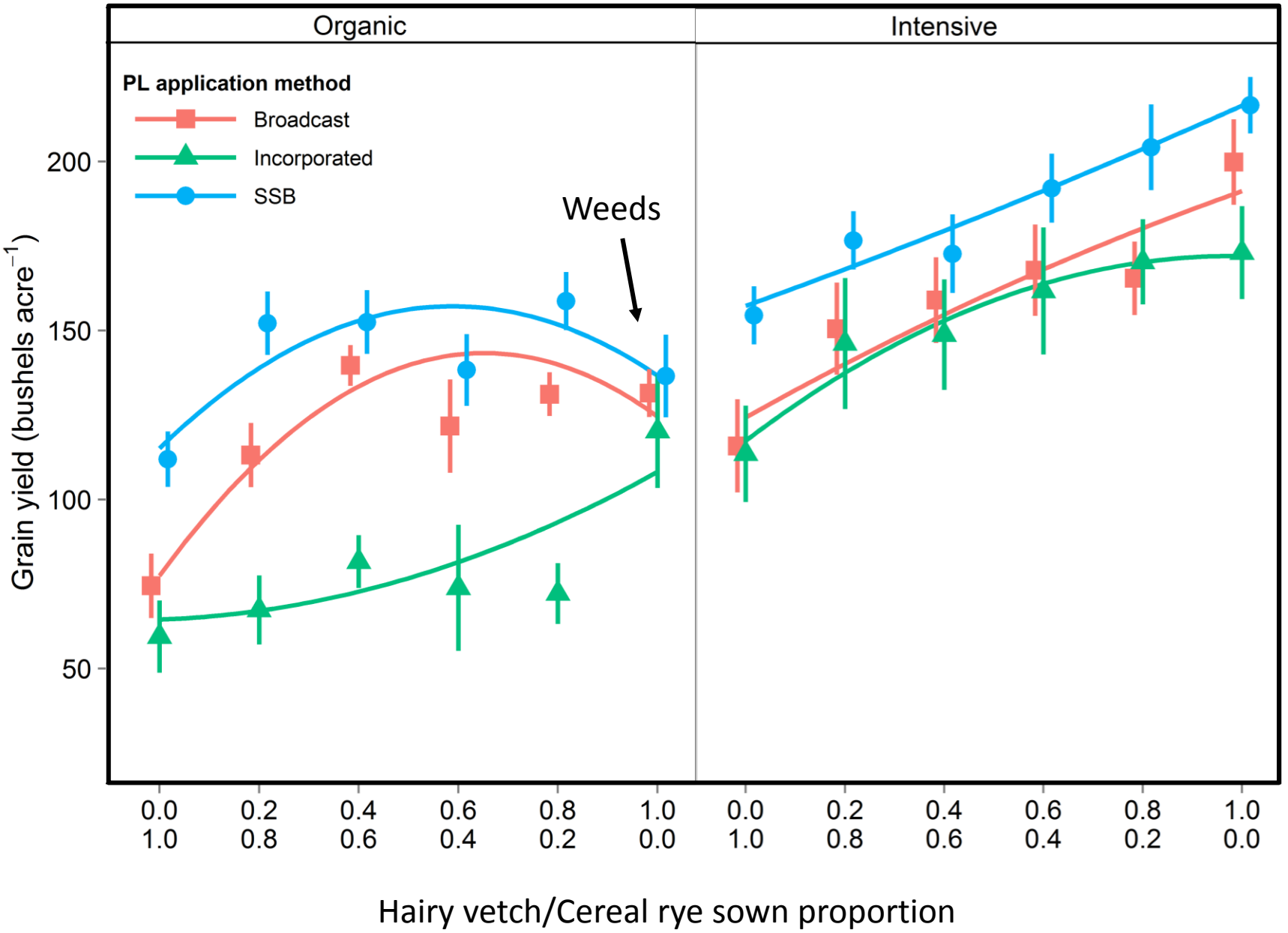
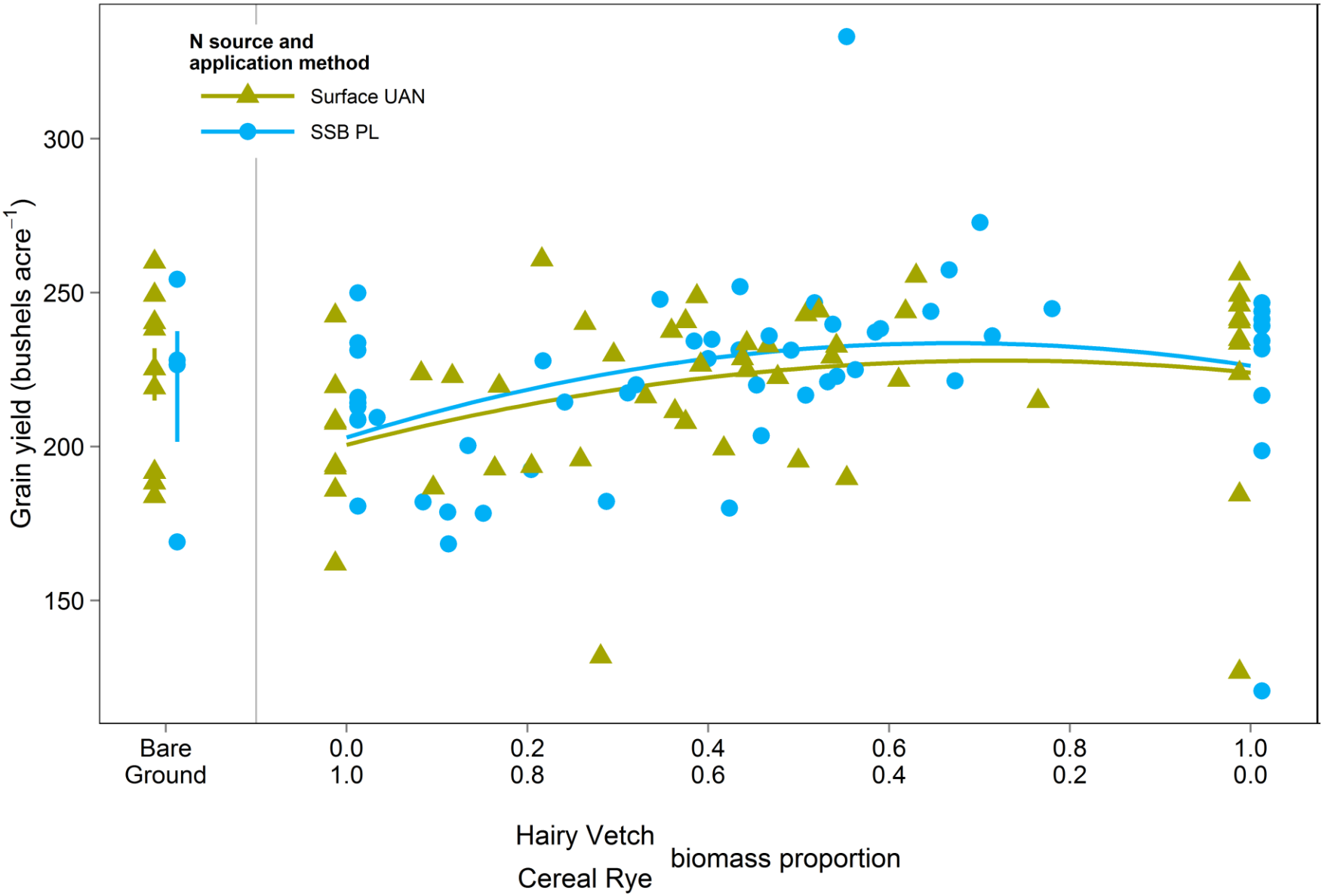


Integrated fertility management in field corn



Questions