Understanding nutrient release from cover crops

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USDA Agricultural Research Service

Agricultural Research Service
Sustainable Agricultural Systems

The spectrum of agro-ecosystem services based on cover crop biomass

Water Quality

Soil Health

Nitrogen

Biomass (Quantity and Quality)

Maximum agro-ecosystem services provisioned

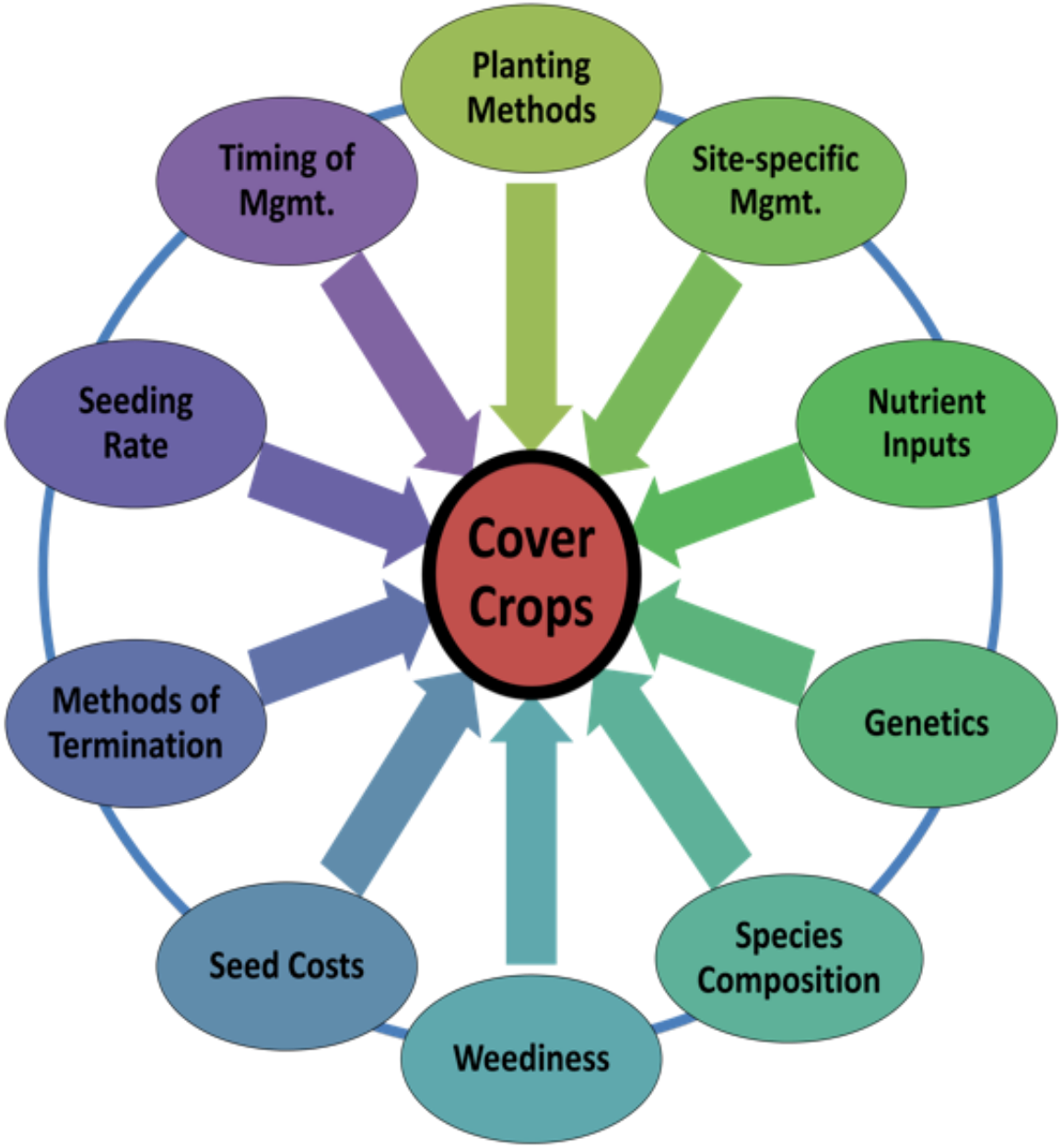
Erosion

Water Infiltration

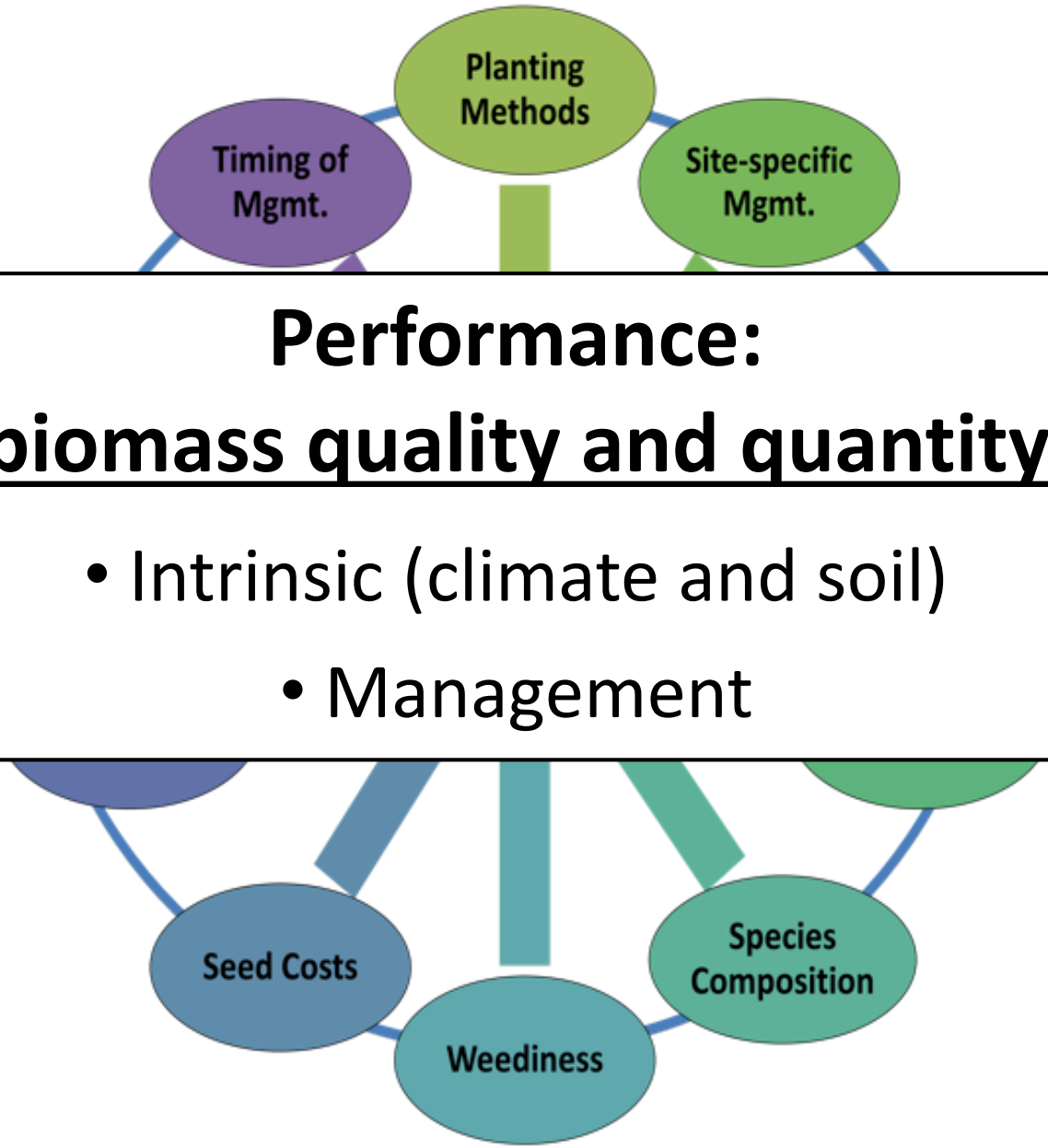
SOM

Weeds

Cover crop management drives performance



Cover crop management drives performance



Performance:

<u>(biomass quality and quantity)</u>

- Intrinsic (climate and soil)
- Management

Legumes

- Fix nitrogen
- 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

Intrinsic (climate and soil) and management

(USDA hardiness zone: 5a to 8a)

University of Massachusetts
Masoud Hashemi

Cornell
Matt Ryan

Penn State
Bill Curran and John Spargo

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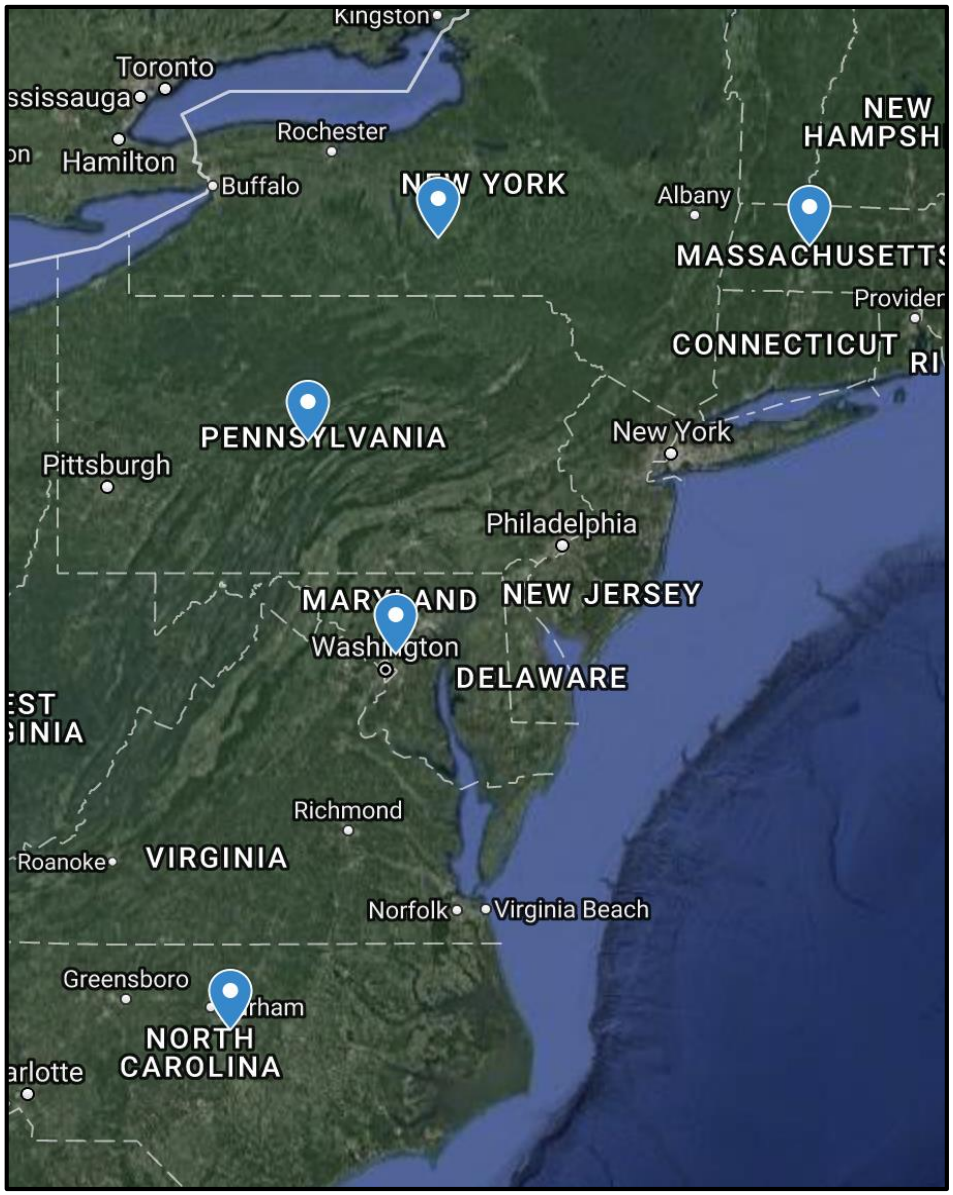
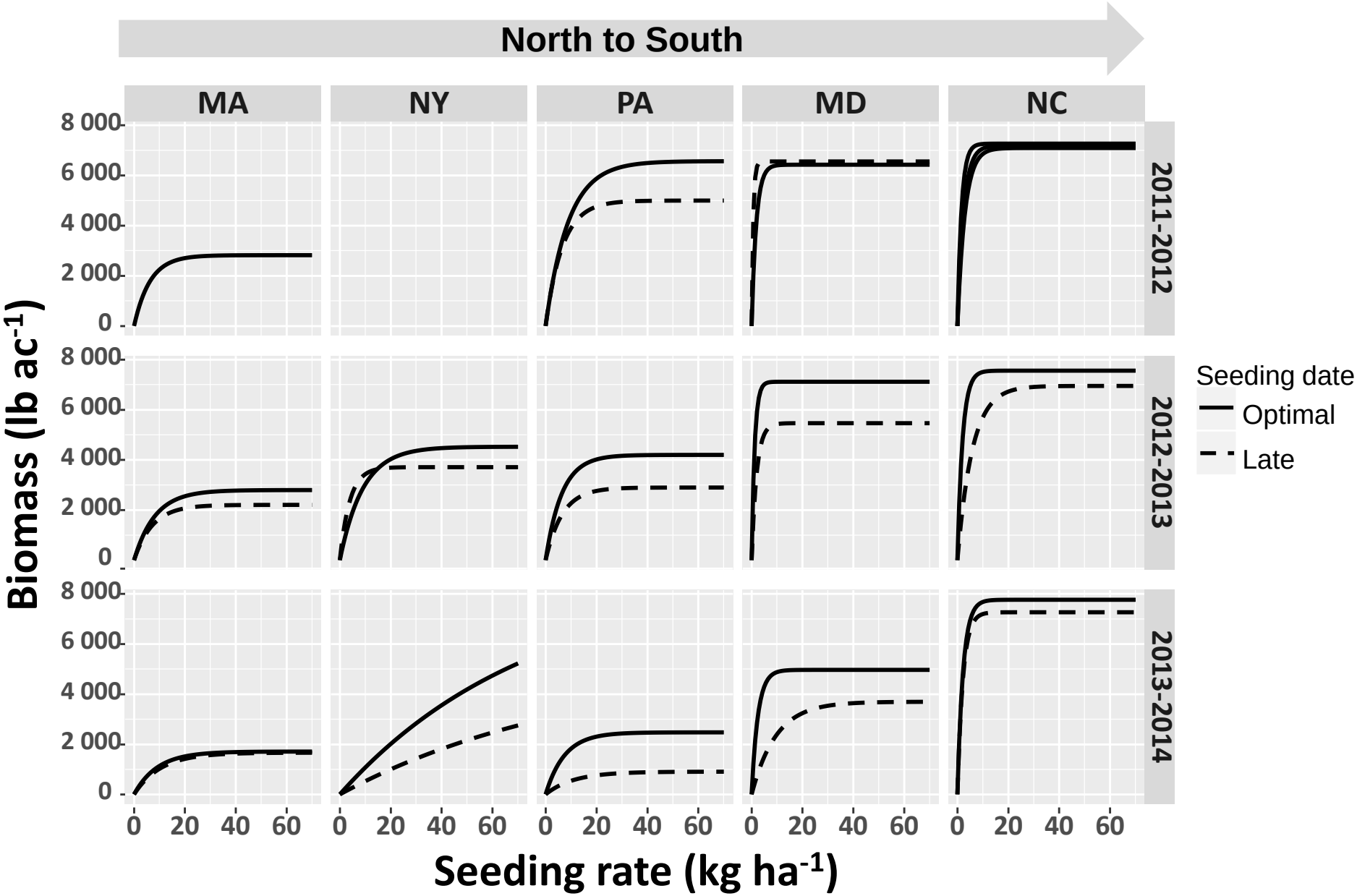
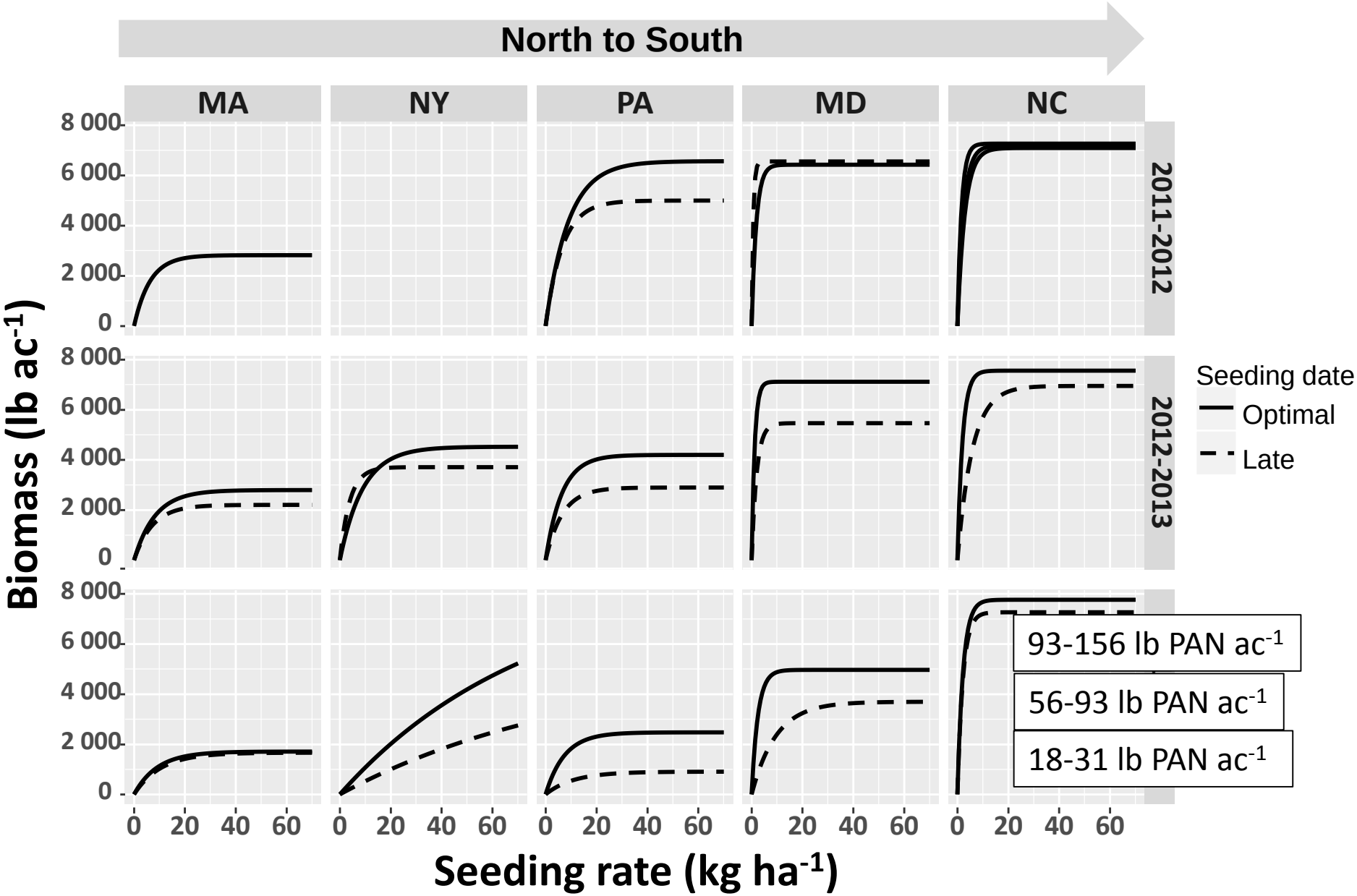
North Carolina State University
Chris Reberg-Horton



Hairy vetch biomass biomass across a seeding rate, latitude, and planting date gradient

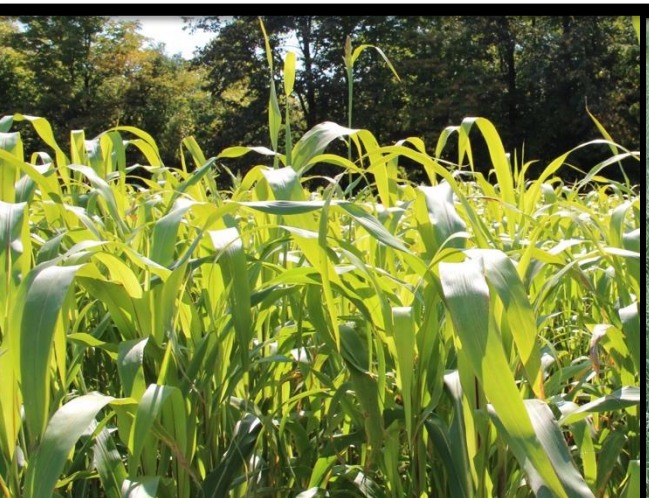


Hairy vetch biomass biomass across a seeding rate, latitude, and planting date gradient



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



Cover Crop Biomass and Nitrogen Content at Select Growth Stages

Species	Cover Crop Biomass (lb ac^{-1})			C:N
	(low range)	*(mid range)*	*(high range)*	
Grasses				
- Tillering	300-700	700-1100	1100-1500	18:1
- Stem elongation	1000-1600	1600-2400	2400-3000	24:1
- Boot	1500-2500	2500-3500	3500-4500	35:1
- Anthesis	2000-4250	4250-6750	6750-9000	50:1
Legumes				
- Early termination	1000-2000	2000-3000	3000-4000	13:1
- Mid termination	3000-4000	4000-5000	5000-6000	13:1
- Late Termination	4000-5000	5000-6000	6000-7000	13:1

*Grasses include wheat, rye, barley, and triticale;
Legumes is hairy vetch and some averaging from clovers

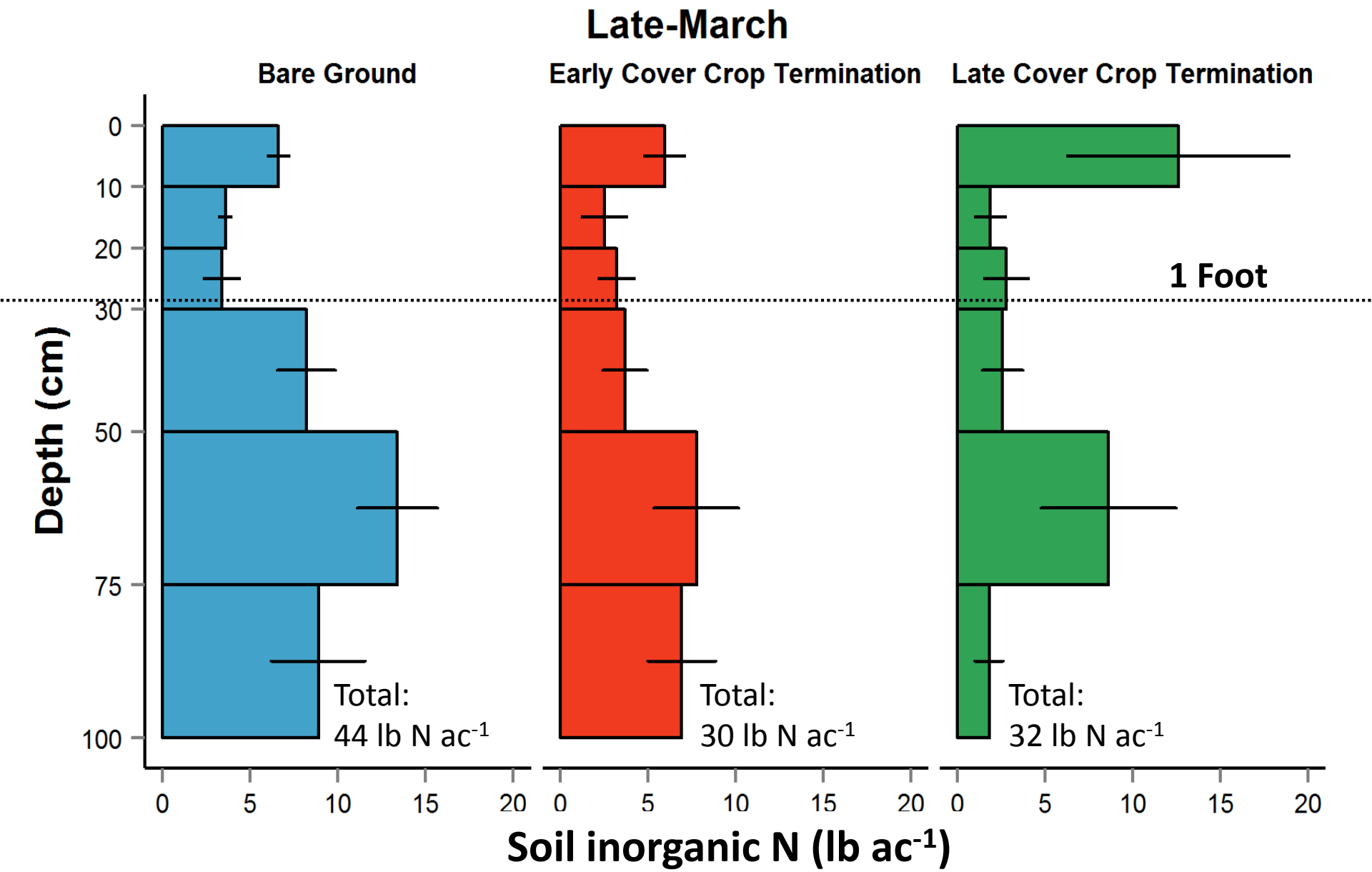
Cereal rye (*Secale cereale*)

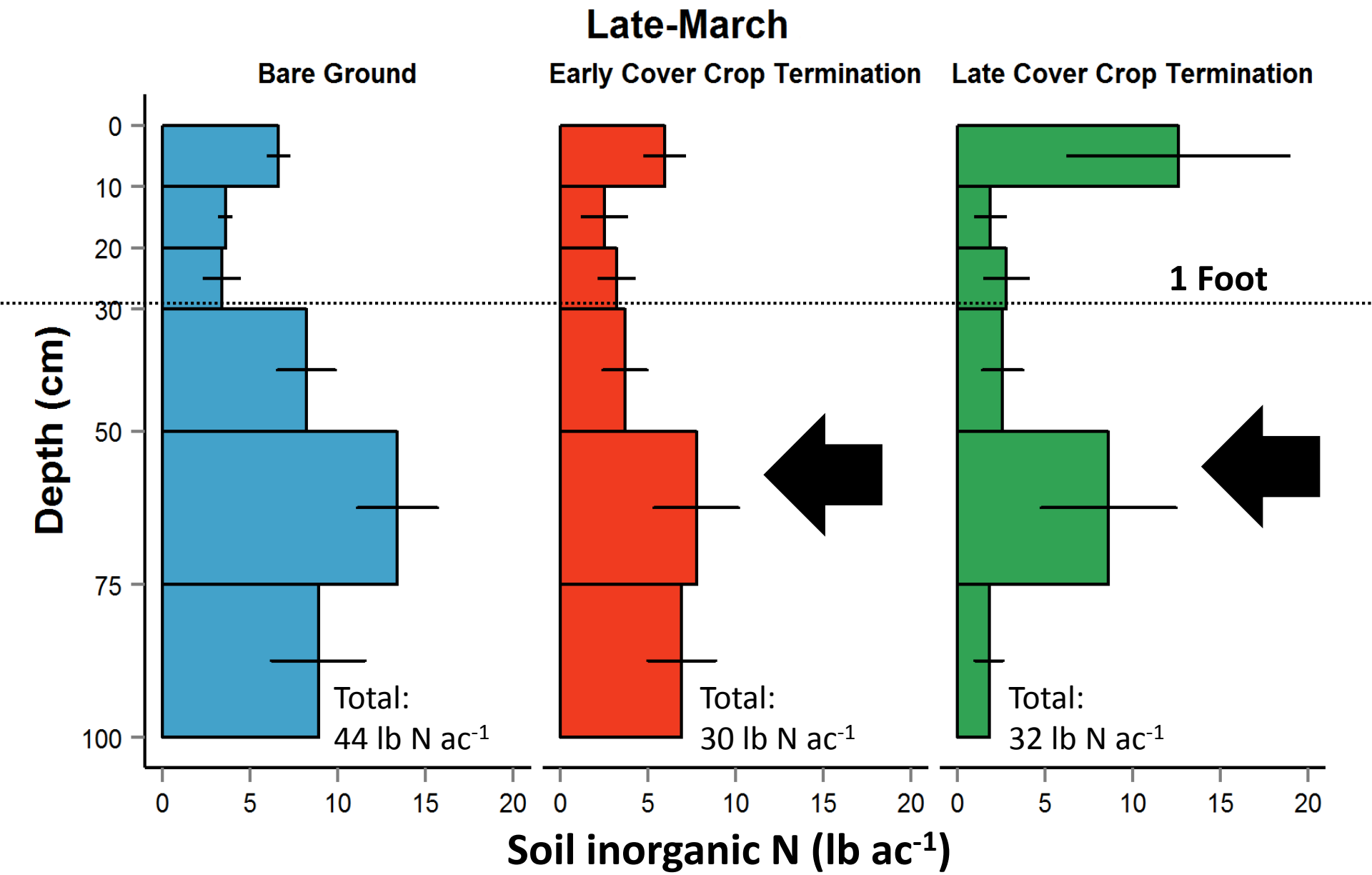
Early Termination

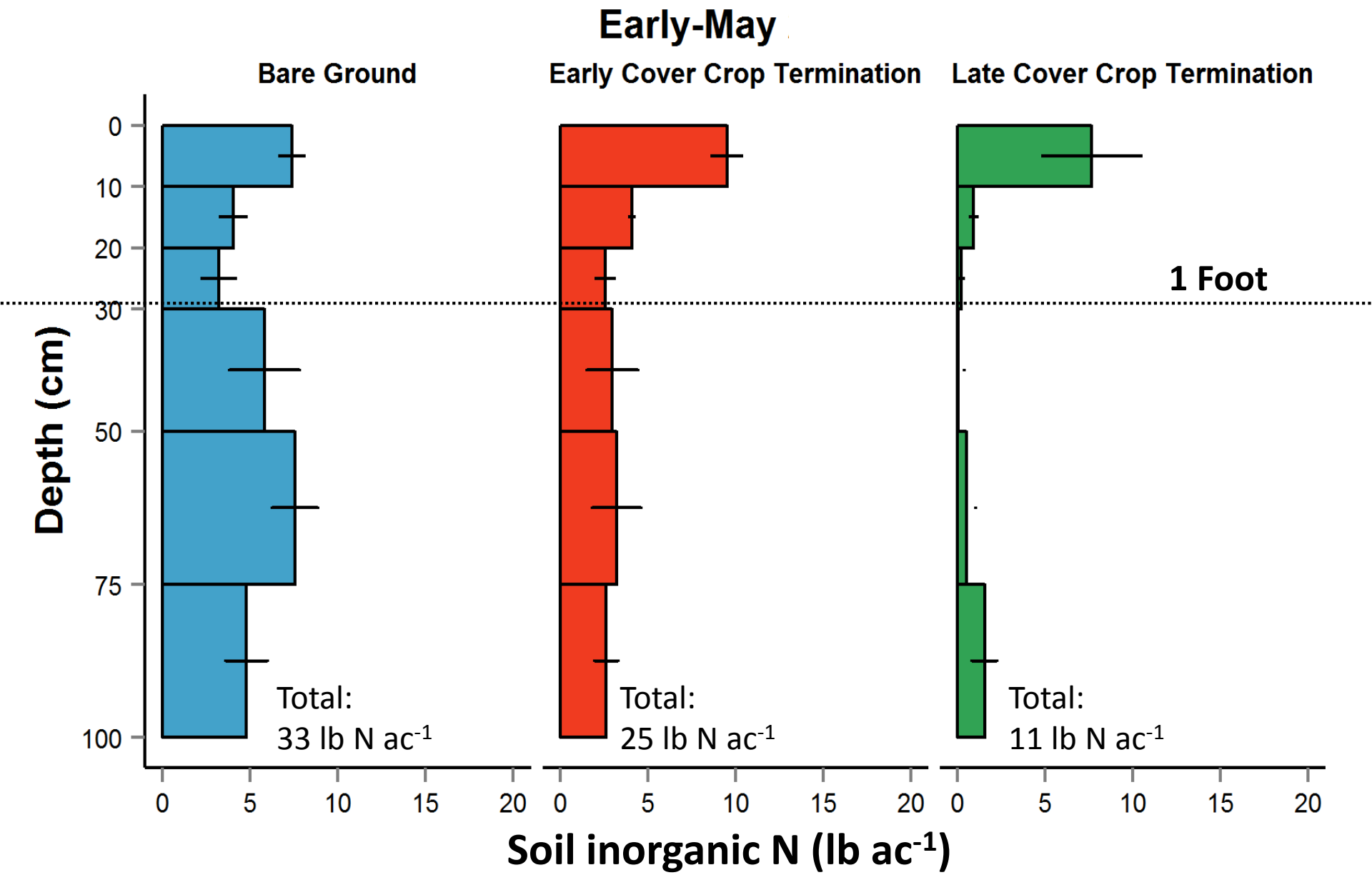
- Low C/N ratio (~27:1)
- Mineralization
- Grown ~7 months
- Terminated early spring

Late Termination

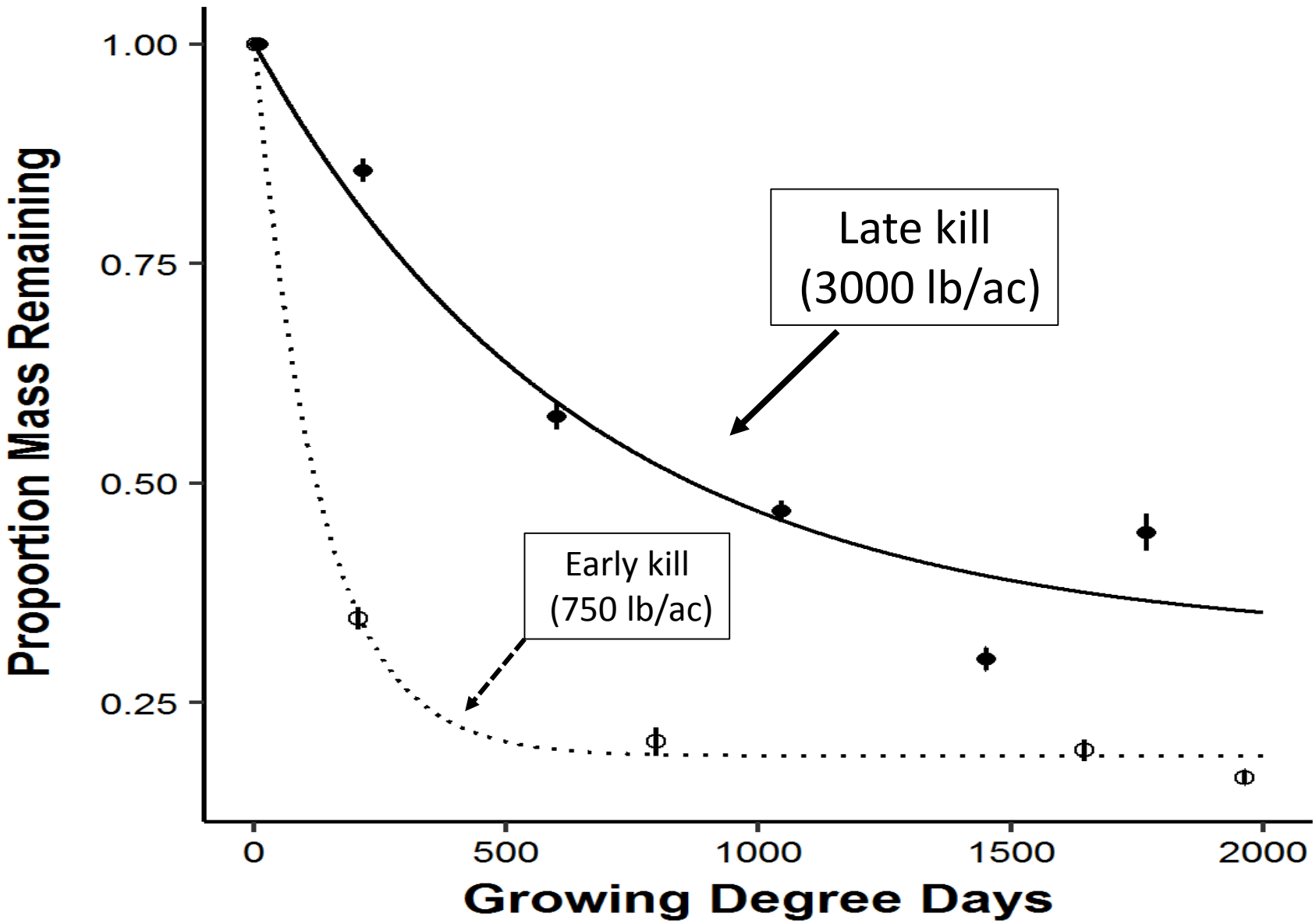
- High C/N ratio (~48:1)
- Immobilization
- Grown ~8 months
- 2.5x more biomass
- Terminated late spring


Late-March
Bare Ground
Early Cover Crop Termination
Late Cover Crop Termination
Depth (cm)
0
10
20
30
50
75
100
1 Foot
Total:
44 lb N ac-1
Total:
30 lb N ac-1
Total:
32 lb N ac-1
0
5
10
15
20
Soil inorganic N (lb ac-1)

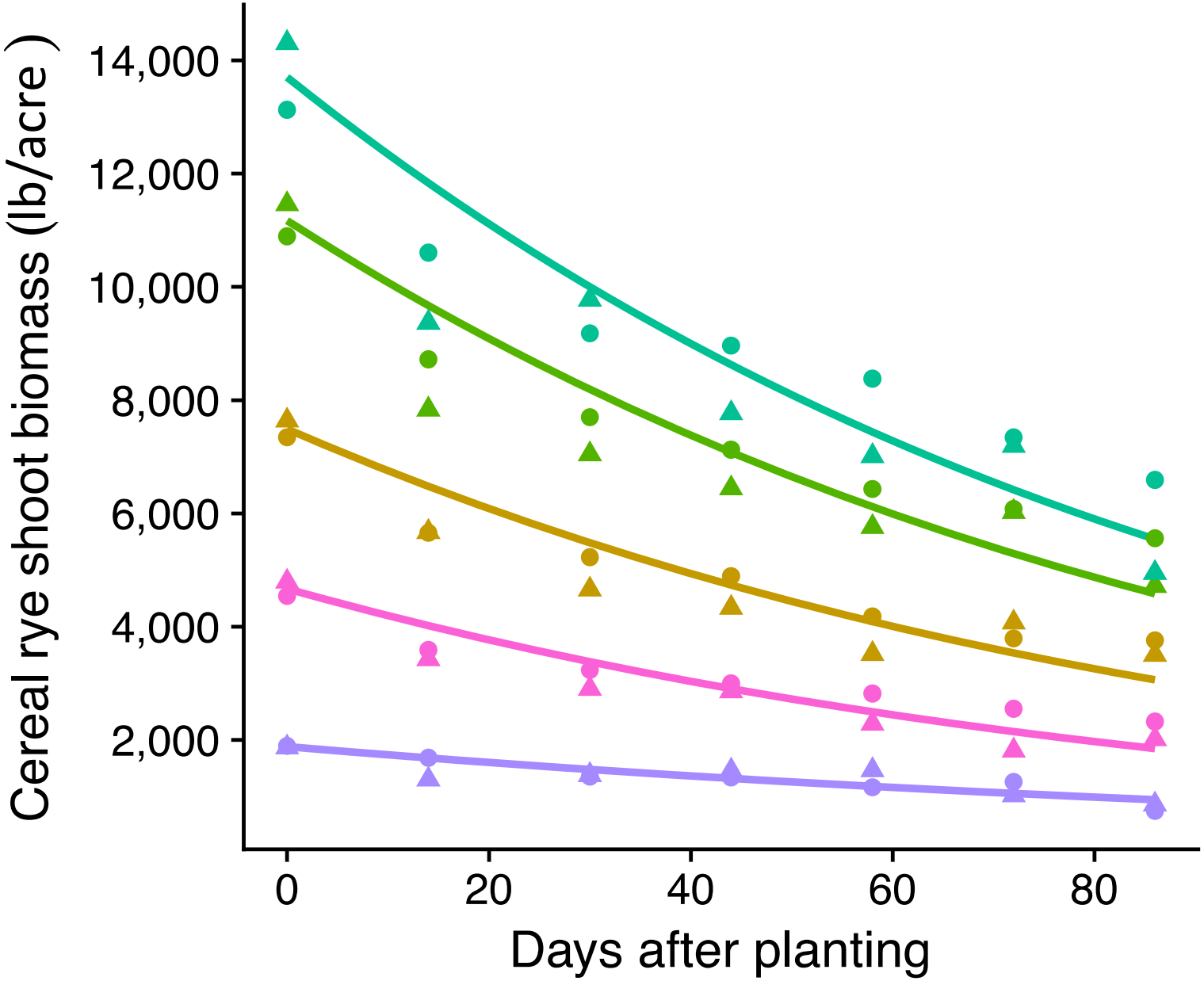

Late-March
Bare Ground
Early Cover Crop Termination
Late Cover Crop Termination
Depth (cm)
0
10
20
30
50
75
100
1 Foot
Total:
44 lb N ac-1
Total:
30 lb N ac-1
Total:
32 lb N ac-1
0
5
10
15
20
Soil inorganic N (lb ac-1)


Early-May
Bare Ground
Early Cover Crop Termination
Late Cover Crop Termination
Depth (cm)
0
10
20
30
50
75
100
1 Foot
Total:
33 lb N ac-1
Total:
25 lb N ac-1
Total:
11 lb N ac-1
0
5
10
15
20
Soil inorganic N (lb ac-1)

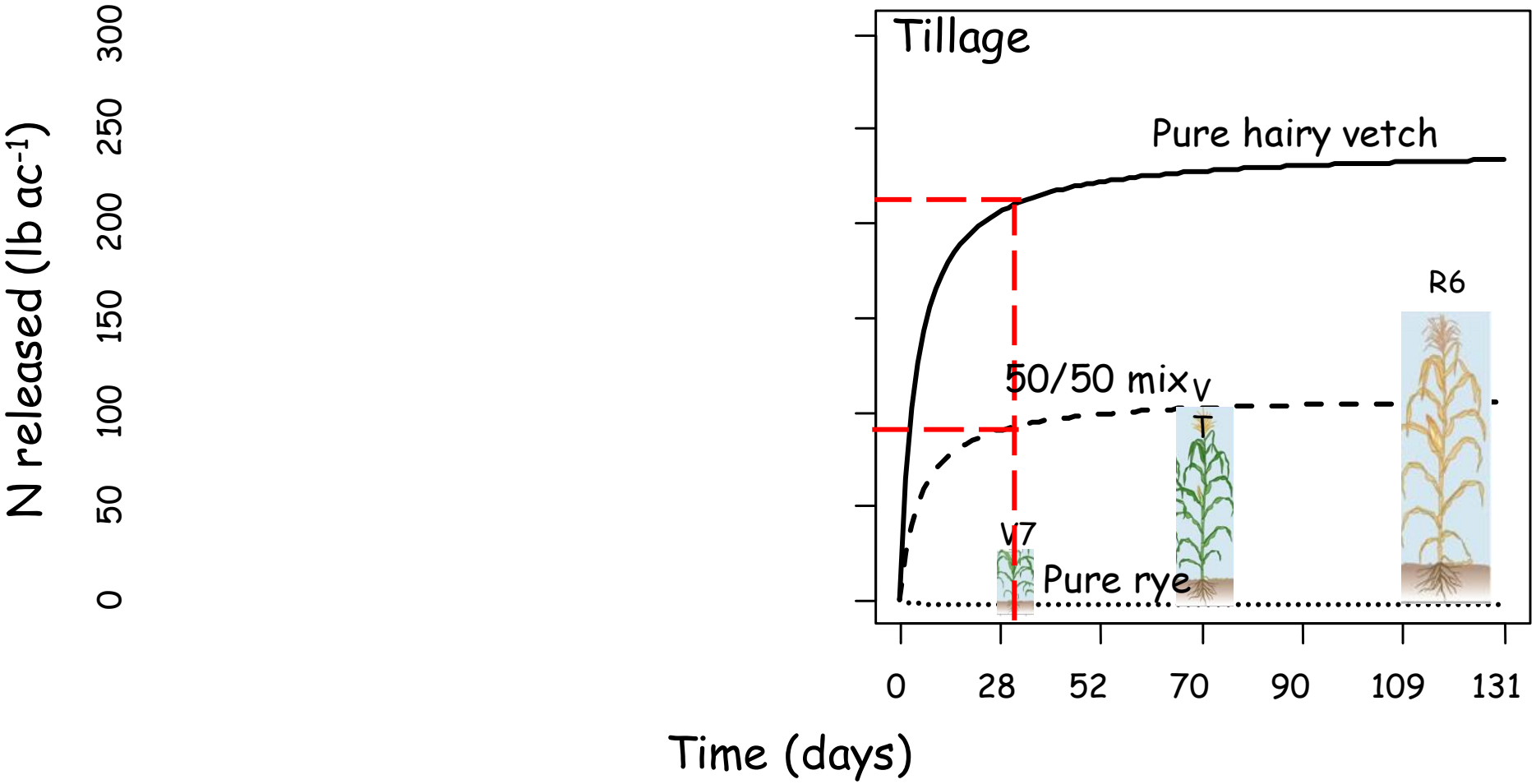
Cereal rye decomposition in field corn



Cereal rye decomposition



Nitrogen release over time



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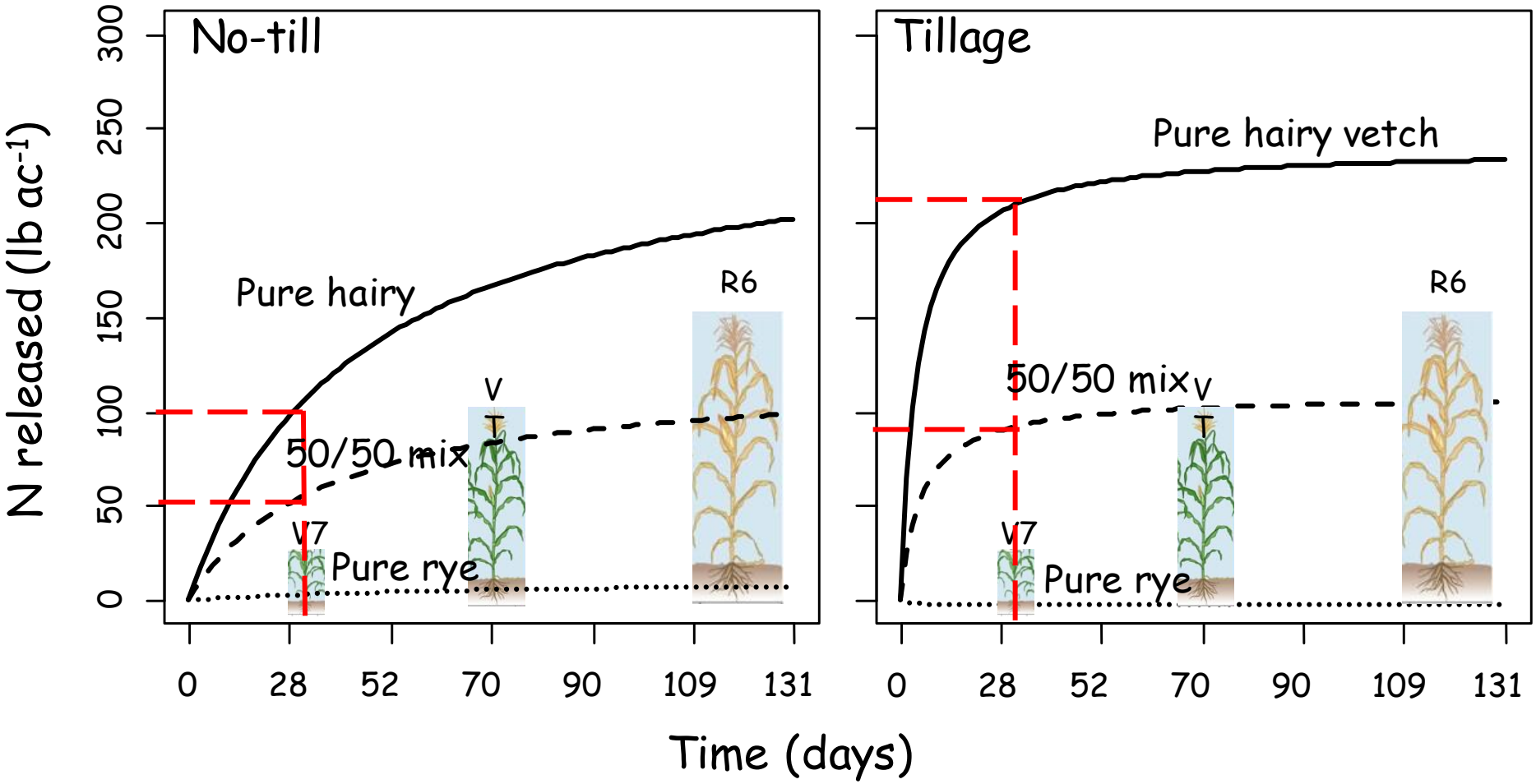
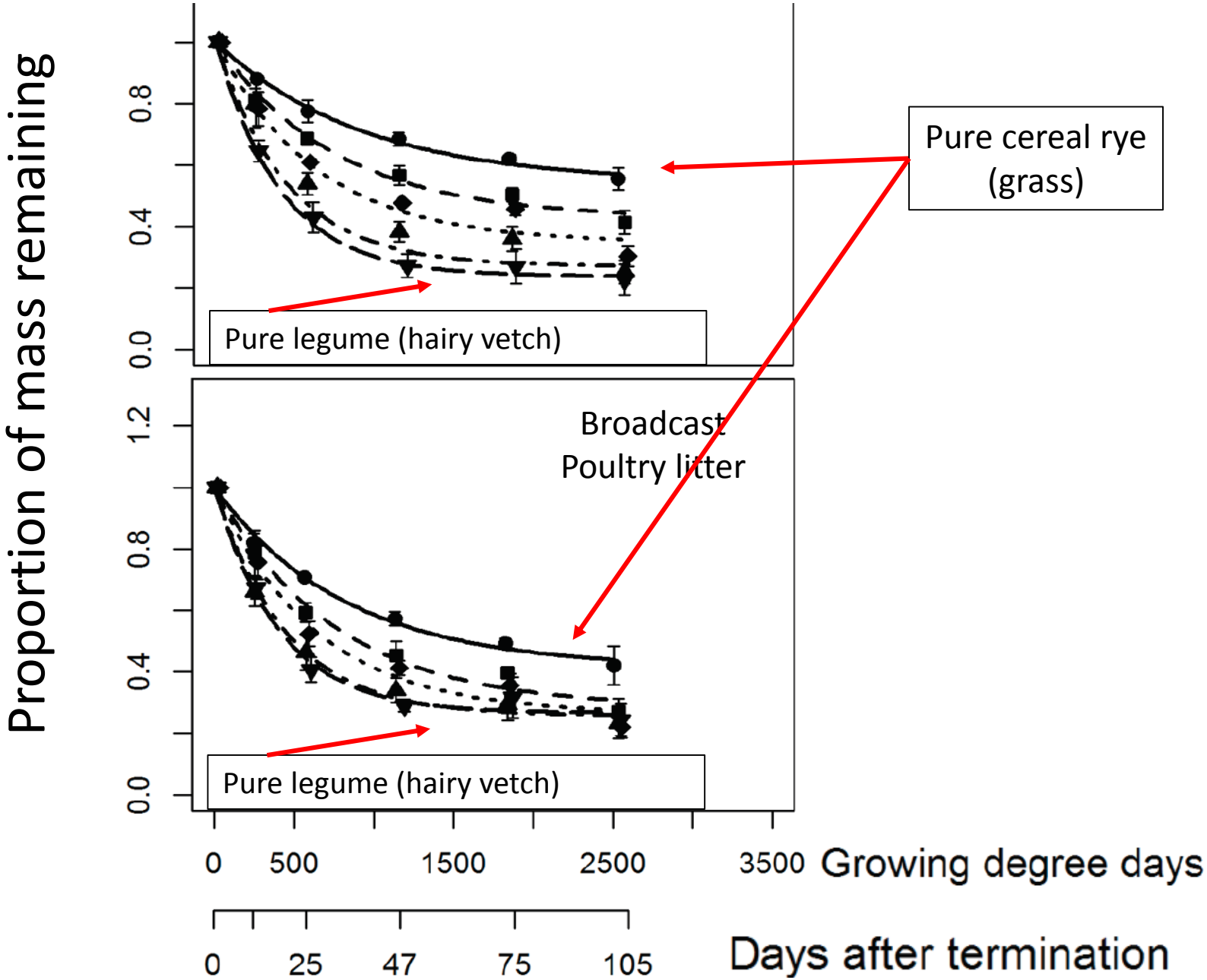


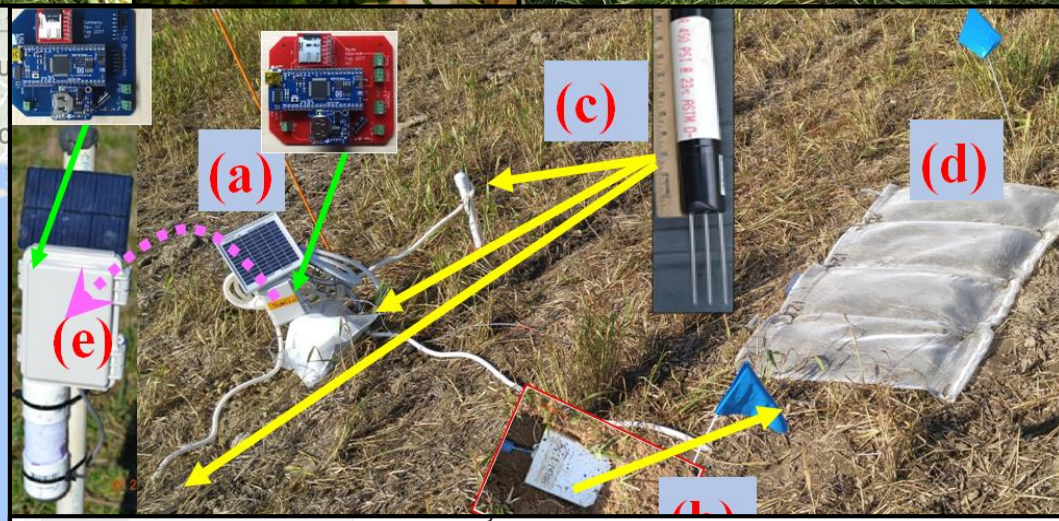
Decomposition of grass:legume cover crop mixtures

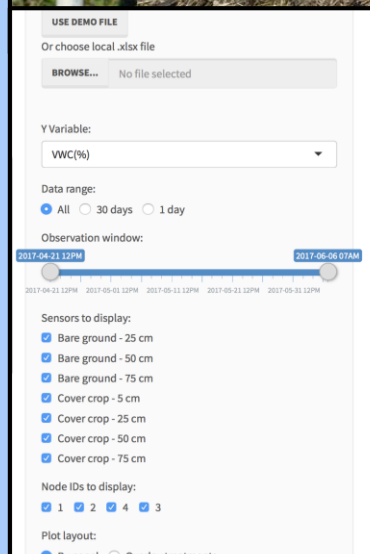


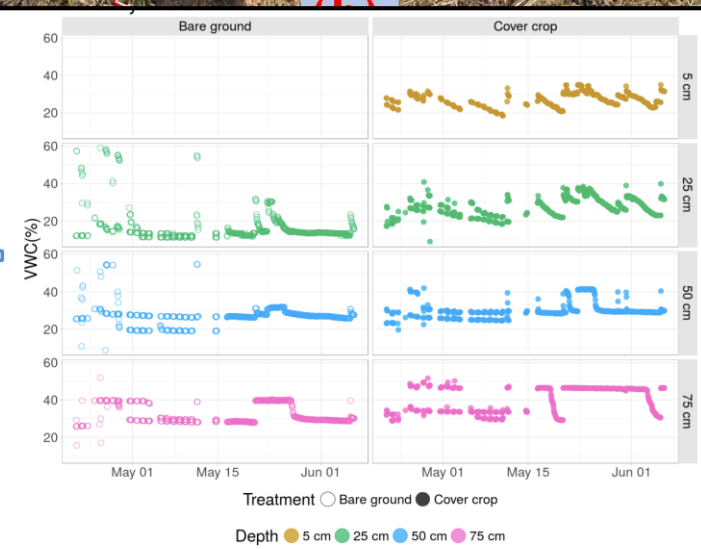
Decision support tools for adaptive nitrogen management

Adapt-N & N Availability Calculator

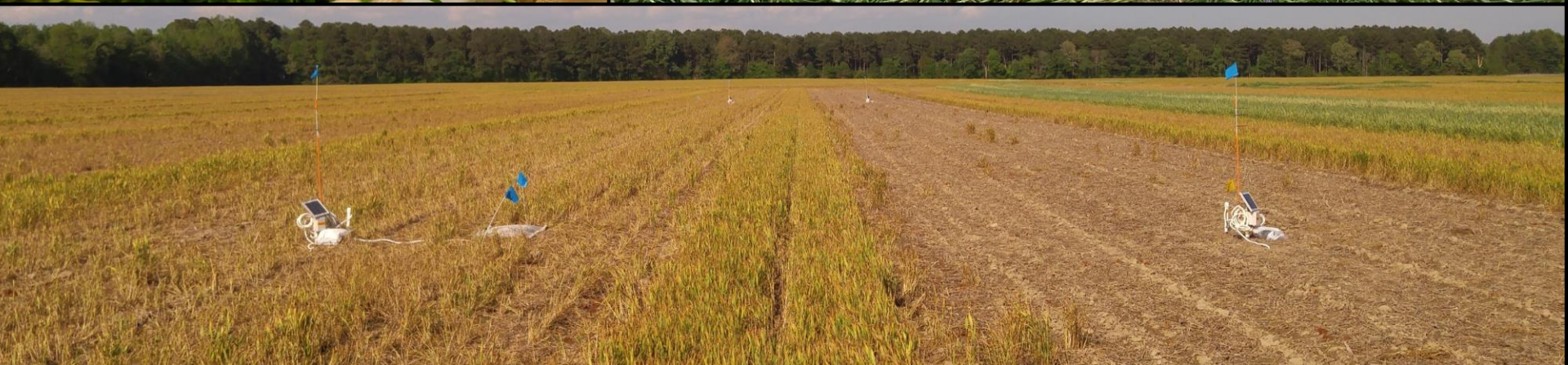
Water and Nitrogen Dynamics on mid-Atlantic and Southeastern Farms







Water and Nitrogen Dynamics on mid-Atlantic and Southeastern Farms



Calculator Outputs

COVER CROP NITROGEN AVAILABILITY CALCULATOR

CALCULATOR | INSTRUCTIONS | CONTACT

If you need instructions, click the **Instructions** tab above.

Please answer the questions below and click "Next Page" when complete.

Background

Was the cover crop residue analyzed by the Agricultural and Environmental Services Labs? • If so, please enter the Lab Number. • IF NOT, leave blank and enter data from another laboratory in the section below.	1567 Lab No.
Please enter the field name	Front Field
Enter the sample ID	1
To choose the closest weather station, what county is your farm located in? (OR Choose from interactive map.)	Clarke Using weather station at: **Horticulture Research Farm**
What is the CASH crop?	Select a crop Broccoli
What is your target nitrogen fertilizer rate?	150 lbs N/acre
What is the planting date?	08/24/2015 mm/dd/yyyy
What is the COVER CROP?	Select one or more cover crops Cowpeas
When was the cover crop killed or incorporated?	08/01/2015 mm/dd/yyyy

UGA extension

Calculator Outputs

COVER CROP NITROGEN AVAILABILITY CALCULATOR

CALCULATOR | INSTRUCTIONS | CONTACT

RESULTS: Wide Bottom Farm — Front Field - 1

Your cover crop Cowpeas was terminated on 08/01/2015.

The cover crop is predicted to release 72 lbs of N per acre from the aboveground biomass over three months. This is a N credit.

The cover crop is predicted to release:

- 29 lbs of N per acre in the first **two** weeks after termination.
- 59 lbs of N per acre in the first **four** weeks after termination.

Your target nitrogen fertilizer rate was 150 lbs N/ac.

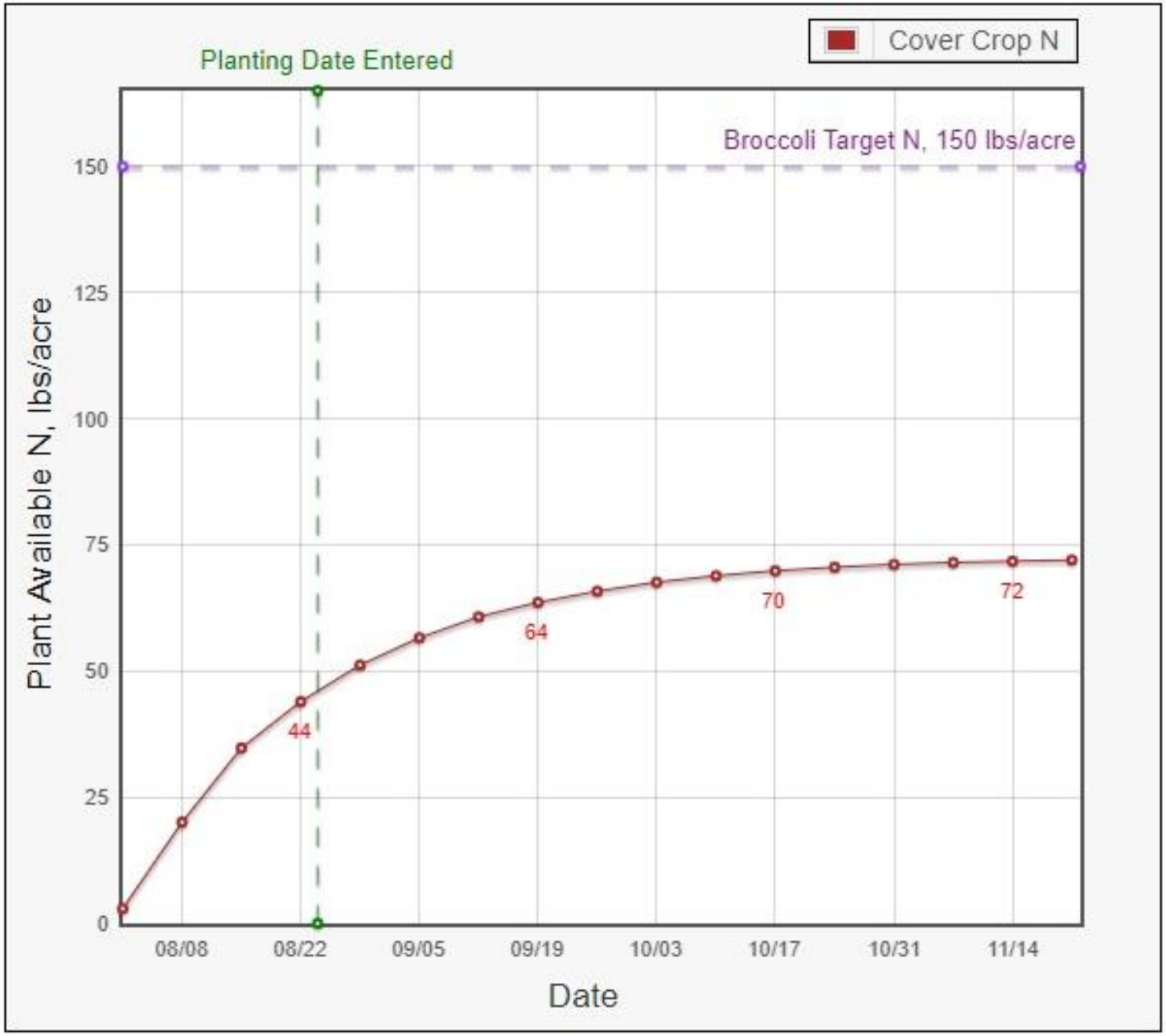
Your recommended N after the cover crop is 78 lbs N/ac.

The available N reported above from the cover crop decompositions is considered a N credit if positive or a debit if negative. The amount of N fertilizer recommended may be reduced by a credit or increased by a debit. Here are examples:

N Credit Example:	N Debit Example:
Recommended or Target N = 150 lbs N/ac	Recommended or Target N = 150 lbs N/ac
Predicted Cover Crop N = 50 lbs N/ac	Predicted Cover Crop N = - 20 lbs N/ac
Recommended N after Credit = 150 - 50 = **100** lbs N/ac	Recommended N after Debit = 150 - (-20) = 150 +20 = **170** lbs N/ac

UGA extension

Calculator Outputs



Questions