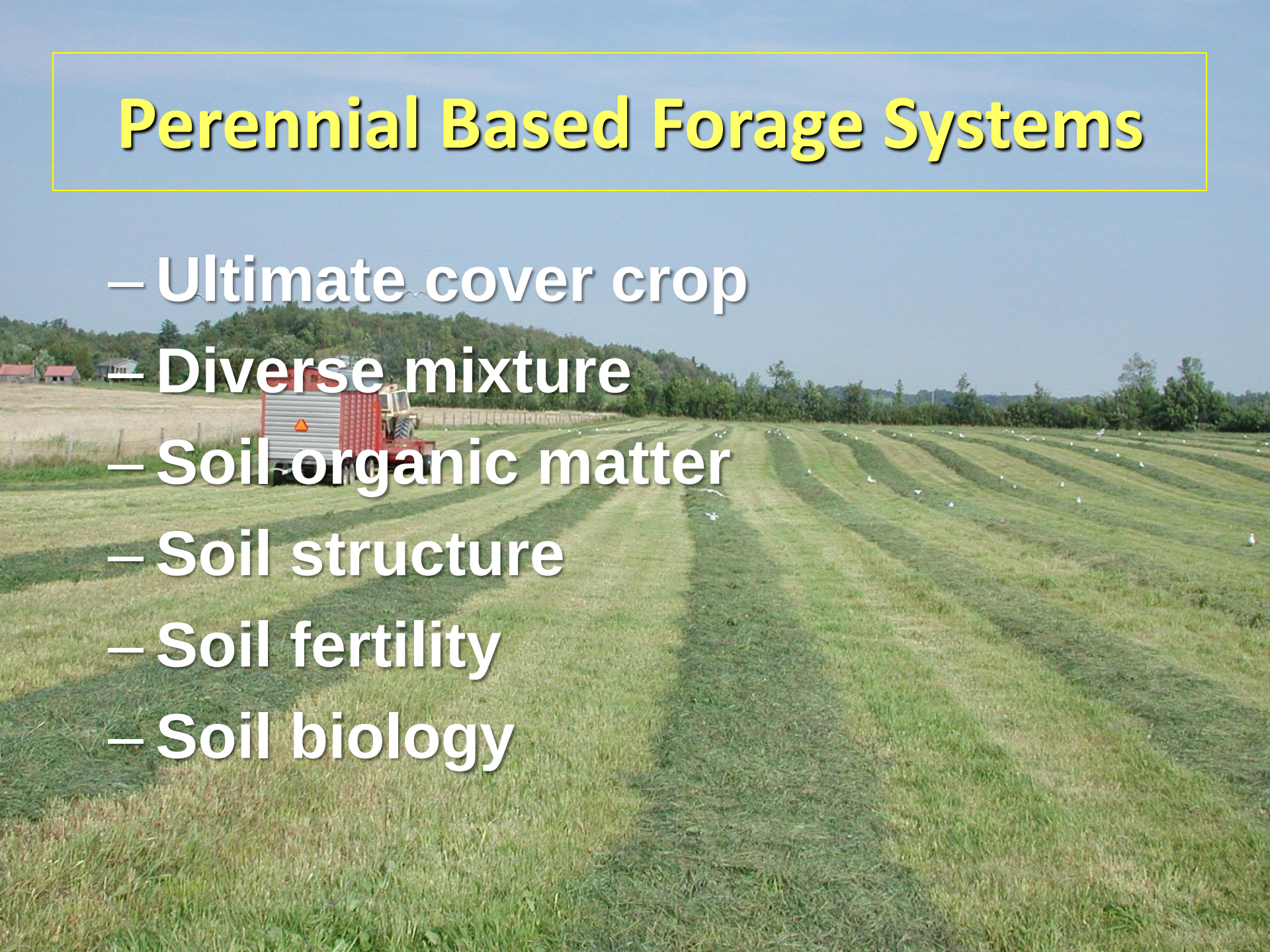
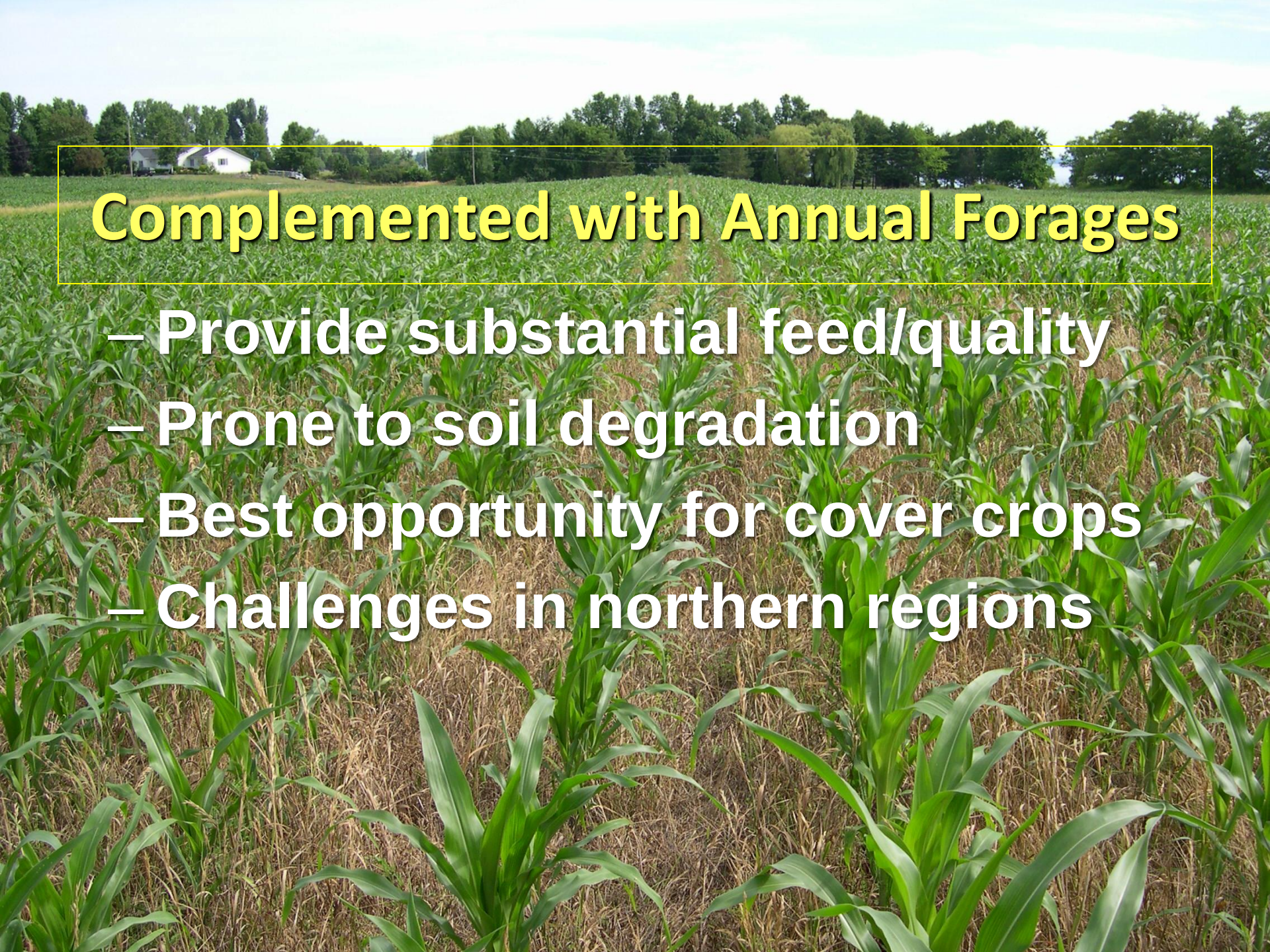

Cover
Cropping in
Dairy Systems
669

Perennial Based Forage Systems



- Ultimate cover crop
- Diverse mixture
- Soil organic matter
- Soil structure
- Soil fertility
- Soil biology



Complemented with Annual Forages

- Provide substantial feed/quality
- Prone to soil degradation
- Best opportunity for cover crops
- Challenges in northern regions


Cover Crops as Annual Forages

On-Farm Organic Matter


Opportunity for Cover Crops
&
Improved Rotations

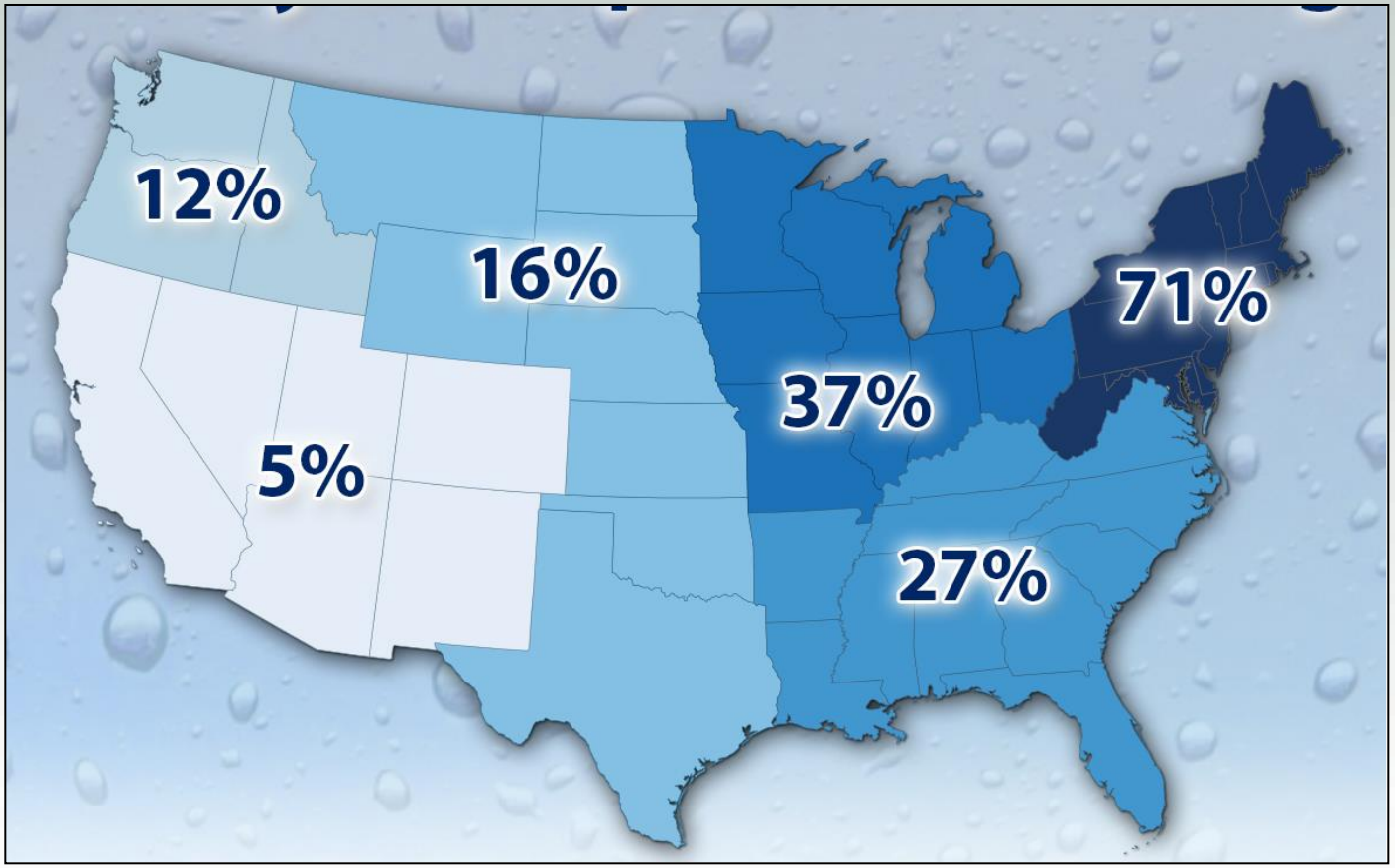
Crop Rotation

A common farming practice where different series of crops are planted in the same area each sequential season.

Today may also include crops grown in the off-season (cover crops).


Monoculture Annual Crops & Tillage
Tough on the Soil

Trends in Extreme Precipitation



Increase in the number of 2” rainfalls per year from 1958 to 2011

What Happens When What Once Worked Doesn't Work Anymore?

USDA Natural Resources Conservation Service

Soil Fact Sheet

Franklin County, Vermont

MuB: Munson silt loam, 3 to 8 percent slopes

MUNSON SOILS formed in loamy over clayey glaciolacustrine deposits on lake plains. They are very deep to bedrock and somewhat poorly drained. These soils have a perched water table at depths of 0.5 to 2.0 feet below the surface from late Fall through early Summer. Permeability is moderate in the surface layer, moderately slow to moderate in the subsoil and slow in the substratum.

This map unit is suited to cultivated crops. It is well suited to hay and pasture. Erosion is a hazard. A seasonal high water table may inhibit the establishment of some crops.

Important Farmland Classification: Statewide	Land Capability: 3 w	Vermont Agricultural Value Group: 4d

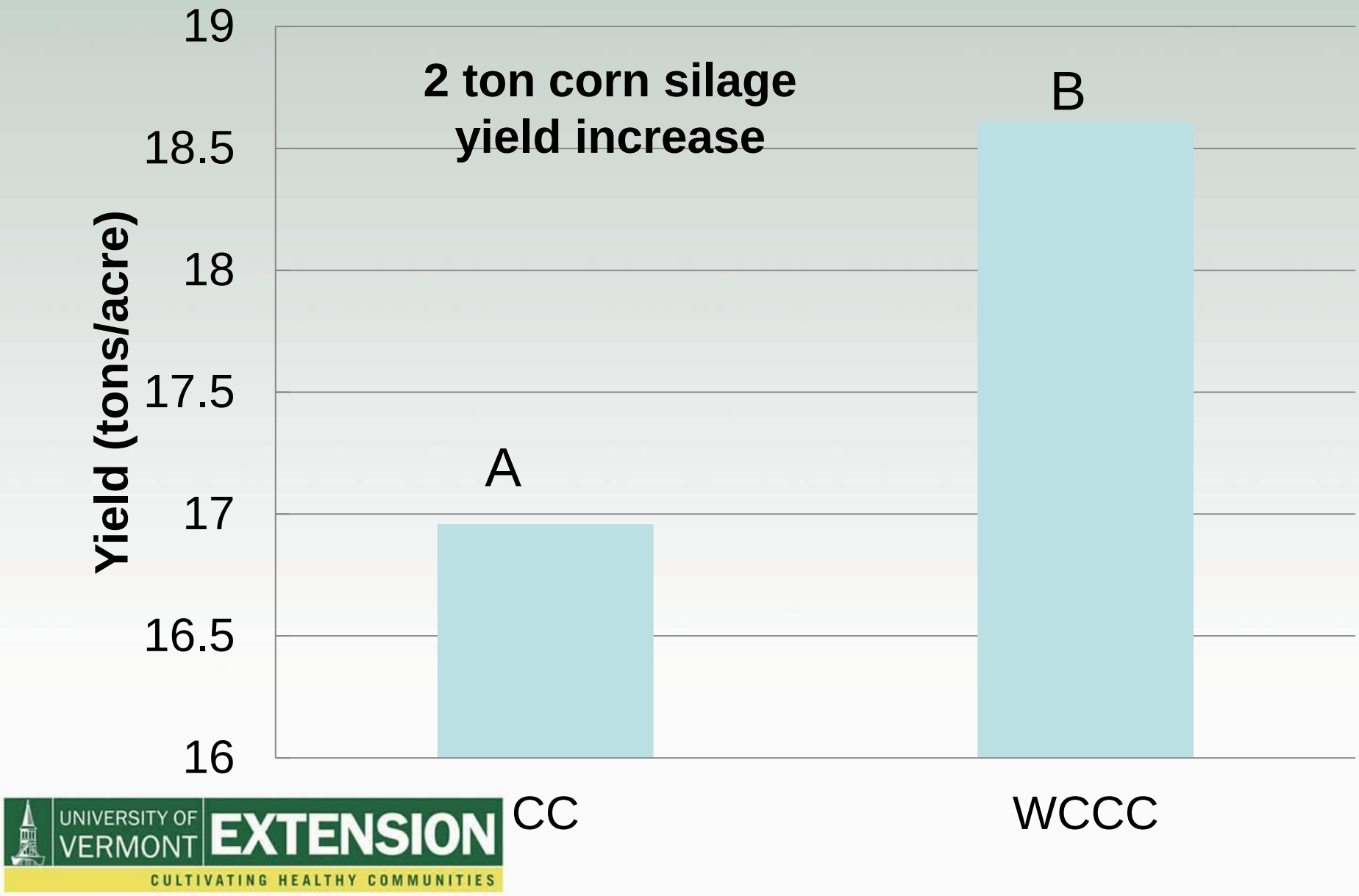
Vermont Residential On-site Waste Disposal Group and Subgroup:

IIIc.- This unit is marginally suited as a site for on-site sewage disposal, based on a review of criteria set forth in the Vermont 2002 Environmental Protection Rules. The depth to the seasonal high water table in association with the minimal slope is the major limitation. A detailed, site-specific analysis is generally required. On-site groundwater level monitoring and determination of induced groundwater mounding is often necessary to establish the suitability of this unit. Curtain drains may help lower the water table to an acceptable level, however, the minimal slope may prevent their use in many areas.

	PHYSICAL and CHEMICAL PROPERTIES						EROSION FACTORS		
Soil Name	Depth (In)	Typical Texture	Clay (Pct)	Soil Reaction (pH)	Permeability (In/Hr)	Organic Matter (Pct)	Kw	Kf	T
Munson	0-8	SIL	3-10	5.6 - 6.5	0.6-2	3.0-10	.49	.49	2
	8-14	SIL	3-16	5.6 - 6.5	0.2-2	0.5-3.0	.49	.49	
	14-40	SICL	35-60	5.6 - 7.3	0.0000-0.2	0.0-1.0	.49	.49	

	WATER FEATURES				SOIL FEATURES	
Soil Name	Hydrologic Group	Depth to Seasonal High Water Table (Feet)	Flooding		Hydric Soil?	Depth to Bedrock (range in inches)
			Frequency	Duration		
Munson	D	0.5-2.0	None		No	---

Corn cropping system	Yield at 35 DM t ac^{-1}
CC	16.98
NC	22.72*
NT	16.54
WCCC	20.40*
LSD (0.10)	2.5
Trial mean	16.16



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CULTIVATING HEALTHY COMMUNITIES

Nitrogen Credits for Alfalfa

Alfalfa Stand Density		Medium or Fine Textured Soils		Sandy Soils	
		> 8 inches regrowth	< 8 inches regrowth	> 8 inches regrowth	< 8 inches regrowth
		NITROGEN CREDIT			
		- - - - - - - - - - lbs N/acre - - - - - - - - - -			
Good	>70%	190	150	140	100
Fair	30-70%	160	120	110	70
Poor	<30%	130	90	80	40

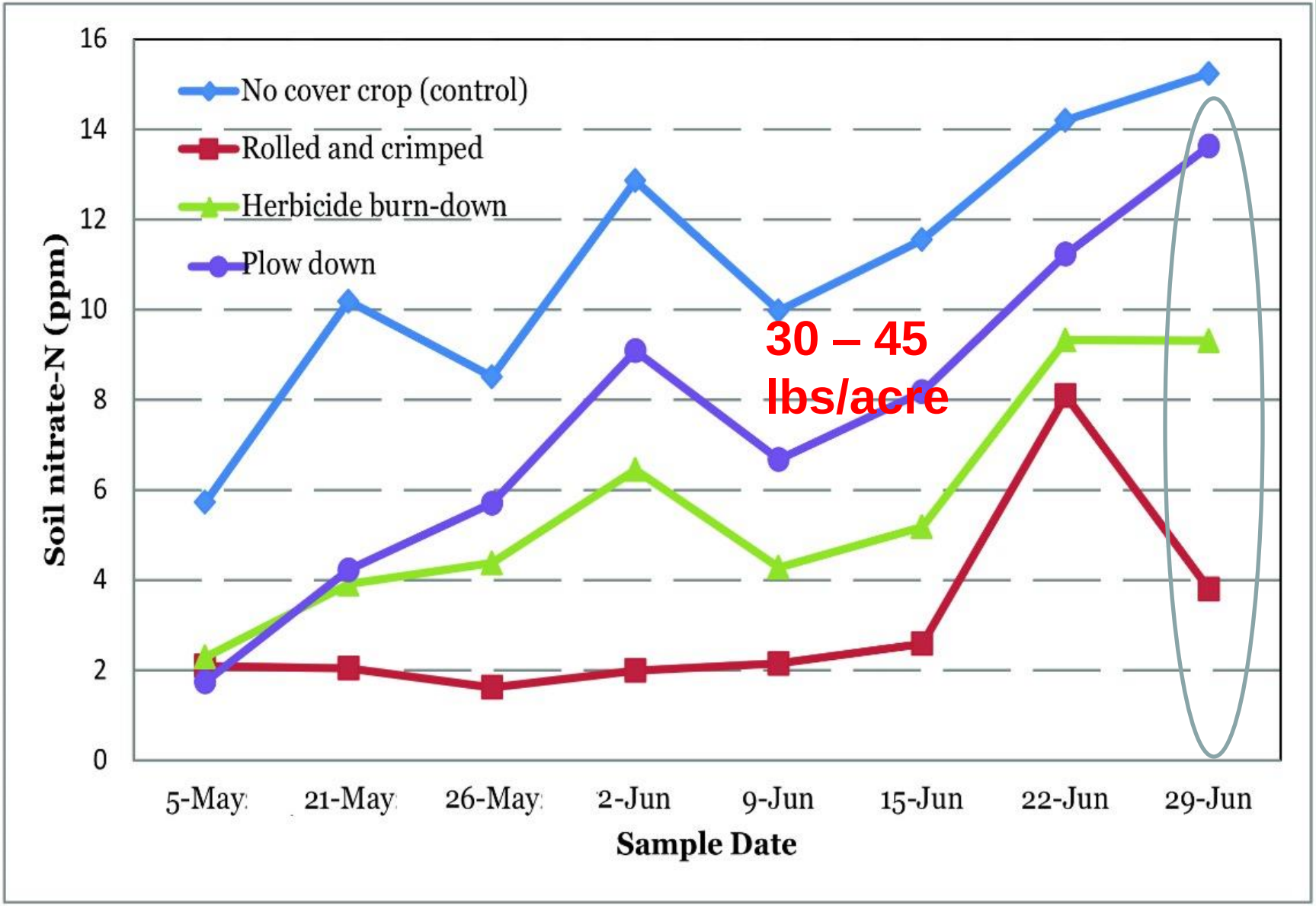
Red Clover and Soybean Nitrogen Credits

- Red Clover
  - 70 lbs N/a minimum
    - *80% of alfalfa credit*
- Soybean
  - 40 lbs N/a
    - *no credit on sands or loamy sands*

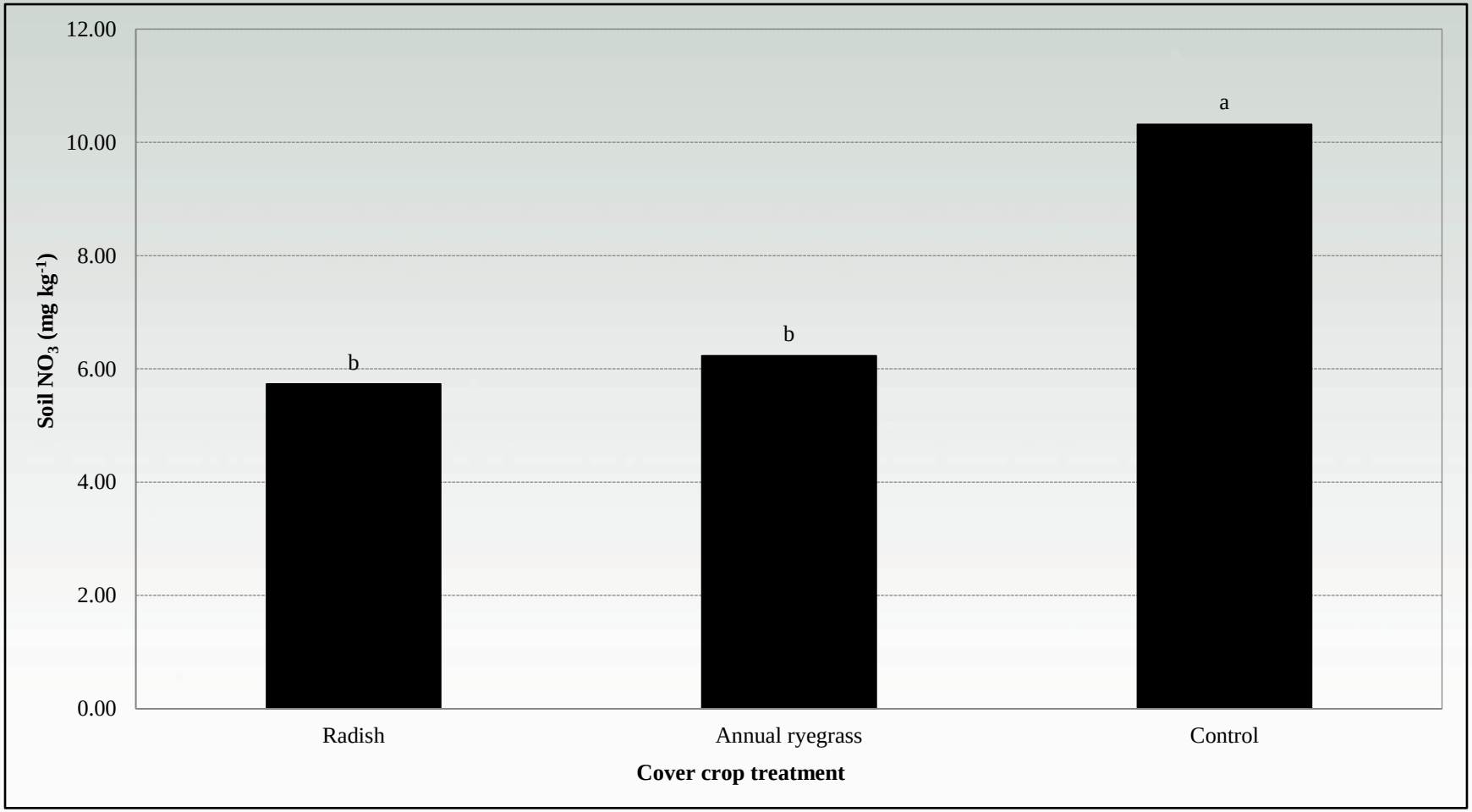
Grass and Cover Crop Nitrogen Credits

- Sod
  - 70 lbs N/a maximum
    - *80% of alfalfa credit*
- Cover crops
  - 0 - 90 lbs N/a

FIGURE 8. Nitrogen release from cover crops terminated by plow down, herbicide and roller-crimper, compared to no cover crop.



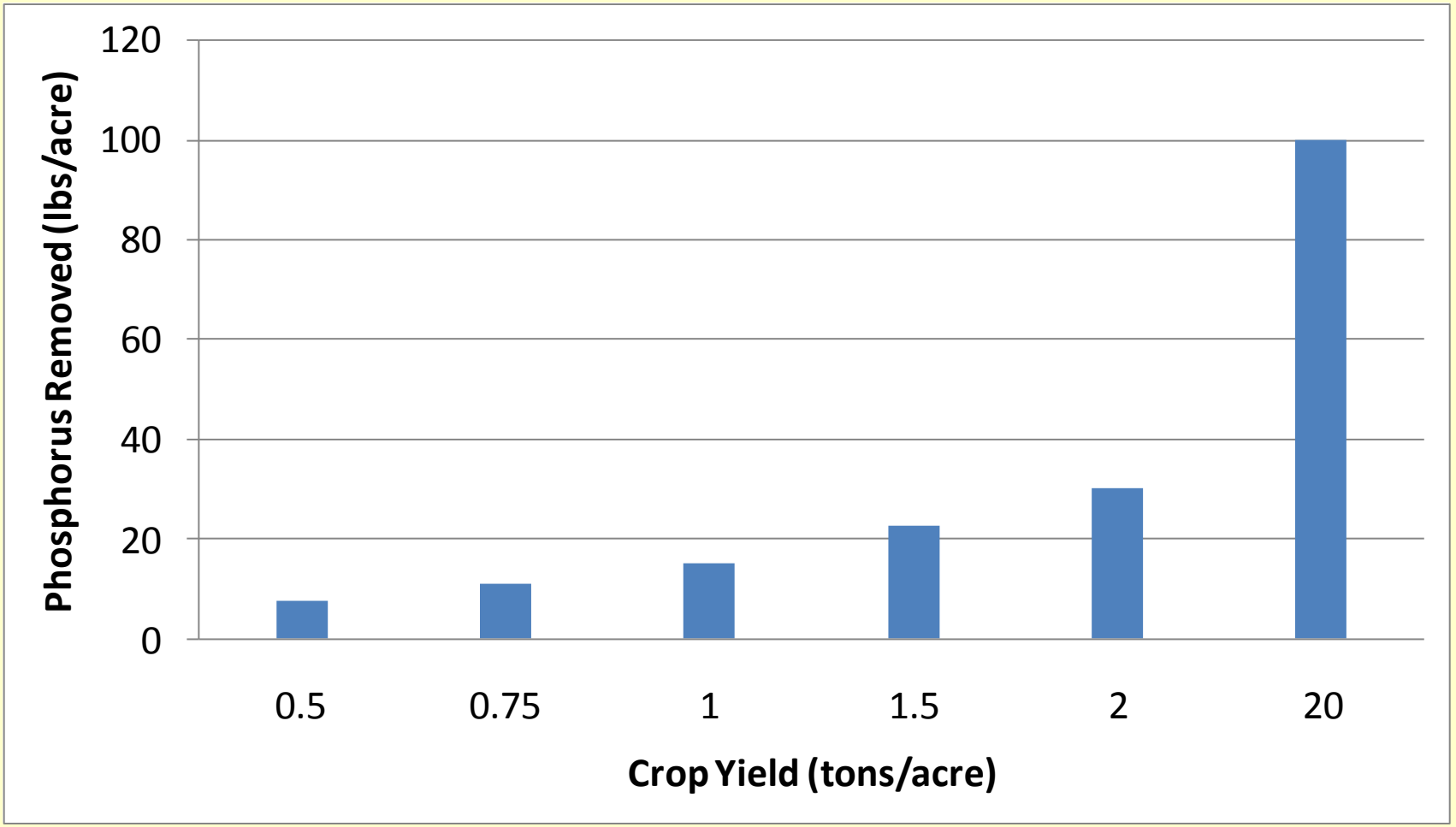
Soil Nitrate-N



Other Soil Nutrients

Cover crop treatment	Soil pH	Available P	K	Mg	Ca	CEC	Zn	Soil Organic Matter
		ppm	ppm	ppm	ppm	meq 100 g^{-1}	ppm	%
Annual ryegrass	**7.23**	44.3	284	193	**3231**	**18.5**	1.33	3.93
Radish	7.10	39.8	253	191	3009	17.3	1.13	4.07
Control	7.20	**57.4**	**322***	**219**	3175	**18.5**	**1.40**	**4.30**
LSD (0.10)	NS	NS	34	NS	NS	NS	NS	NS
Trial mean	7.18	47.2	286	201	3138	18.1	1.29	4.10

Phosphorus Reduction



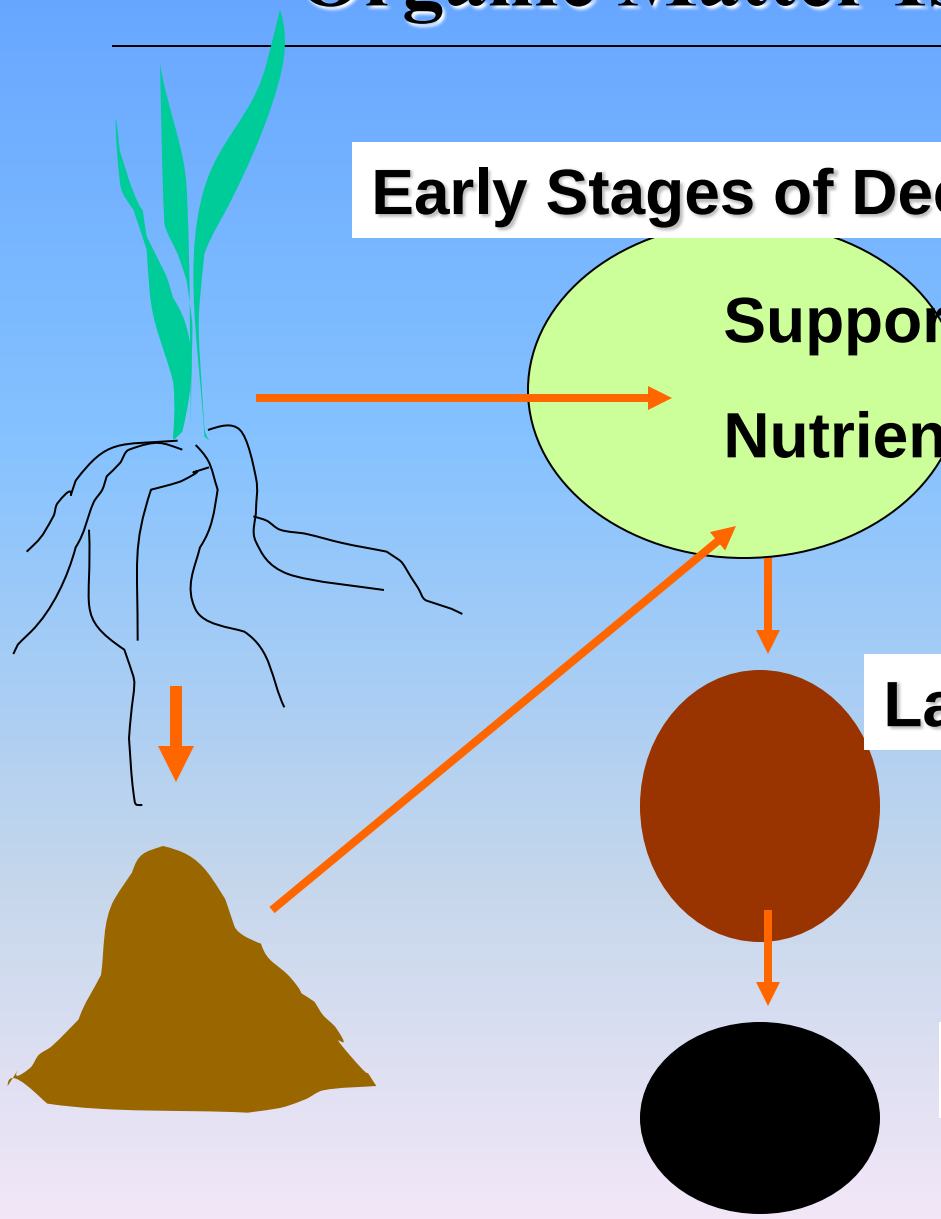
Soil Quality

Treatment	Organic Matter	Water stable aggregation	Active carbon	Potentially mineralizable N
	%	%	mg kg^{-1}	ug N g^{-1} d soil
No cover crop	4.46a	22.1b	676b	11.1a
Cover crop	4.42a	39.0a	701a	12.3a

Cropping System Soil Quality

Corn cropping system	Aggregate stability %	Available water capacity (m/m)	Surface hardness psi	Organic matter %
CC	23.9d	0.24a	145b	3.4b
NC	45.7bc	0.25a	153b	4.0b
NT	50.5ab	0.24a	158b	3.7b
WCCC	38.7c	0.21b	123c	3.6b
PF	56.2a	0.25a	196a	4.2a

Organic Matter Is Not Created Equal



Early Stages of Decomposition

Supports high microbial activity

Nutrient Cycling & Aggregation

Later Stages of Decomposition

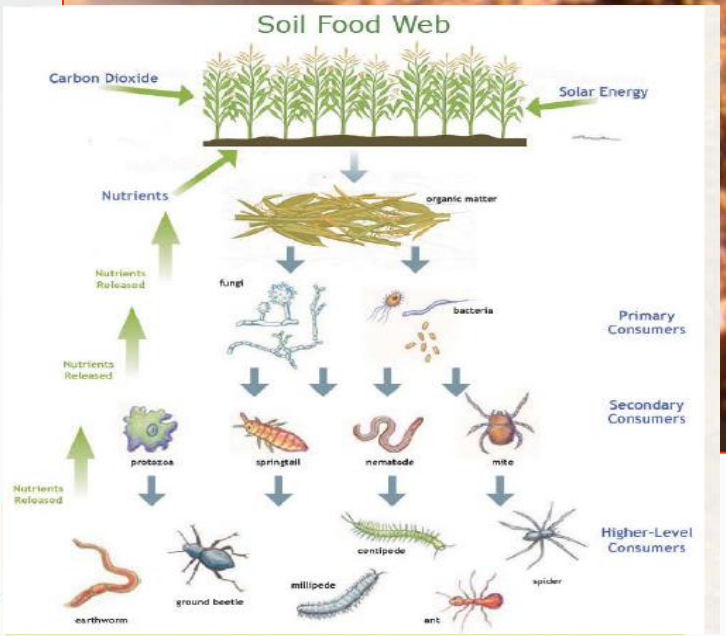
Most labile OM degraded

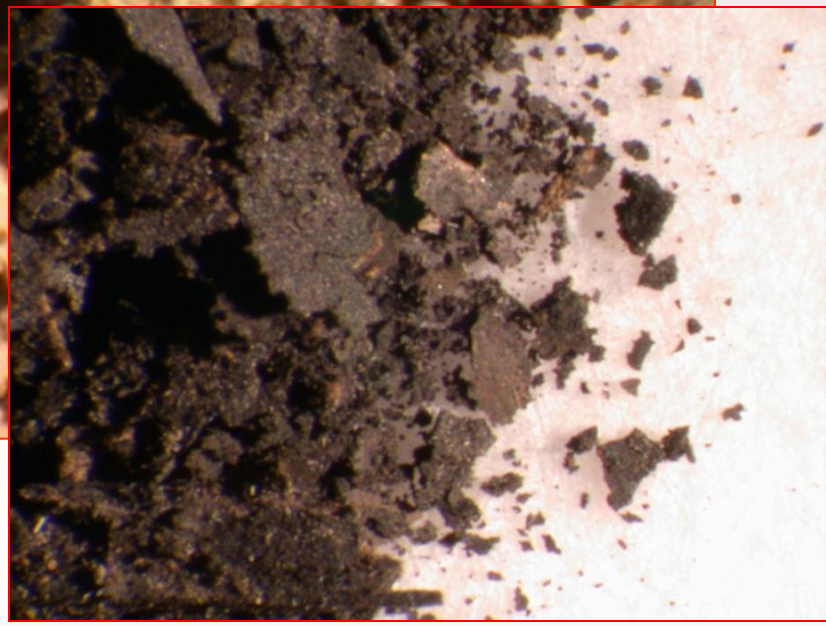
Considerable energy left that supports microbes

Even Later Stages

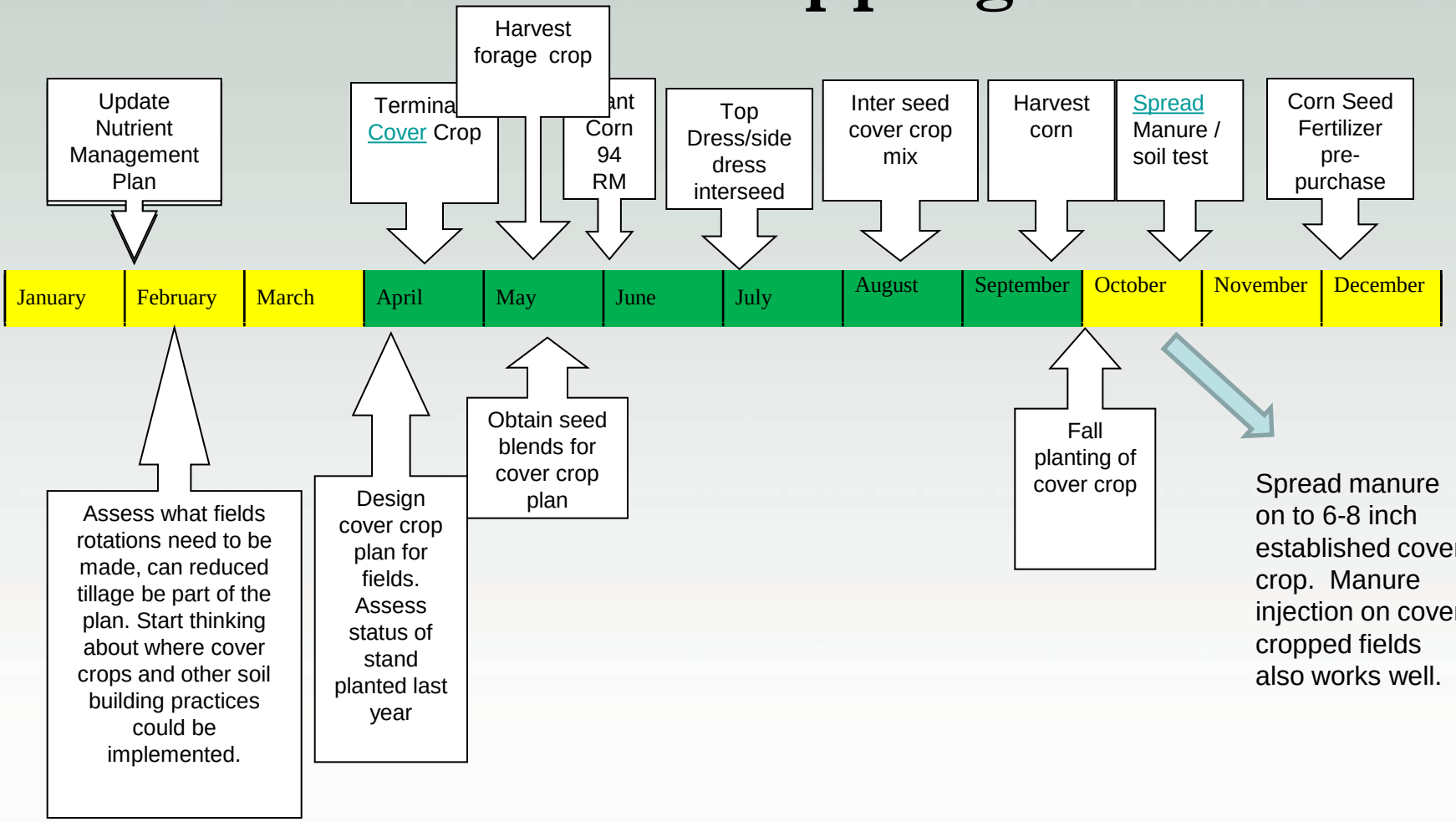
Leftovers not good to eat

Active OM


Soil Food Web
Carbon Dioxide
Solar Energy
Nutrients
organic matter
Nutrients Released
fungi
bacteria
Primary Consumers
Nutrients Released
Secondary Consumers
protozoa
springtail
nematode
mite
Nutrients Released
Higher-Level Consumers
centipede
spider
earthworm
ground beetle
millipede
ant



12 Month Cropping System for CoverCropping



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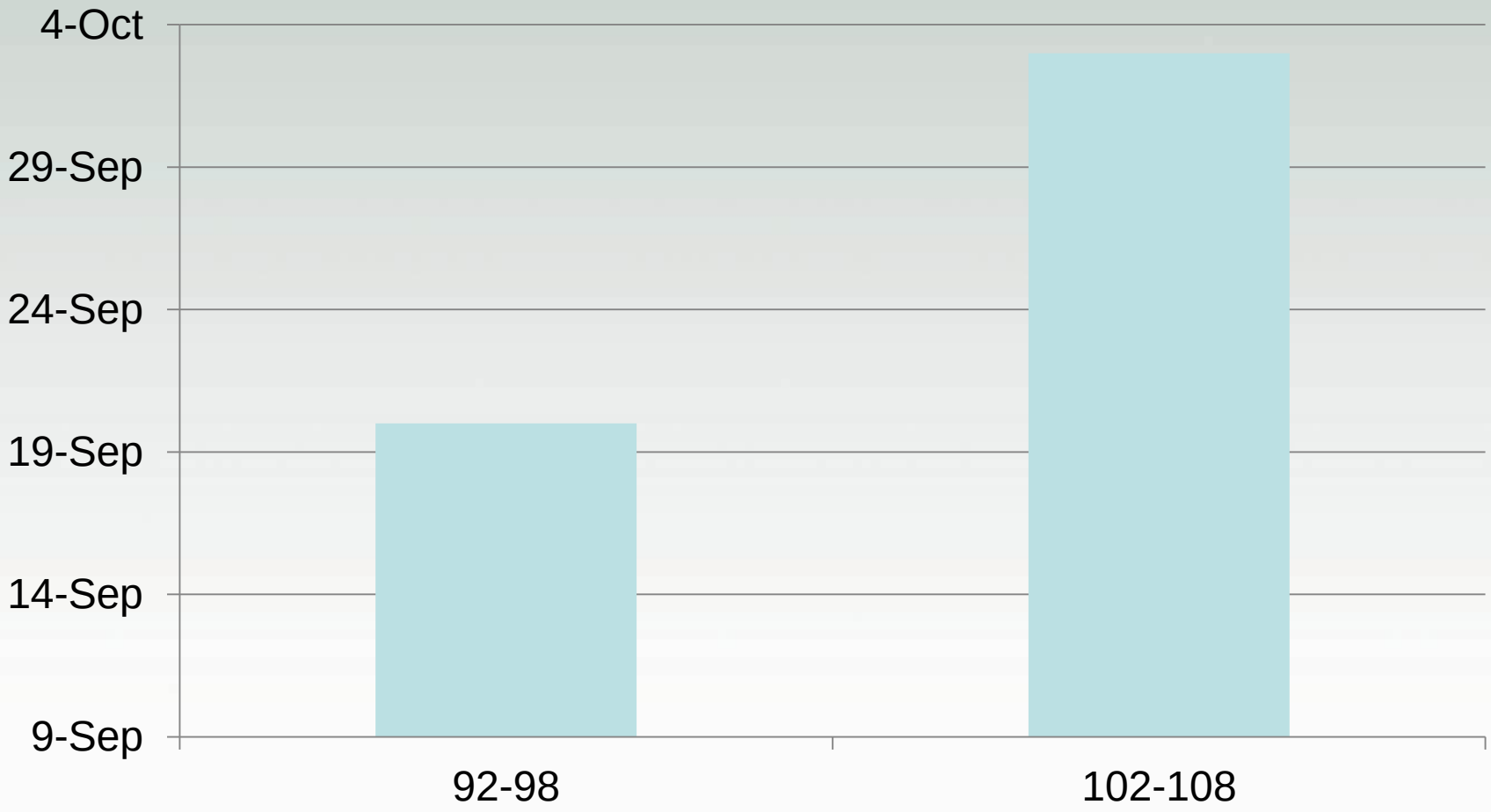
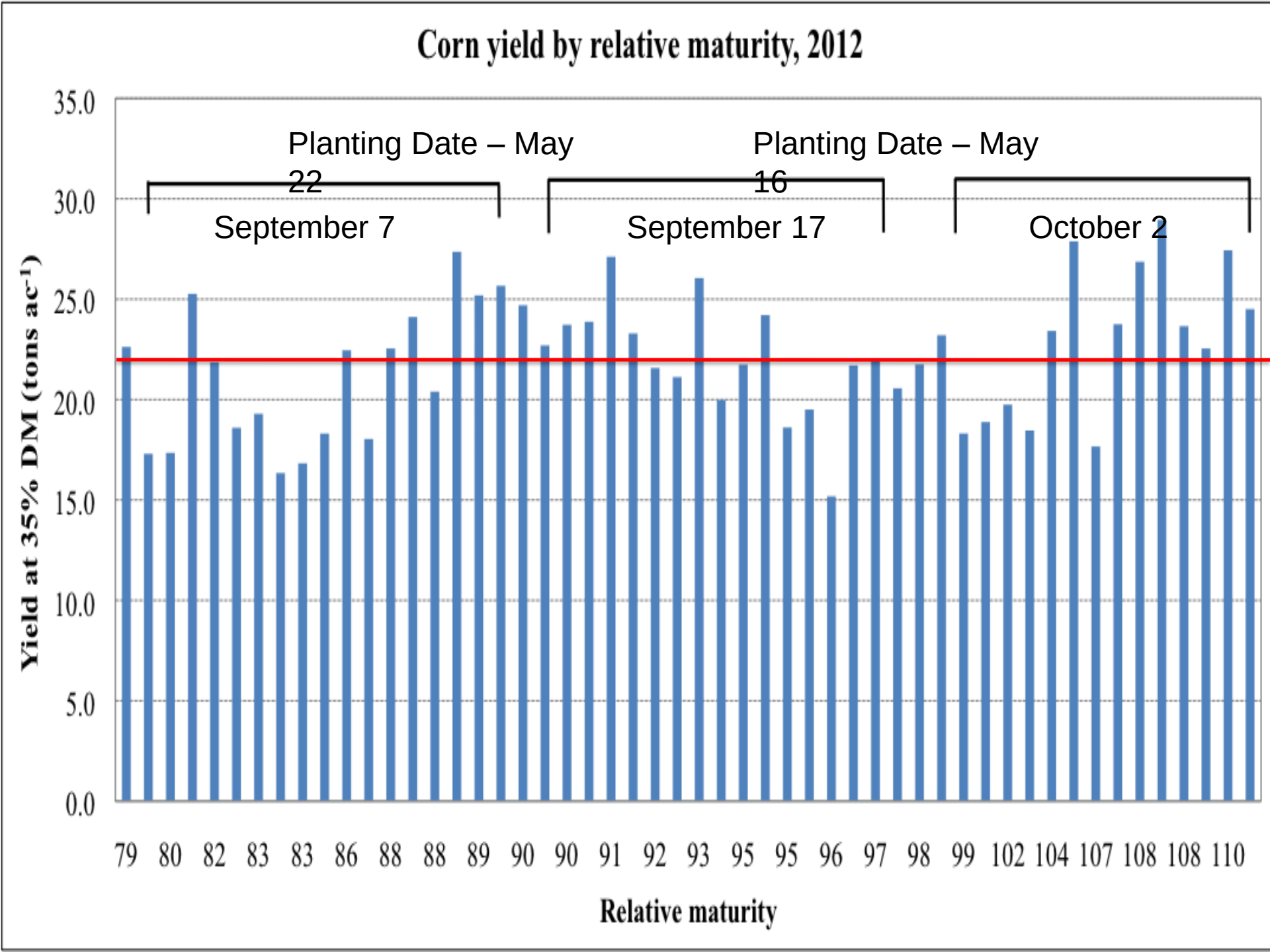
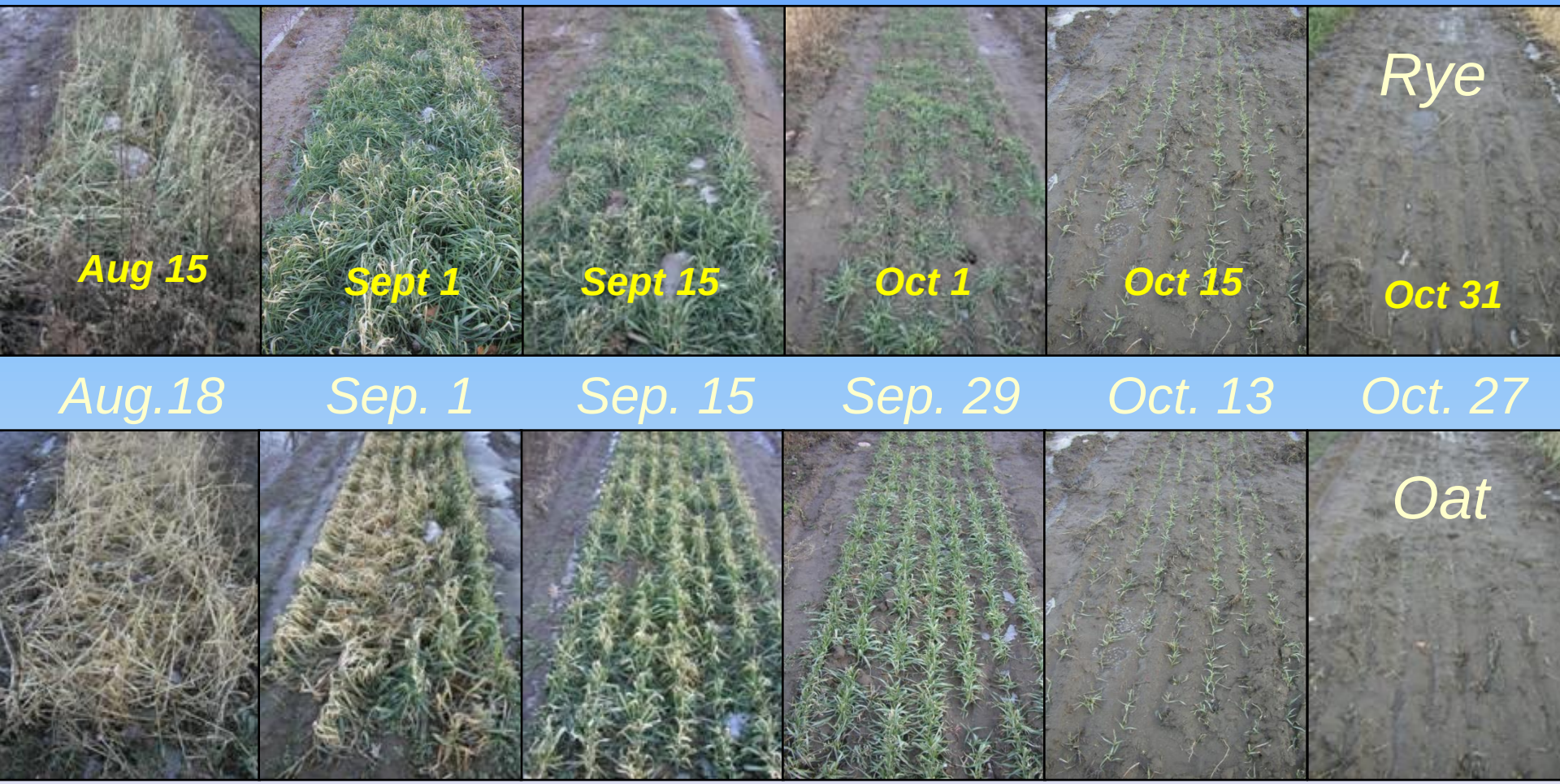
Harvest Dates of Corn




Corn yield by relative maturity, 2012
Planting Date – May 22
September 7
Planting Date – May 16
September 17
October 2
Yield at 35% DM (tons ac-1)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
79 80 82 83 83 86 88 88 89 90 90 91 92 93 95 95 96 97 98 99 102 104 107 108 108 110
Relative maturity

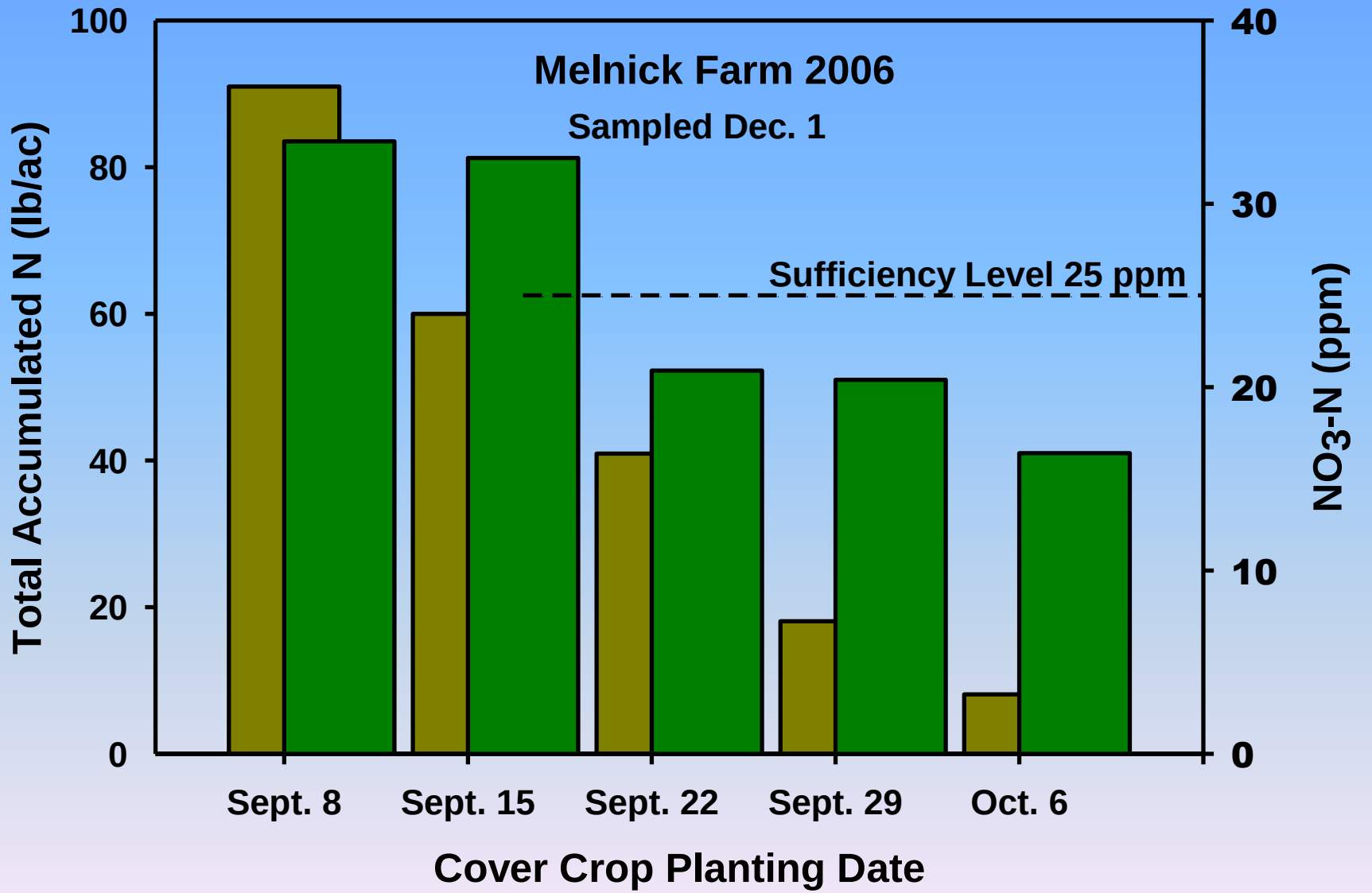
End-of-season Nutrient Recovery

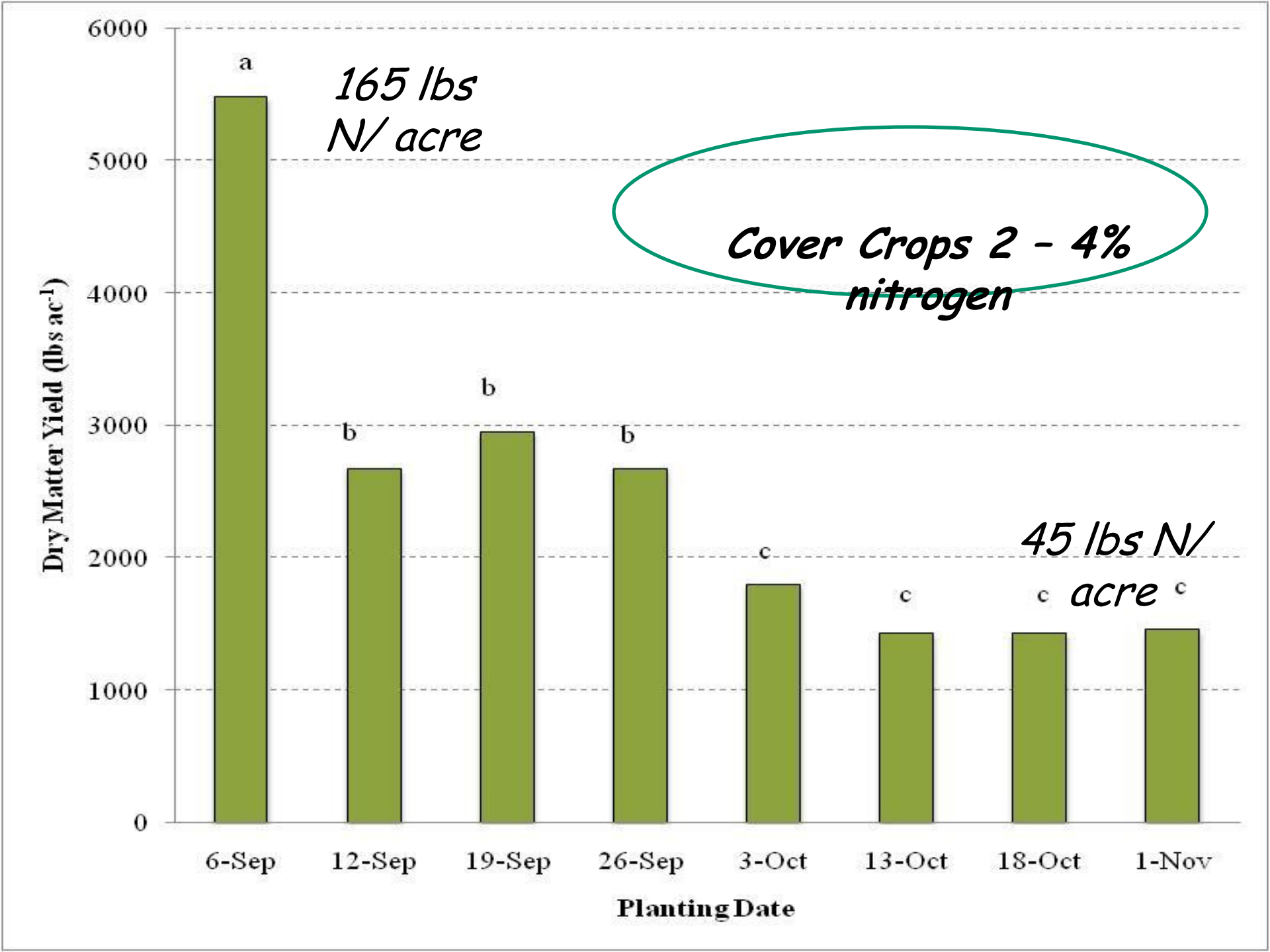


Cover Crop Growth on Dec. 31st

Herbert, S. 2006

N accumulation and PSNT level




6000
5000
4000
3000
2000
1000
0
Dry Matter Yield (lbs ac-1)
a
b
b
b
c
c
c
c
165 lbs N/ acre
45 lbs N/ acre
Cover Crops 2 – 4% nitrogen
6-Sep
12-Sep
19-Sep
26-Sep
3-Oct
13-Oct
18-Oct
1-Nov
Planting Date

Estimates of Percent N in Plant Tissue

Legumes: Non-woody			
	Aboveground:	**Pre-flowering**	**3.5-4.0**
		Flowering	**3.0-3.5**
	Below ground:	**Roots**	**2.0-2.5**
Legumes: Woody			
	Aboveground:	**Leaves only**	**3.0-3.5**
		Leaves + stems	**2.0-3.0**
	Below ground:	**Roots**	**1.5-2.5**
Grasses			
	Aboveground:	**Pre-flowering**	**2.0-3.5**
		Flowering	**1.5-2.5**
		Straw	**0.5-0.8**
	Below ground:	**Roots**	**1.5-2.5**

Adapted from Sarrantonio, M. 1994. Northeast Cover Crop Handbook. Emmaus, Pennsylvania: Rodale Institute.

Cereal Rye

Dry matter estimates using height and %GC (1,000s of lbs/Acre).

	Height (inches)									
%GC	**4**	**8**	**12**	**16**	**20**	**24**	**28**	**32**	**36**	**40**
10	<0.1	0.1-0.2	0.2-0.3	0.3-0.4	0.4-0.6	0.6-0.9	0.8-1.1	0.9-1.1	1.0-1.2	1.0-1.3
20	0.1-0.2	0.4-0.6	0.6-1.0	0.8-1.2	0.9-1.4	1.0-1.5	1.1-1.7	1.2-1.9	1.3-2.1	1.4-2.2
30	0.2-0.3	0.6-1.0	0.9-1.3	1.0-1.5	1.1-1.9	1.3-2.1	1.4-2.2	1.6-2.4	1.8-2.6	1.9-2.7
40	0.3-0.4	0.8-1.2	1.0-1.5	1.1-1.9	1.3-2.1	1.6-2.4	1.8-2.6	2.1-2.9	2.2-3.0	2.5-3.3
50	0.4-0.6	0.9-1.4	1.1-1.9	1.3-2.1	1.6-2.4	2.00-2.8	2.3-3.1	2.6-3.4	2.8-3.6	3.1-3.9
60	0.6-0.9	1.0-1.5	1.3-2.1	1.6-2.4	1.8-2.8	2.2-3.2	2.6-3.6	2.9-3.9	3.3-4.2	3.6-4.6
70	0.8-1.1	1.1-1.7	1.4-2.2	2.0-2.6	2.3-3.1	2.6-3.6	3.0-4.0	3.4-4.4	3.8-4.8	4.2-5.2
80	0.9-1.1	1.2-1.9	1.6-2.4	2.1-2.9	2.6-3.4	2.9-3.9	3.4-4.4	3.8-4.8	4.3-5.2	4.6-5.8
90	1.0-1.2	1.3-2.1	1.8-2.6	2.2-3.1	2.8-3.6	3.3-4.2	3.8-4.8	4.3-5.2	4.7-5.8	5.2-6.4
100	1.0-1.3	1.4-2.2	1.9-2.7	2.5-3.3	3.1-3.9	3.6-4.6	4.5-5.2	4.6-5.8	5.2-6.4	

Adapted from Sarrantonio, M. 1994. Northeast Cover Crop Handbook. Emmaus, Pennsylvania: Rodale Institute.

Calculating Total N Content of the Green Manure

Example:

You estimated 3,000 lb/acre of cover crop; 80% (0.80) of it was vetch that was just about to flower and 20% (0.20) was various grasses and weeds. You estimate that the vetch contained about 3.5% (0.035) N, and the grasses and weeds contained about 2.2% (0.022) N:

3,000 lb/acre x 0.80 x 0.035 = 84 lb N/acre from legume

3,000 lb/acre x 0.20 x 0.022 = 13.2 lb N/acre from weeds

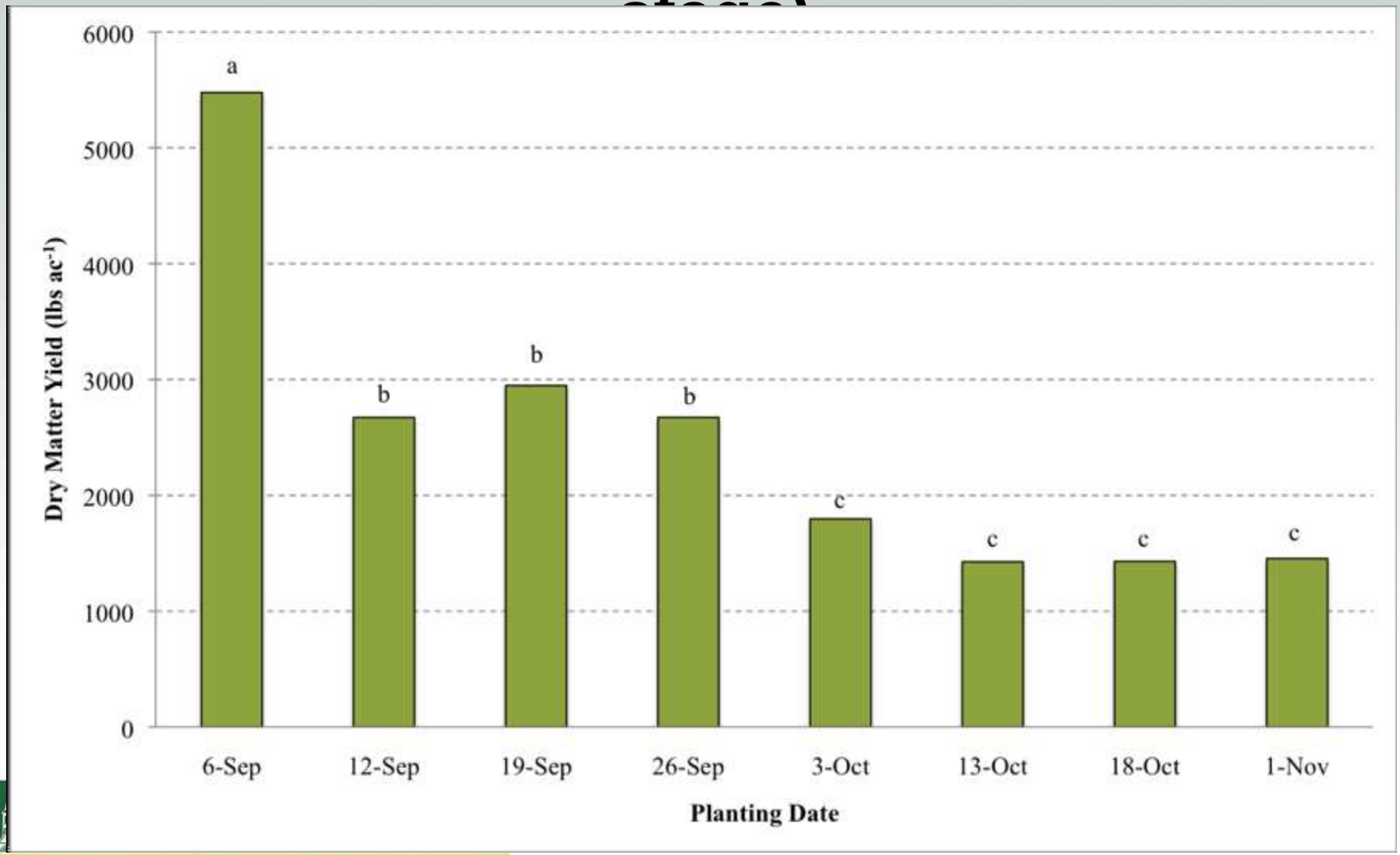
84 lb N/acre + 13.2 lb N/acre = 97.2 N/acre total

Remember that only up to 75% of the N in the legume represents "new" N; the rest came from existing N in the soil. Also, remember that unless you actually tested the green manure for percent N, this is only a ballpark figure based on a number of assumptions and guesses.

Adapted from Sarrantonio, M. 1994. Northeast Cover Crop Handbook. Emmaus, Pennsylvania: Rodale Institute.

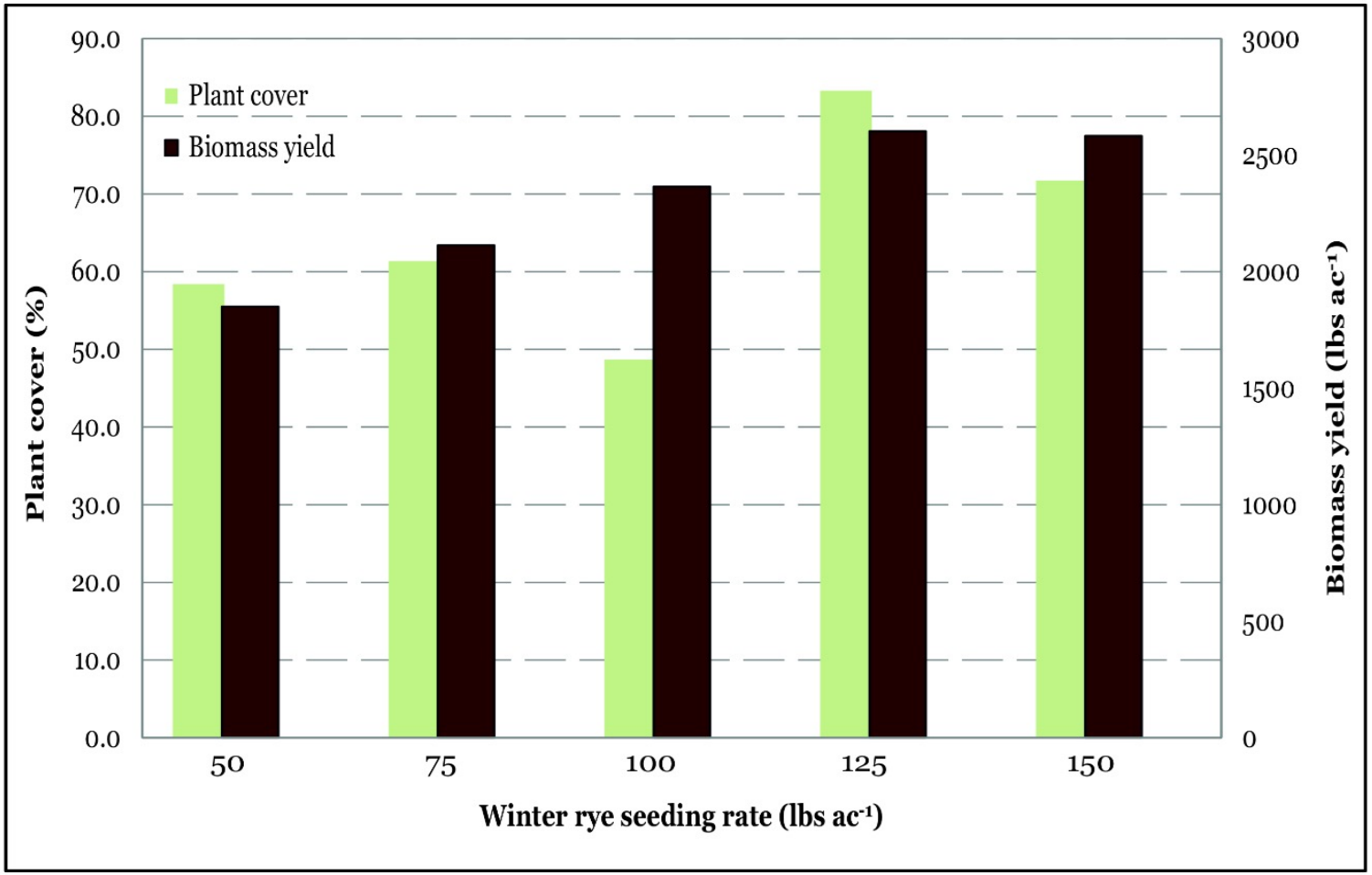
Double &Triple Cropping

One month delay in planting results in one week delay in heading date (boot stage)

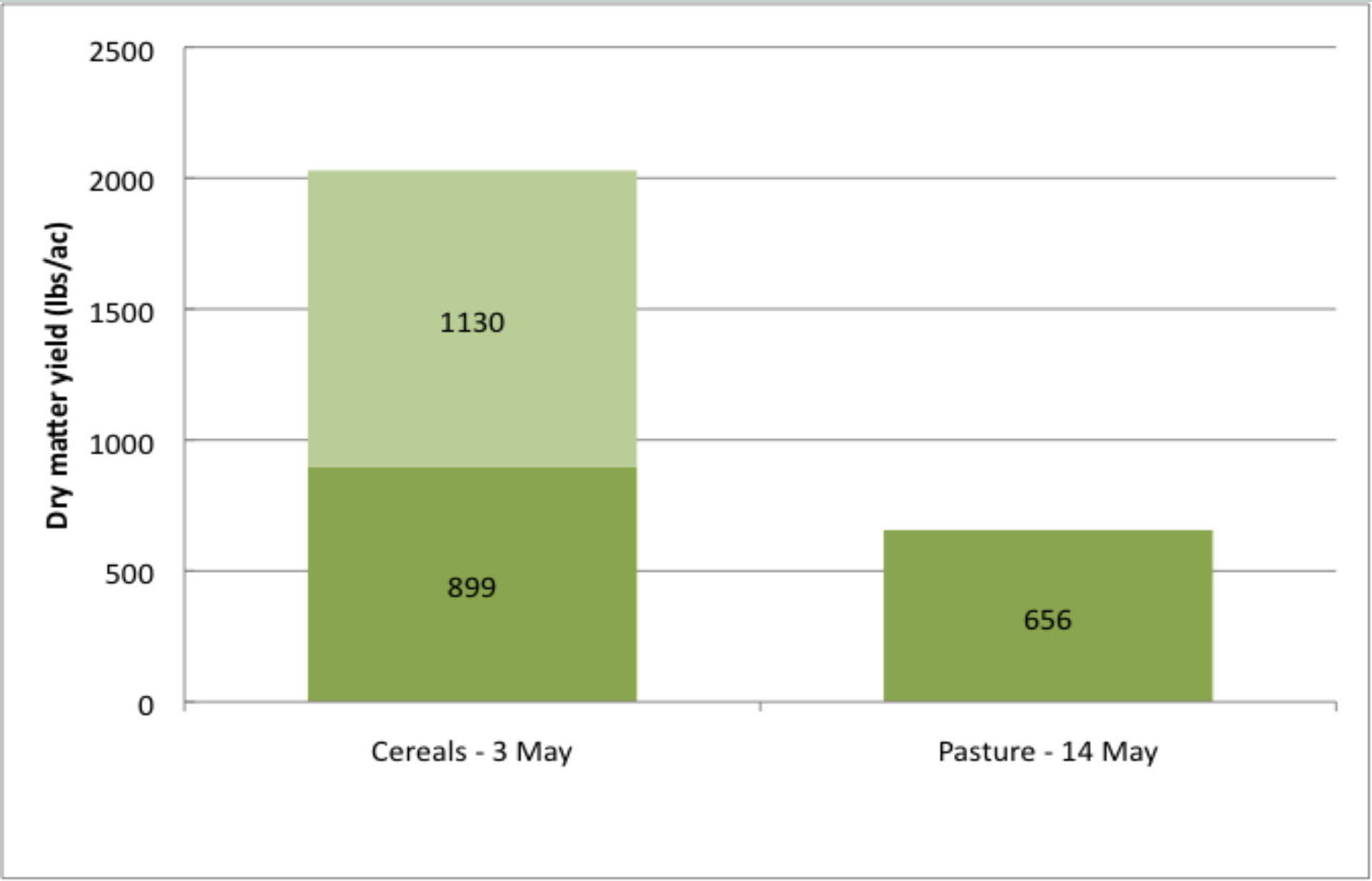



Tillers can account for 60% of yields!

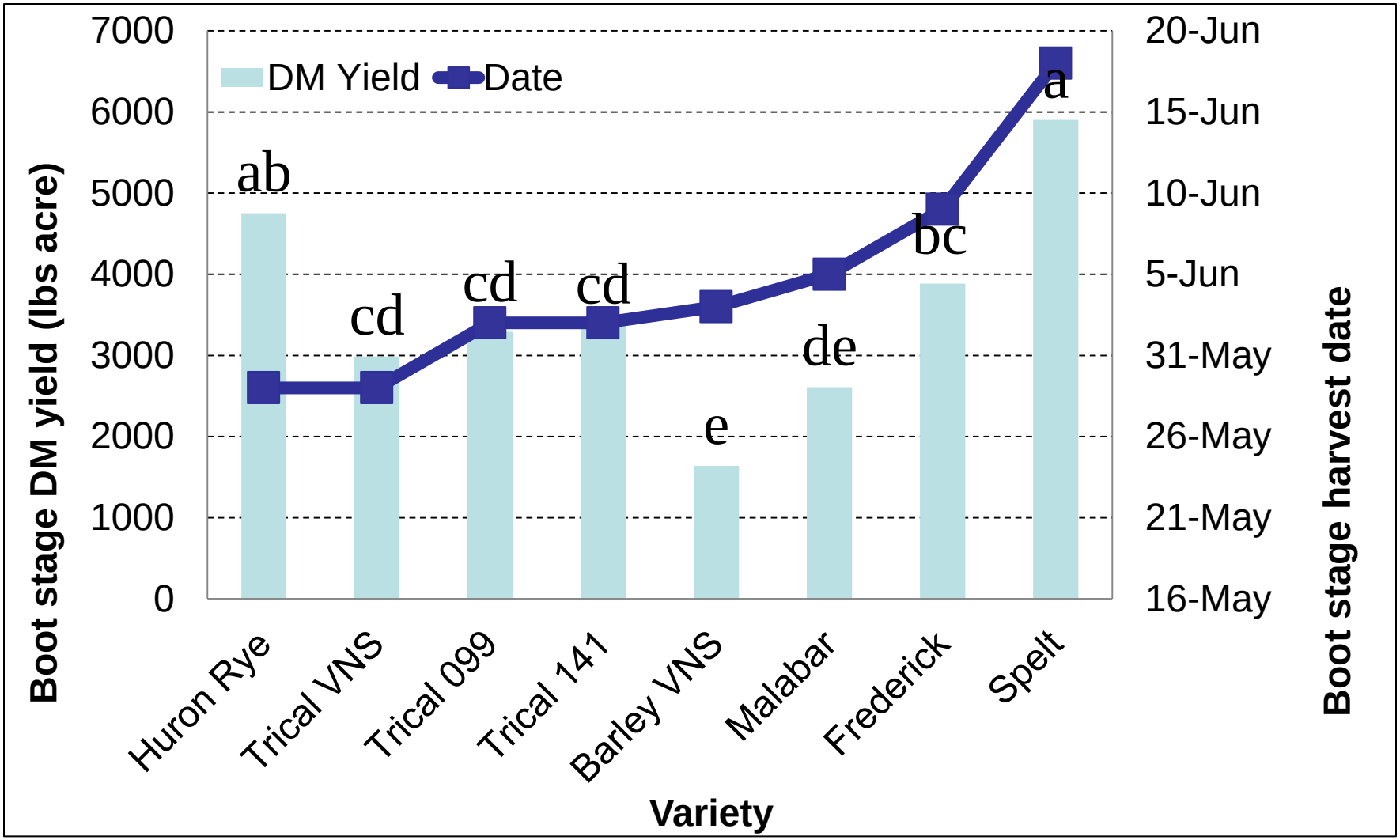
FIGURE 7. **Effects of seeding rate on winter rye plant cover and biomass accumulation (Alburgh, VT, 2009-2012).**



Pasture vs. Cereals



Winter Grain Forages, 2014



Cool Season Annuals

- **Small grains for winter cover crops**
  - **Triticale alone on fields renovated in late summer**
  - **One Graze in spring before reseeding**
  - **Early feed if weather cooperates**
  - **Worse case scenario green manure**
  - **Reasonable dry matter for early feed**
  - **Good quality**
  - **Cows like to graze very palatable**

Spring and Winter Cereal Crops

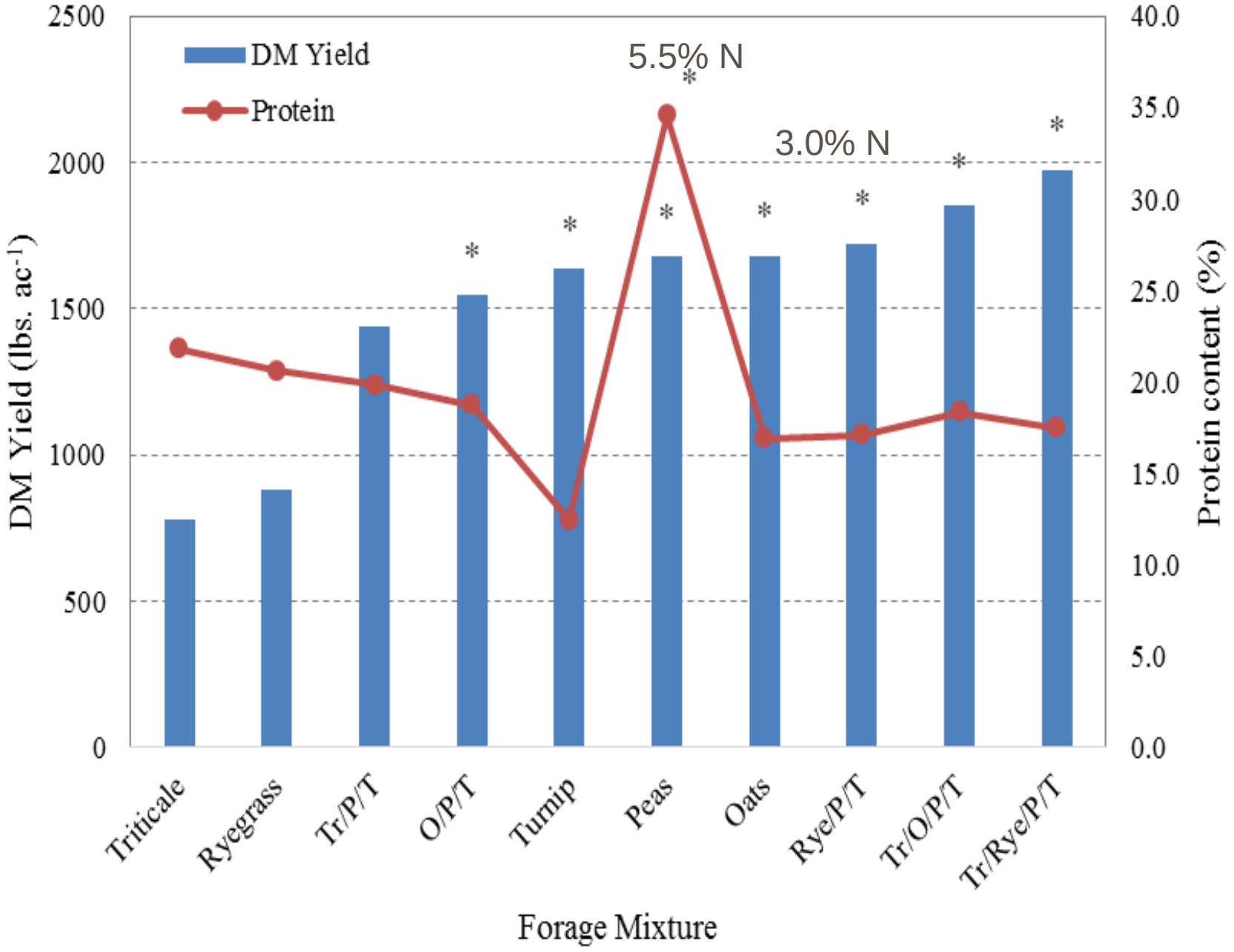
Oats & Triticale in late summer (middle of August)

Same as planting triticale – higher seeding rate 150 lbs/acre

Planting two crops one for fall and one for spring grazing

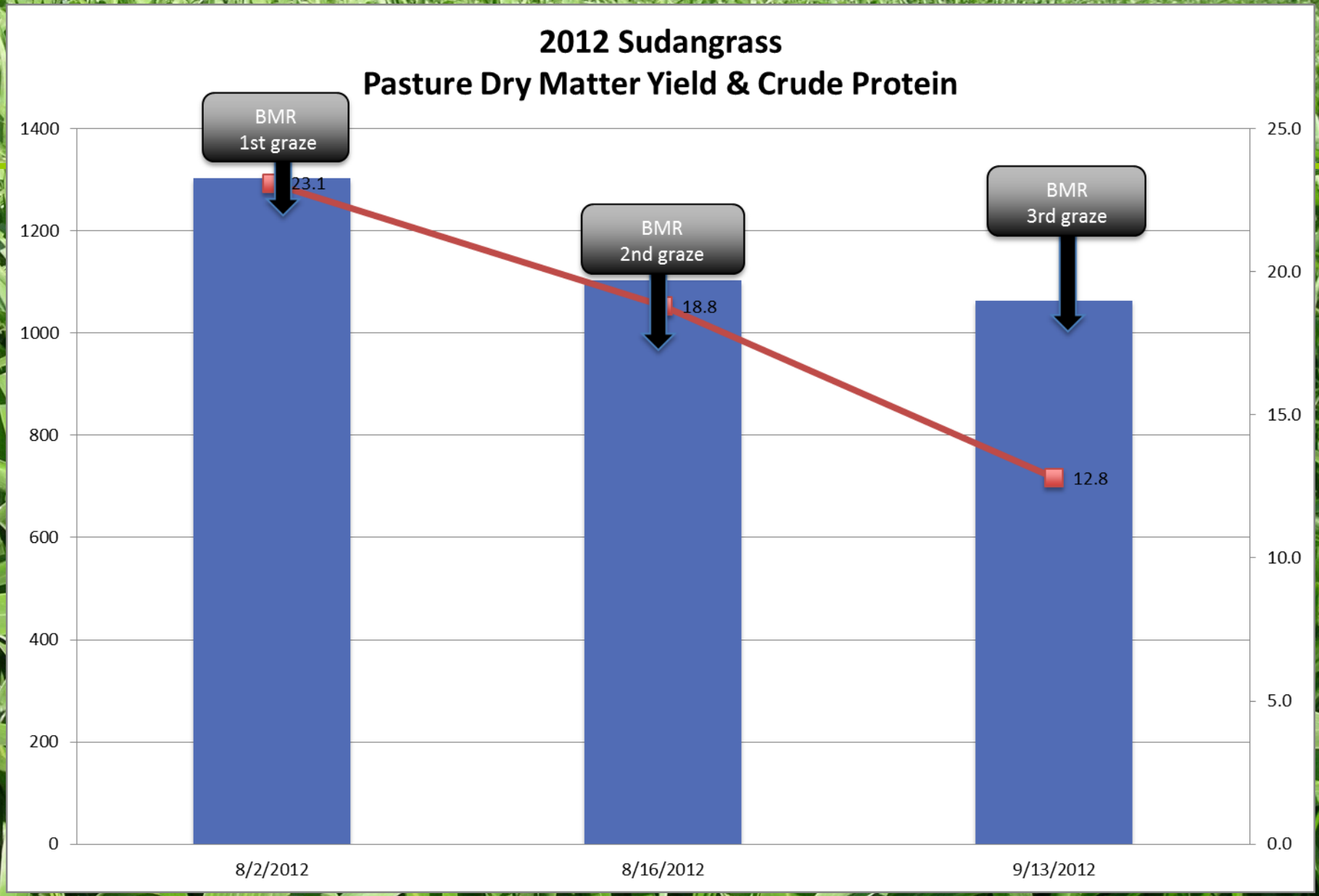
Graze oats in fall – Planted Aug. 19th and grazed first of Oct.

High quality and palatable -Of all annuals cows milk


DM Yield
Protein
5.5% N
3.0% N
DM Yield (lbs. ac-1)
Protein content (%)
2500
2000
1500
1000
500
0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Triticale
Ryegrass
Tr/P/T
O/P/T
Turnip
Peas
Oats
Rye/P/T
Tr/O/P/T
Tr/Rye/P/T
Forage Mixture

Warm Season Annuals

- **Rotation**
  - **Take first and/or second cut**
  - **25th of June and 1st of July planting**
  - **Graze 3x**
  - **Leave residue through winter**
  - **Reseed field in early spring**


2012 Sudangrass
Pasture Dry Matter Yield & Crude Protein
BMR
1st graze
BMR
2nd graze
BMR
3rd graze
23.1
18.8
12.8
1400
1200
1000
800
600
400
200
0
25.0
20.0
15.0
10.0
5.0
0.0
8/2/2012
8/16/2012
9/13/2012

Summer Annual Forage Mixes

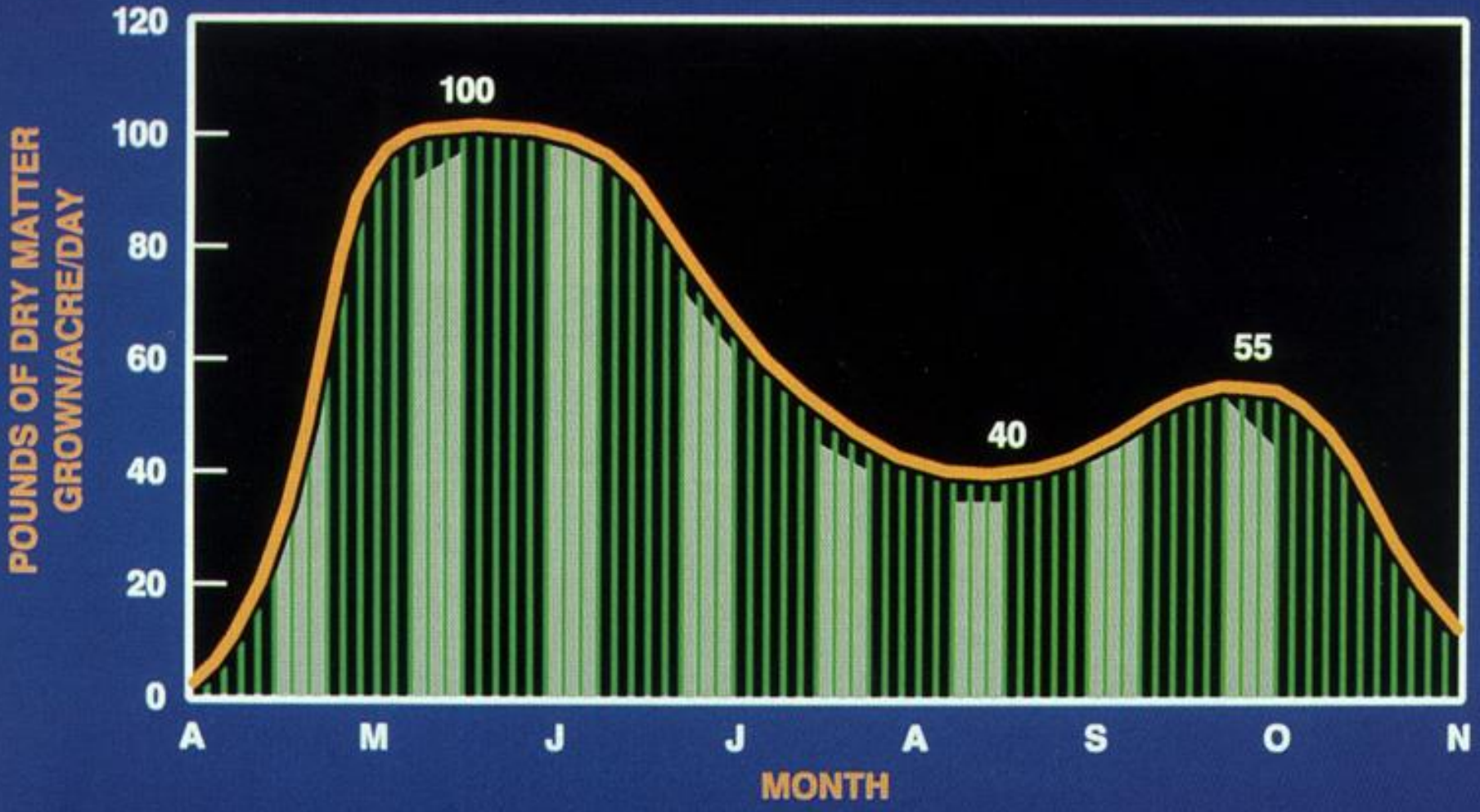
Abbreviation	Species	Seeding Rate	
		Alone	In Mixture
M/V/Ch	Wonderleaf Millet	20	10
	AC Greenfix Chickling Vetch	60	30
	TFL 200 Chicory	6	3
S/Cl/Ch	Hayking Sudangrass	50	15
	Berseem Clover	15	8
	TFL 200 Chicory	6	3
R/Cl/Ch	Fria Annual Ryegrass	30	15
	Berseem Clover	15	8
	TFL 200 Chicory	6	3
S/M/Cl/V/Ch	Hayking Sudangrass	50	15
	Wonderleaf Millet	20	10
	Berseem Clover	15	8
	AC Greenfix Chickling Vetch	60	30
	TFL 200 Chicory	6	3
M/R/V/Cl/Ch	Wonderleaf Millet	20	10
	Fria Annual Ryegrass	30	15
	AC Greenfix Chickling Vetch	60	30
	Berseem Clover	15	8
	TFL 200 Chicory	6	3

Forage Brassica Varieties

Variety	Species
AC Pennent	Mustard
Appin	Turnip
Barkant	Turnip
Barsica	Rape
Bonar	Rape
Daikon	Radish
Dwarf Essex	Rape
Kestrel	Kale
Major Plus	Swede
Purple Top	Turnip
T-Raptor	Brassica Hybrid
Vivant	Brassica Hybrid


T-raptor
Pasja
Barkant
Bonar
Appin

PASTURE GROWTH RATE OVER TIME



Cost/Benefit

Cost of Cover Cropping: $37 - $100 per acre

Seed: $34 - $70 (includes legumes)

Seeding costs: $3-$10

Seed incorporation costs: $10 - $15

Additional incorporation costs in spring: $10 - $20

Benefit of Cover Cropping: $0 - $234 per acre

Yields: 2 tons of corn per acre = $0 to $100

Fuel Savings = -$14 to $4 per acre

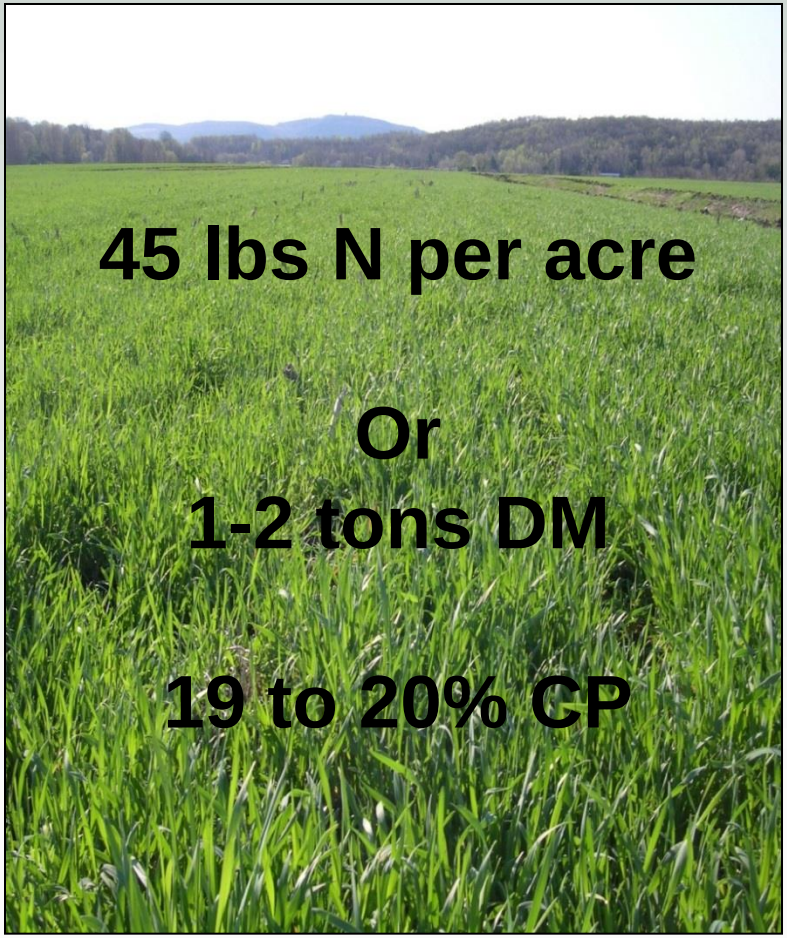
Nitrogen Fertilizer Savings = $0 to $120

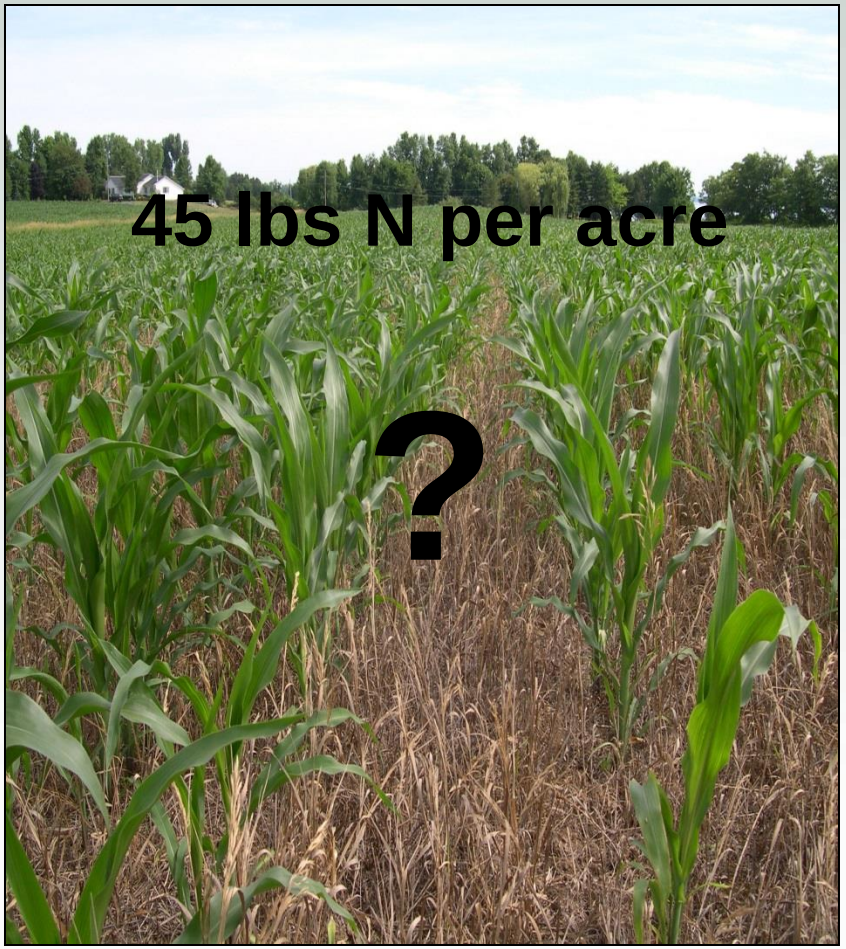
Top Soil Saved (2 tons) = $

Feel Good About What You Are Doing!! = PRICELESS


FORAGE DIVERSITY IS KEY

Cover Crop Termination





UNIVERSITY OF VERMONT EXTENSION
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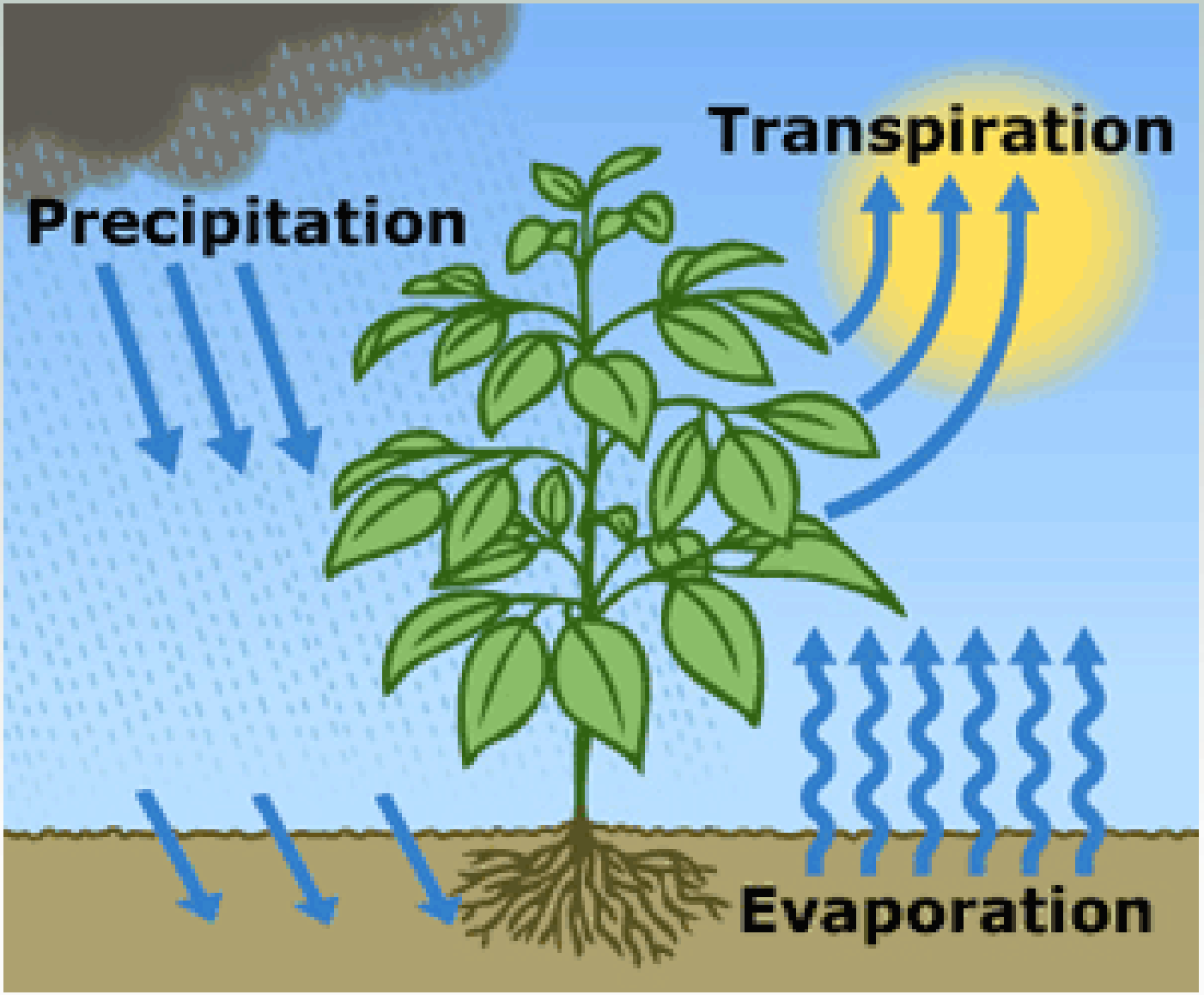
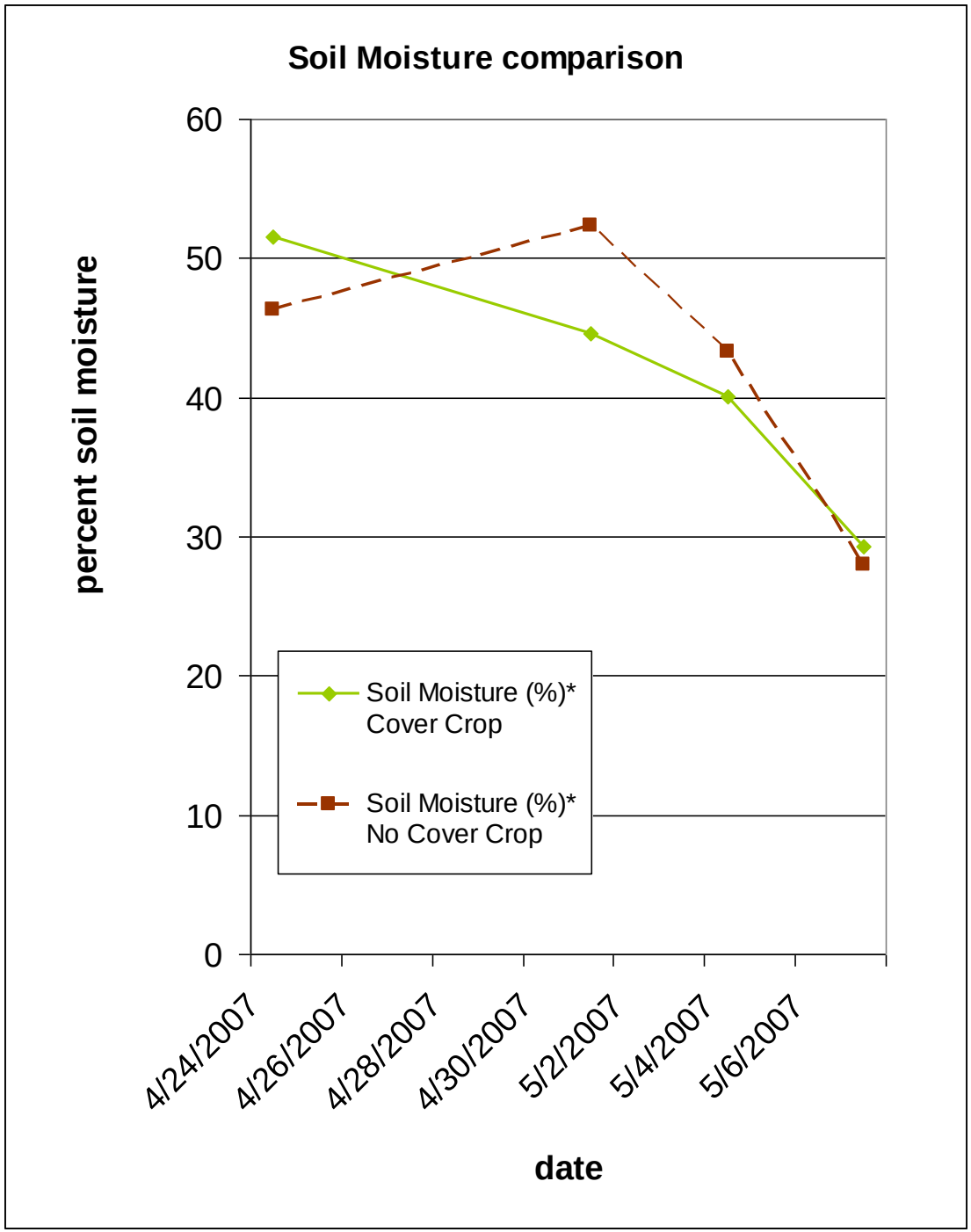

Transpiration
Precipitation
Evaporation


Soil Moisture comparison
percent soil moisture
60
50
40
30
20
10
0
4/24/2007
4/26/2007
4/28/2007
4/30/2007
5/2/2007
5/4/2007
5/6/2007
date
Soil Moisture (%)* Cover Crop
Soil Moisture (%)* No Cover Crop