



UNIVERSITY OF  
VERMONT

**EXTENSION**

CULTIVATING HEALTHY COMMUNITIES

# MULTI-SPECIES COVER CROP MIXTURES

Kirsten Workman, Agronomy Outreach Specialist, UVM Extension  
No Till and Cover Crop Symposium (Burlington, Vt.)  
February 2016



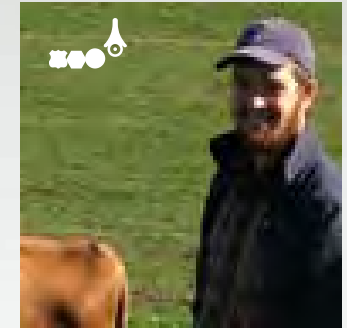
**Champlain Valley Crop, Soil and Pasture Team**

# CHAMPLAIN VALLEY CROP, SOIL & PASTURE TEAM

- Field & Forage Crop Production
- Grazing & Pasture Management
- Nutrient Management
- No-Till
- Cover Crops
- Soil Health
- Water Quality
- Agronomic Technical Assistance



*We are proud to work with farmers throughout the Champlain Basin to investigate and share techniques to grow the highest quality crops in the most efficient way, while protecting soil health and water quality.*





If it aint broke...why fix it?

*picture taken November 16, 2013*





# Why Mixtures?

- Soil Health
- Transition to No-Till
- Maximize diversity & rotations
- C:N Ratio...*stop tying up N*
- Management Objective
  - Nutrient (N,P,K)
  - Weed Control
  - Pollinators
  - Compaction
  - Forage Quality
  - Disease
- Better cost share \$\$



Photo: L. Ruhl



# Management Challenges in New England Agronomic

## **Challenge**



## **Solutions**

Sourcing seed	Grow your own, Better suppliers already
Different seed sizes can be difficult to mix together	Coated seed, narrower pattern Different boxes in the drill
Often cover crops/mixes require different equipment	Custom Service Providers, new technology You wanted a new drill anyway, didn't you?
How to fit it in the rotation (timing)	Add a small grain to your rotation, Interseeding into cash crops, Be aware in vegetable rotations
Herbicides: Carryover impacts on emergence Good termination	Keeping residuals in check...work with your suppliers Glyphosate may not be enough





# Management Challenges in New England Climatic

- Short growing season
- Cold winters
- Soil temperatures
- Unpredictable weather at establishment and termination

## *Solutions:*

- Shorter RM Corn
- Interseed
- Pay attention to details
- Quality seed
- Seed treatments





# Management Challenges in New England Economic

- Some species can make your mix significantly more expensive.
- The good news: usually these are the species you can use very little of.
- **LEGUMES**  
*invest in C:N ratio*





## Cost Per Acre





# CHAMPLAIN VALLEY CROP, SOIL & PASTURE TEAM 2015-2016 SEASON

## 16 Demonstration & Research Projects on Cover Crop Mixes

- 7 CIG Cover Crop Mixes (5 Corn/2 Soy)
- 5 Prevented Planting Cover Crop
- 2 Winter Rye x Radish in Corn Silage w/ Manure (*research*)
- 2 Misc. Cover Cropping

Soil Health Field Day Site  
Foster Bros. Farm—Middlebury VT



# THANK YOU TO OUR FUNDERS



United States Department of Agriculture  
Natural Resources Conservation Service

**Conservation Innovation Grants**



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This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2014-68006-21864.



Sustainable Agriculture  
Research & Education





# THANK YOU TO OUR FARMERS!!

- Audy Farm (*New Haven*)
- Bourdeau Bros. of Middlebury
- Chimney Point Farm (*Addison*)
- Clifford Farm (*Starksboro*)
- Conant's Riverside Farm (*Richmond*)
- Deer Valley Farm (*Ferrisburgh*)
- Farr Farm (*Richmond*)
- Foster Bros. Farm (*Middlebury*)
- Jillian Holsteins (*Orwell*)
- Kennett Farm (*Addison*)
- LaBerge Bros. Dairy (*Charlotte*)
- Nichols Fodder Farm (*Charlotte*)
- No-Mon-Ne Farm (*Addison*)
- Rail View Dairy (*New Haven*)
- Senesac Farm (*Colchester*)
- Vorsteveld Family Farm (*Panton*)



# Cover Crop Diversity in No-Till Systems

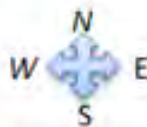
## Cover Crop Mixes in Corn Silage

Mix 1 = Oat/Pea/Radish

Mix 2 = Triticale/Winter Pea/Winter Rape

Low Rate = 50 lbs/acre

High Rate = 116 lbs/acre



### Broadcast into standing corn: 8-15-13

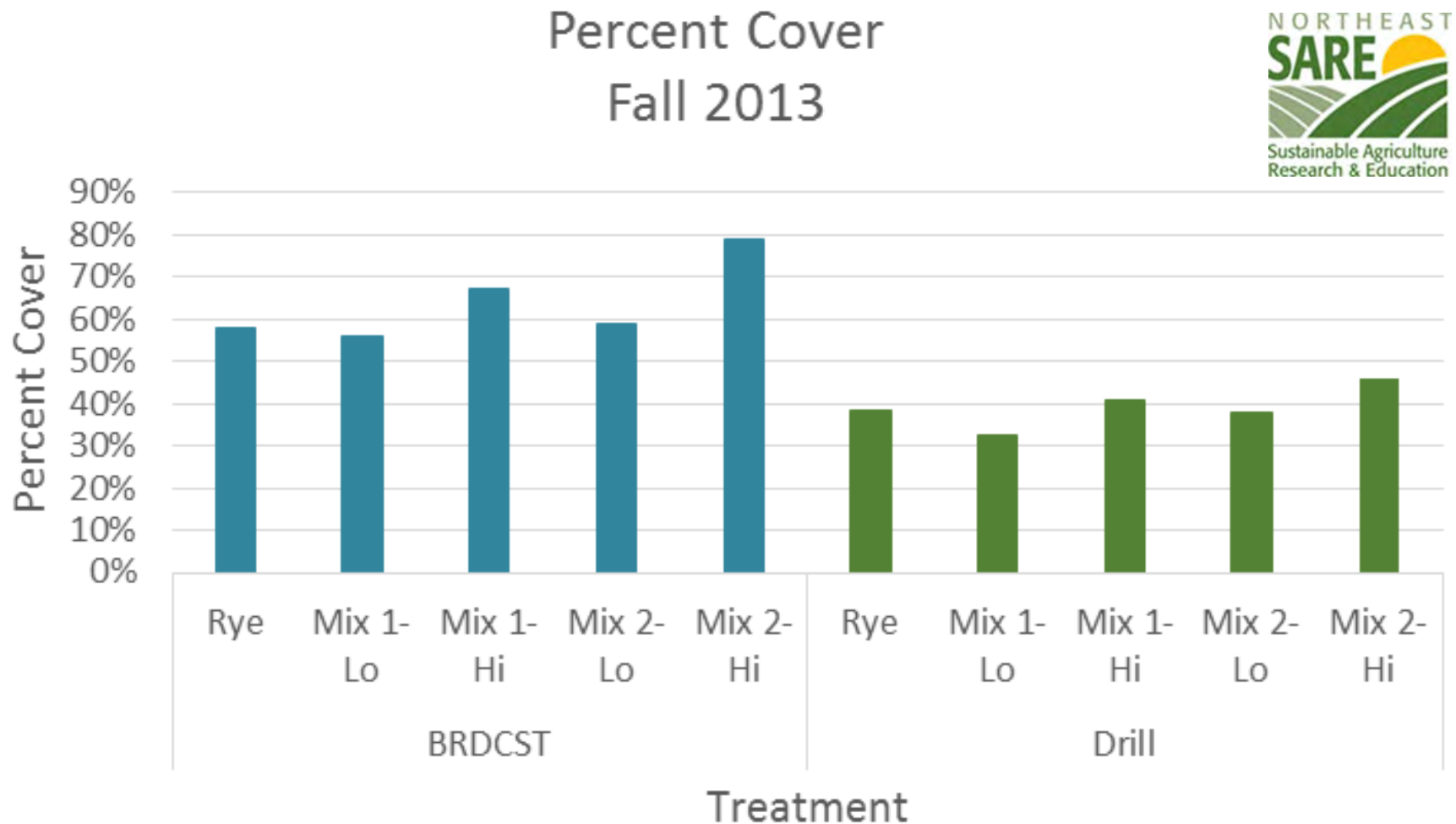
### Drilled after corn harvest: 9-26-13

R1	Mix 1 @ 116 lbs	15	15	Mix 1 @ 116 lbs
	Mix 2 @ 116 lbs	14	14	Mix 2 @ 116 lbs
	Mix 2 @ 50 lbs	13	13	Mix 2 @ 50 lbs
	Control (Winter Rye @ 100 lbs)	12	12	Control (Winter Rye @ 100 lbs)
R2	Mix 1 @ 50 lbs	11	11	Mix 1 @ 50 lbs
	Mix 2 @ 116 lbs	10	10	Mix 2 @ 116 lbs
	Mix 2 @ 50 lbs	9	9	Mix 2 @ 50 lbs
	Control (Winter Rye @ 100 lbs)	8	8	Control (Winter Rye @ 100 lbs)
R3	Mix 1 @ 50 lbs	7	7	Mix 1 @ 50 lbs
	Mix 1 @ 116 lbs	6	6	Mix 1 @ 116 lbs
	Mix 2 @ 116 lbs	5	5	Mix 2 @ 116 lbs
	Mix 1 @ 116 lbs	4	4	Mix 1 @ 116 lbs
	Mix 2 @ 50 lbs	3	3	Mix 2 @ 50 lbs
	Mix 1 @ 50 lbs	2	2	Mix 1 @ 50 lbs
	Control (Winter Rye @ 100 lbs)	1	1	Control (Winter Rye @ 100 lbs)

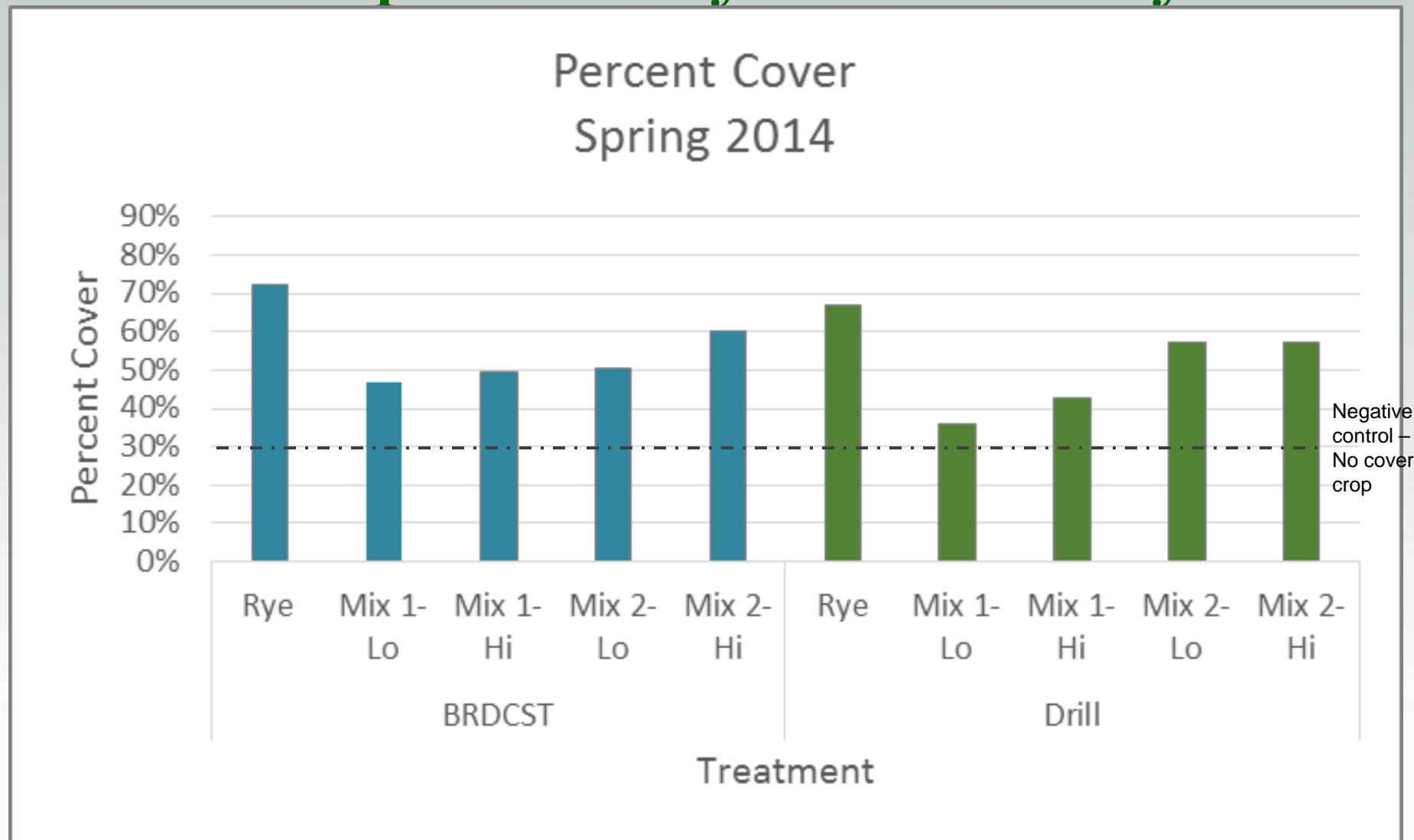




# Cover Crop Diversity in No-Till Systems



# Cover Crop Diversity in No-Till Systems





# Fall 2013/Spring 2014 Nutrient Uptake by Mixture (SARE Cover Crop Diversity)



Winter  
Rye

Winter  
Kill  
Mix

Winter  
Kill  
Mix  
(high)

Winter  
Hardy  
Mix  
(low)

Winter  
Hardy  
Mix  
(high)



# Cover Crop Diversity in No-Till Systems

*\*sampled on September 8, 2014...actual dry matters of corn silage averaged 26%, yields were adjusted to silage equivalents*

Treatment	Seeding Rate	Method of Planting Corn	tons/acre (adjusted to silage @ 32% DM)*	Dry Matter tons/acre	Population	% DM @ Sampling
Rye	112 lbs/acre winter rye	No-Till into green cover	17.62	5.64	29,333	26%
Mix 1-Hi	Oat/Pea/Radish @ 116 lbs/acre	No-Till into winter killed residue	19.98	6.39	35,000	26%
Mix 2-Hi	Triticale/W. Pea/W. Rape @ 116 lbs/ac	No-Till into green cover	17.63	5.64	34,000	28%
Conv.	no cover crop	Manure, Fall plowed, spring tillage	22.60	7.23	34,000	22%





# Better Cover Crop Mixes for Vermont



**United States Department of Agriculture**  
Natural Resources Conservation Service  
**Conservation Innovation Grants**

# Better Cover Crop Mixes for Vermont

## Plot Design

Early Broadcast						Late Broadcast						Drilled					
20 feet	Grass/Grain		Legume	Brassica/ Forbe	Lbs/Acre	20 feet	Grass/Grain		Legume	Brassica/ Forbe	Lbs/Acre	20 feet	Grass/Grain		Legume	Brassica/ Forbe	Lbs/Acre
	Control	Winter Rye 100					Control	Winter Rye 100					Control	Winter Rye 100			
	Mix 1:	Forage Oats 30	Field Pea 25	Tillage Radish 5	60		Mix 1:	Forage Oats 30	Field Pea 25	Tillage Radish 5	60		Mix 1:	Forage Oats 30	Field Peas 25	Tillage Radish 5	60
	Mix 2:	Winter Triticale 50	Aust. Winter Pea 25	Rapeseed 5	80		Mix 2:	Winter Triticale 50	Aust. Winter Pea 25	Rapeseed 5	80		Mix 2:	Winter Triticale 50	Aust. Winter Peas 25	Rapeseed 5	80
	Mix 3:	Ann. Ryegrass 15	Aust. Winter Pea 25	Tillage Radish 5	45		Mix 3:	Ann. Ryegrass 15	Aust. Winter Pea 25	Tillage Radish 5	45		Mix 3:	Ann. Ryegrass 15	Aust. Winter Pea 25	Tillage Radish 5	45
	Mix 4:	Winter Wheat 50	Aust. Winter Pea 25	Tillage Radish 5	80		Mix 4:	Winter Wheat 50	Aust. Winter Pea 25	Tillage Radish 5	80		Mix 4:	Winter Wheat 50	Aust. Winter Pea 25	Tillage Radish 5	80
	Mix 5:	Ann. Ryegrass 15	Clover - Berseem 5	Tillage Radish 5	25		Mix 5:	Ann. Ryegrass 15	Clover - Berseem 5	Tillage Radish 5	25		Mix 5:	Ann. Ryegrass 15	Clover - Berseem 5	Tillage Radish 5	25
	Mix 6:	Winter Triticale 50	Clover - Crimson 5	Tillage Radish 5	60		Mix 6:	Winter Triticale 50	Clover - Crimson 5	Tillage Radish 5	60		Mix 6:	Winter Triticale 50	Clover - Crimson 5	Tillage Radish 5	60
	Mix 7:	Forage Oats 30	Hairy Vetch 10	Mustard 5	45		Mix 7:	Forage Oats 30	Hairy Vetch 10	Mustard 5	45		Mix 7:	Forage Oats 30	Hairy Vetch 10	Mustard 5	45
	Mix 8:	Winter Triticale 50	Hairy Vetch 10	Mustard 5	65		Mix 8:	Winter Triticale 50	Hairy Vetch 10	Mustard 5	65		Mix 8:	Winter Triticale 50	Hairy Vetch 10	Mustard 5	65
	Mix 9:	Winter Rye 50	Aust. Winter Pea 25	Forage Turnip 5	80		Mix 9:	Winter Rye 50	Aust. Winter Pea 25	Forage Turnip 5	80		Mix 9:	Winter Rye 50	Aust. Winter Pea 25	Forage Turnip 5	80
	Mix 10:	Winter Rye 50	Clover-Crimson 5	Rapeseed 5	60		Mix 10:	Winter Rye 50	Clover-Crimson 5	Rapeseed 5	60		Mix 10:	Winter Rye 50	Clover-Crimson 5	Rapeseed 5	60
100 feet						100 feet						100 feet					

### Winter Hardy Mixes

Those in blue and green shades with winter rye, winter triticale, or winter wheat

Austrian winter pea is theoretically winter hardy but produced minimal to no growth in the spring (it was a very hard winter)  
Hairy vetch can overwinter, but we did not see substantial spring growth before termination

### Winter Kill Mixes

Those in orange and tan shades with annual ryegrass or forage oats

All brassicas are winter killed

Crimson and Berseem clovers do not over winter in VT



# Better Cover Crop Mixes for Vermont

## 2014-2015 Mixes

Mix	Grass	Legume	Brassica
CTR L	W. Rye		
1	Oat	Pea	Radish
2	Triticale	W. Pea	Rapeseed
3	ARG	W. Pea	Radish
4	W. Wheat	W. Pea	Radish
5	ARG	Bersee m	Radish
6	Triticale	Crimson	Radish
7	Oats	Vetch	Mustard
8	Tritic	Vetch	Mustard

## 2015-2016 Mixes

Mix	Grass	Legume	Brassica
CTR L	W. Rye		
1	Oat	Pea	Radish
2	Tritical	W. Pea	Rapeseed
3	ARG	W. Pea	Radish
4	W. Rye*	W. Pea	Radish
5	ARG	Bersee m	Radish
6	W. Rye/Oat*		Radish
7	W. Rye/Oat*	Vetch	
8	Tritical	Vetch	Turnip *



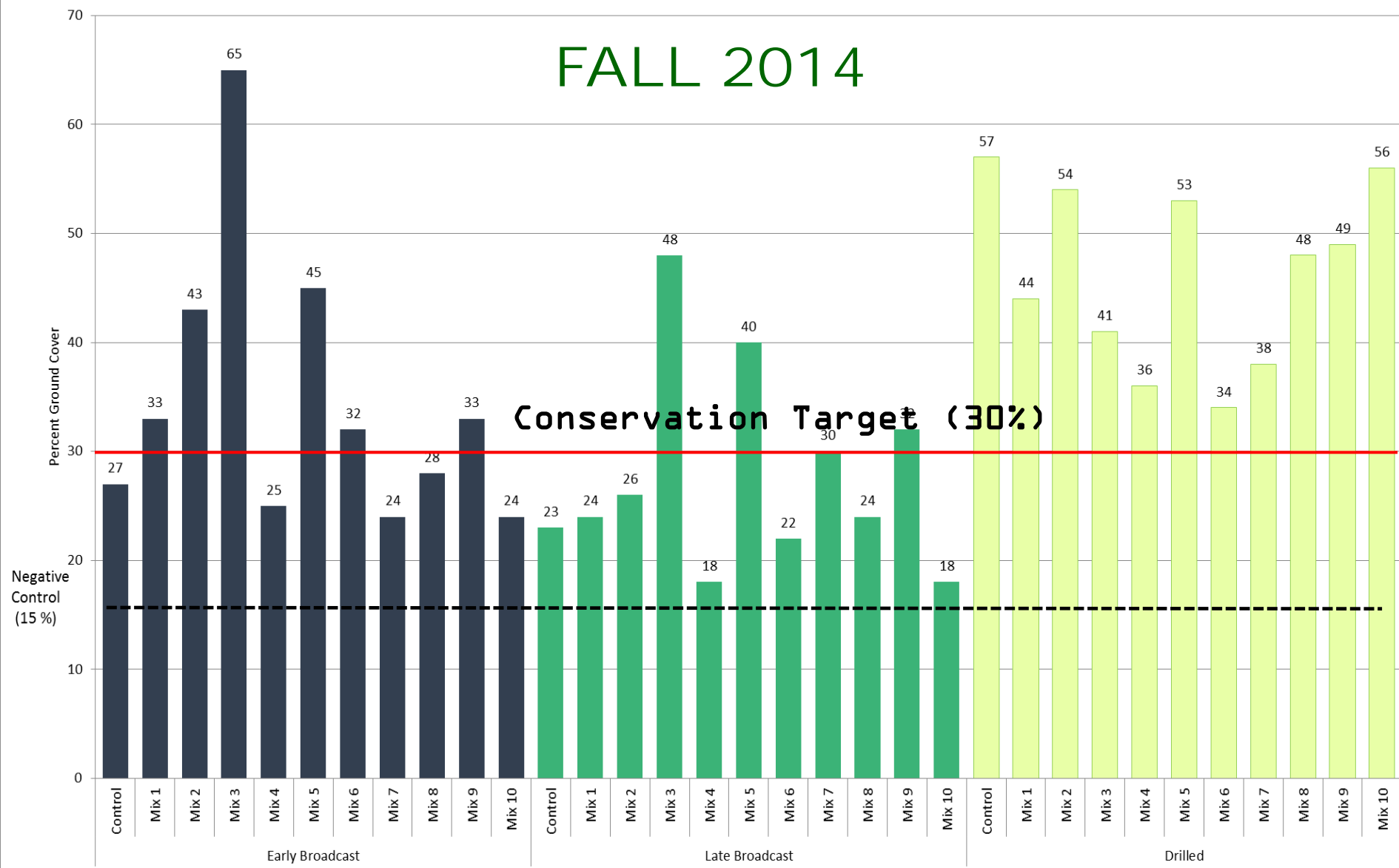
# Fall 2014: Mixes Better Drilled, Except Mix 3

## (Annual Rye, Winter Pea, Tillage Radish)

Average Percent Cover By Application and Seeding Mix  
Manure and Non-Manure Combined; 10/22/14

FALL 2014

Conservation Target (30%)

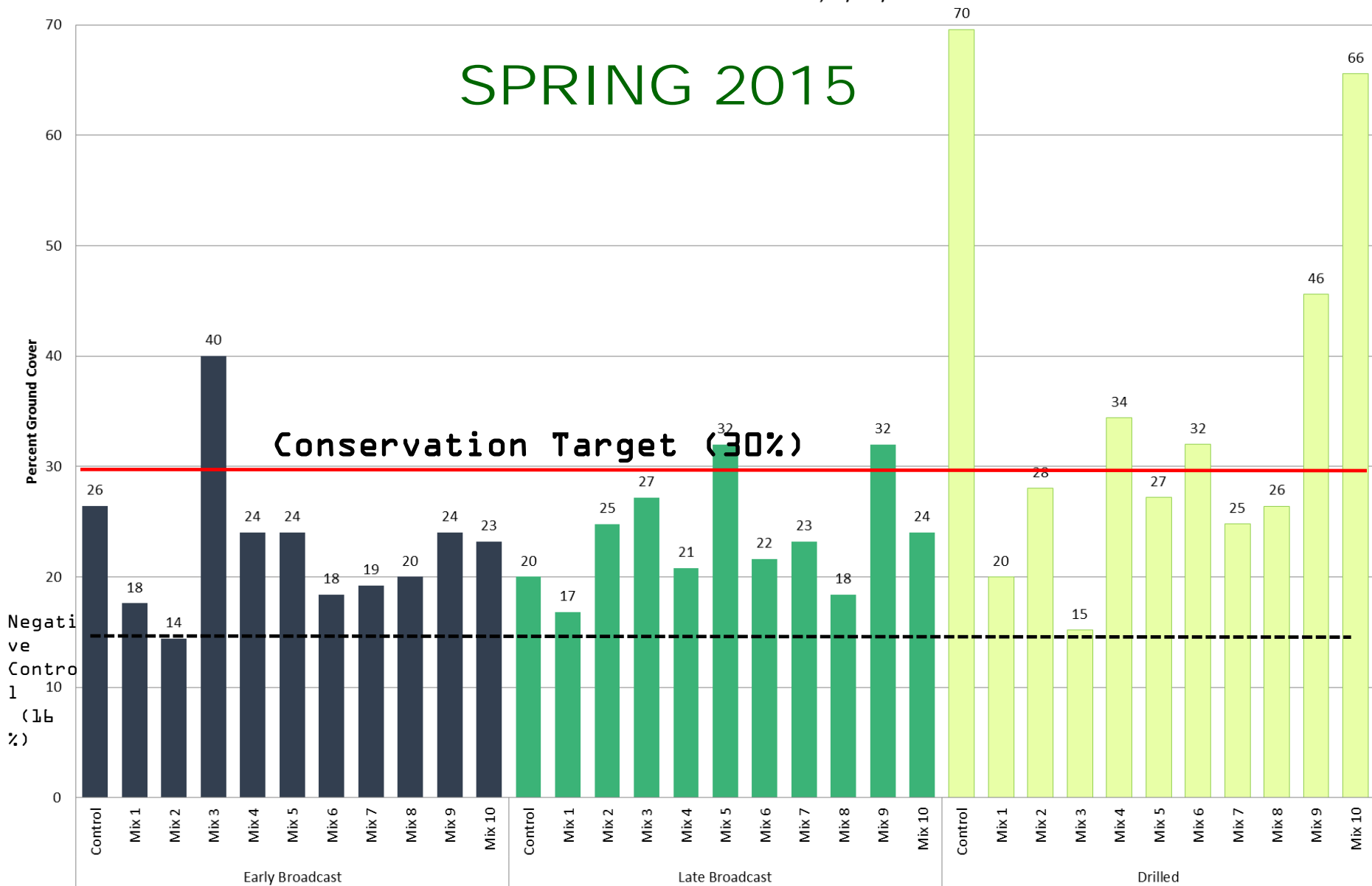




## Spring 2015: Winter Rye, Mix 9 & 10 Drilled

### Average Percent Cover By Application and Seeding Date

Manure and Non-Manure Combined; 4/29/15

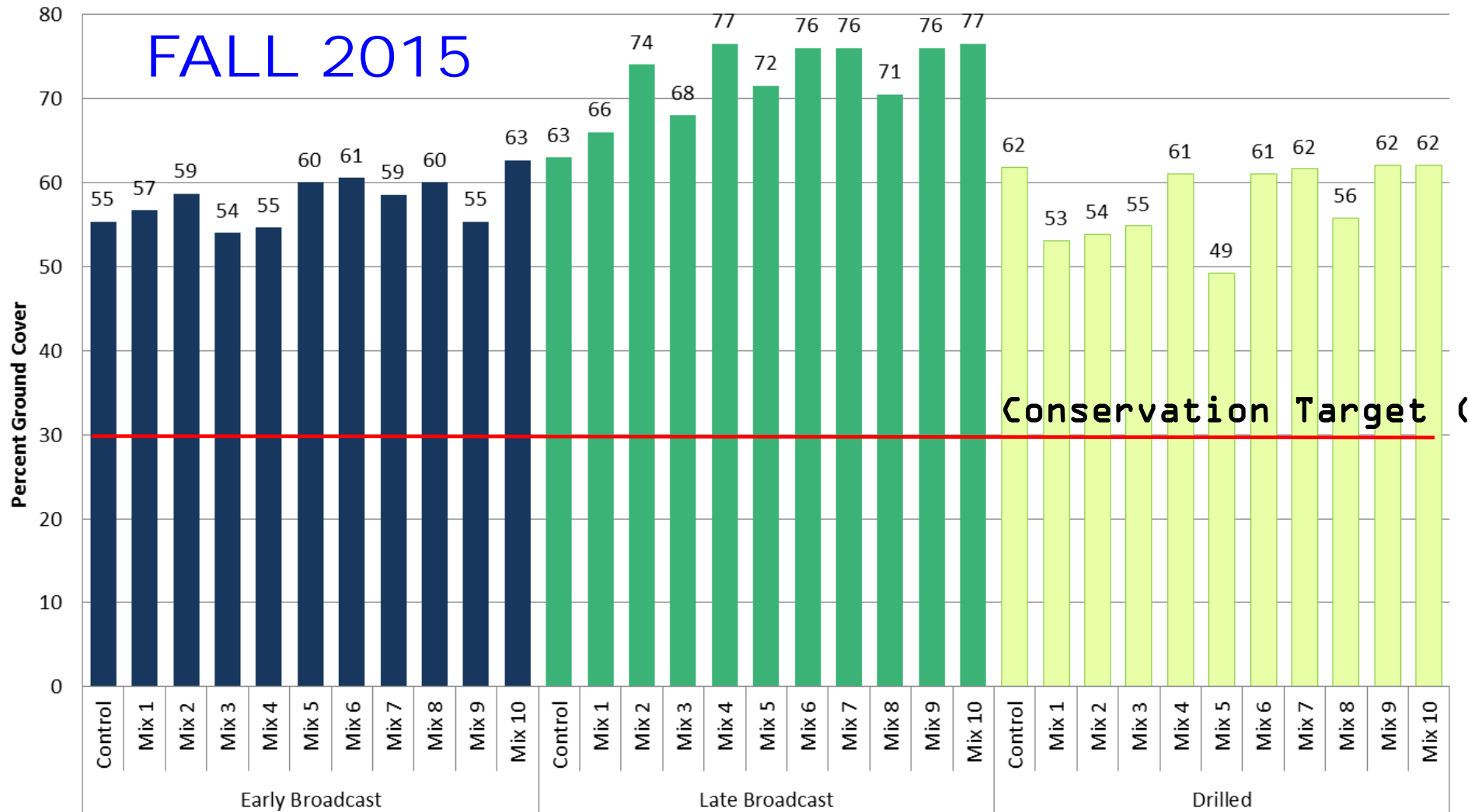


# Better Cover Crop Mixes for Vermont

## Average Percent Cover By Application and Seeding Date

Fall 2015 (All Corn Silage Fields)

FALL 2015

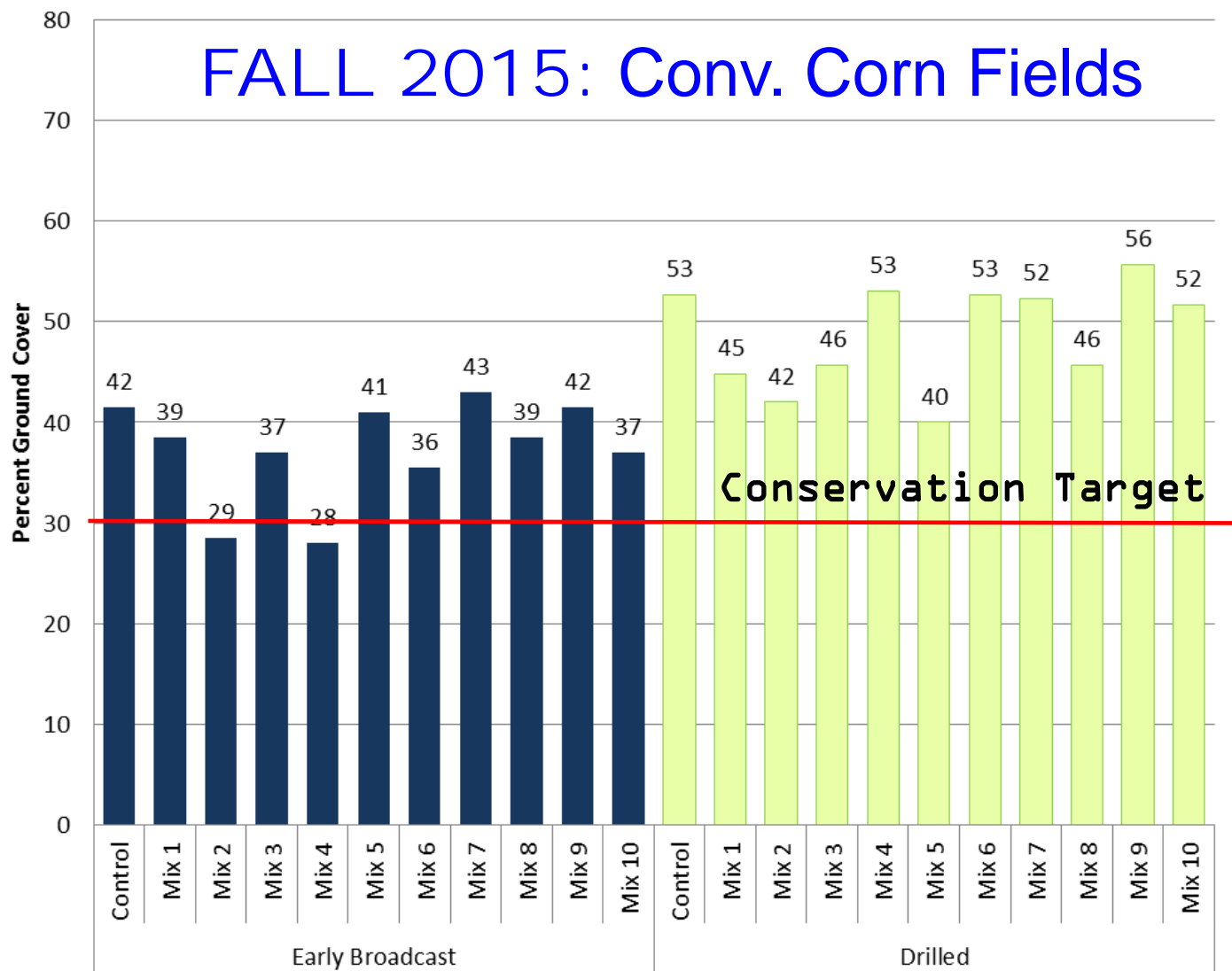




# Better Cover Crop Mixes for Vermont

Average Percent Cover By Application and Seeding Date  
Fall 2015: *Conventionally Tilled Corn Silage Fields*

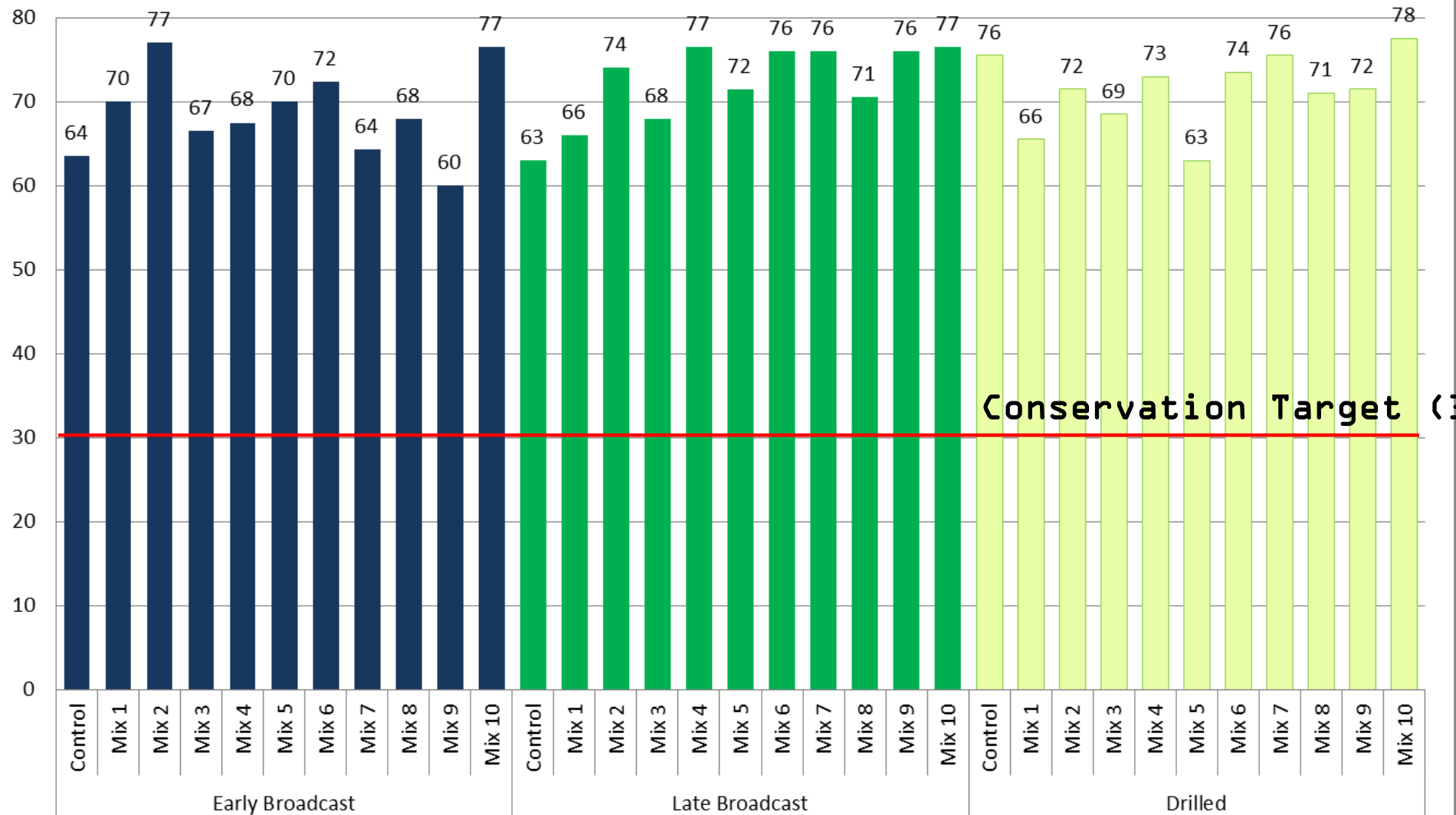
## FALL 2015: Conv. Corn Fields



# Better Cover Crop Mixes for Vermont

Average Percent Cover By Application and Seeding Date

FALL 2015: No-Till Corn Fields



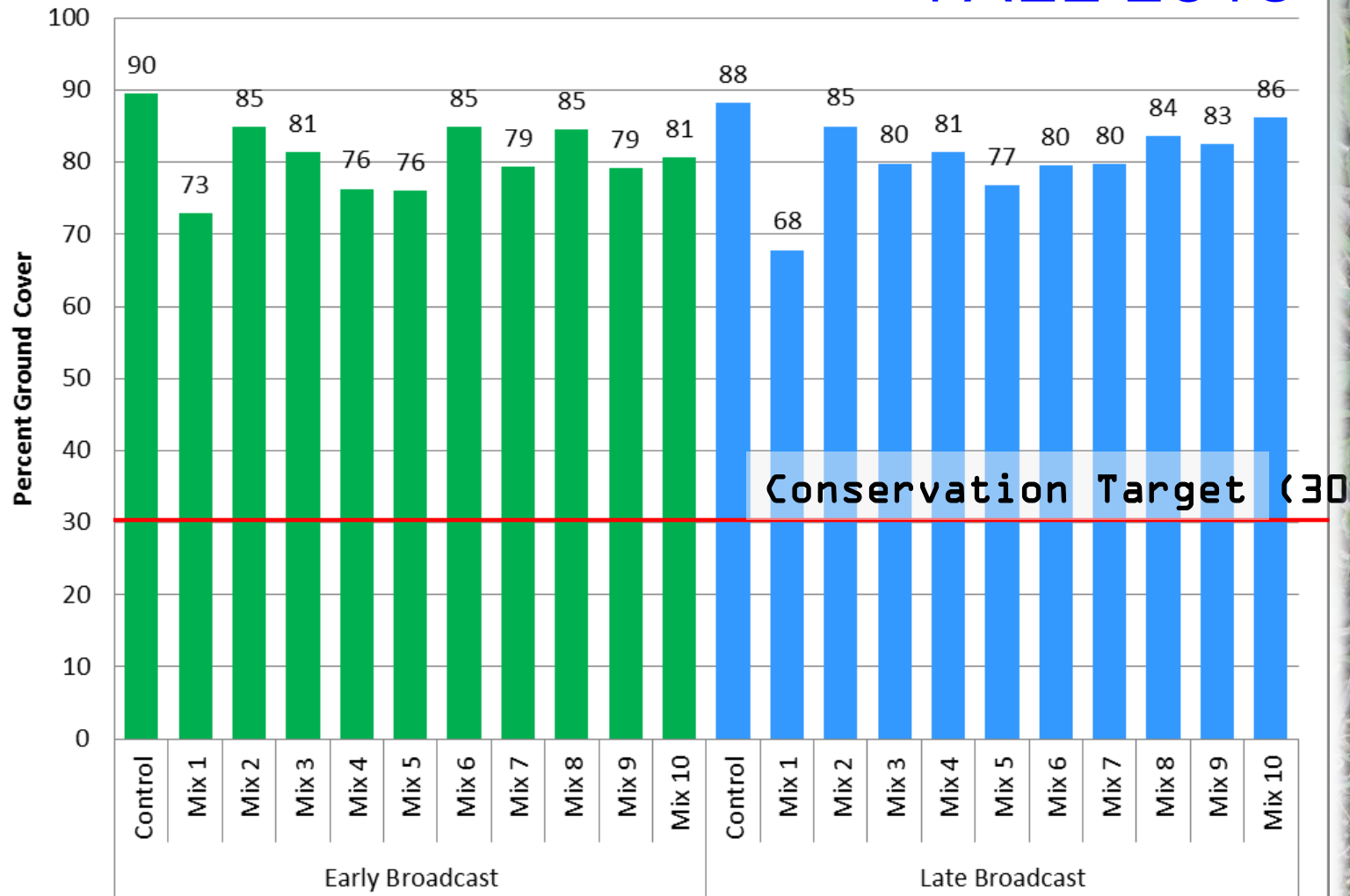


# Cover Crop Mixes in Soybeans

## Average Percent Cover By Application and Seeding Date

Fall 2015: High Residue Soybean Fields

FALL 2015





# Control Fall & Spring: 100 lbs Winter Rye

Early Broadcast

Late Broadcast

Drill

*Fall*



*Spring*





# Mix 3 Fall & Spring: ARG+W. Pea+Radish

Early Broadcast

Late Broadcast

Drill

*Fall*



*Spring*





# Mix 10 Fall & Spring: Rye + Crimson Clover + Rapeseed

Early Broadcast

Late Broadcast

Drill

*Fall*

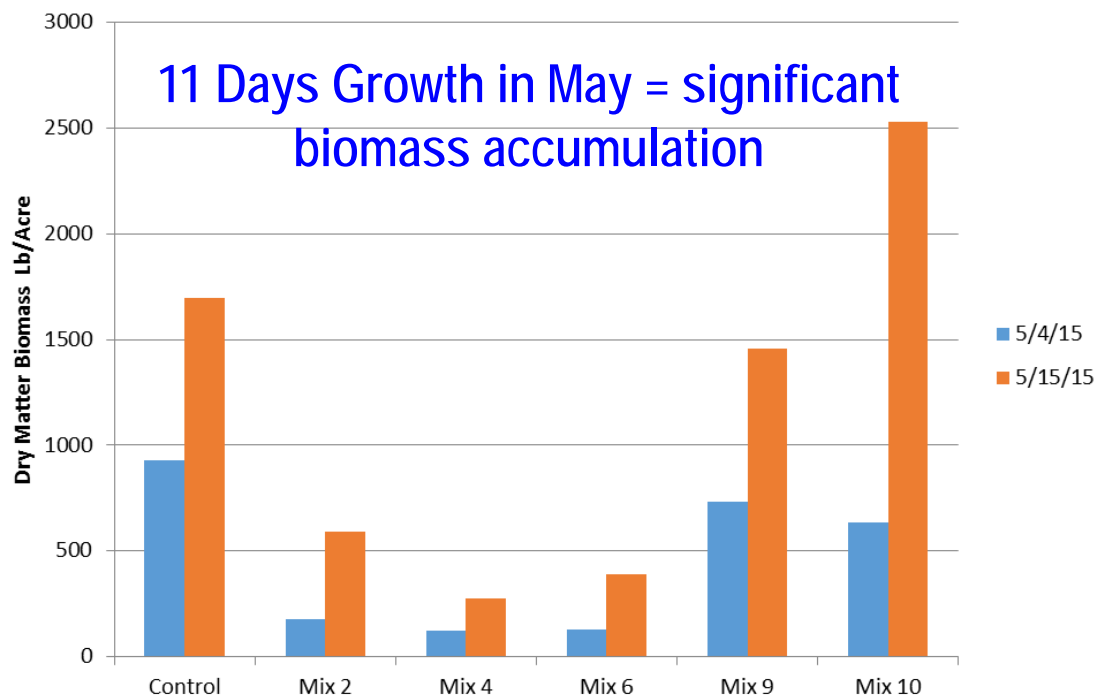


*Spring*

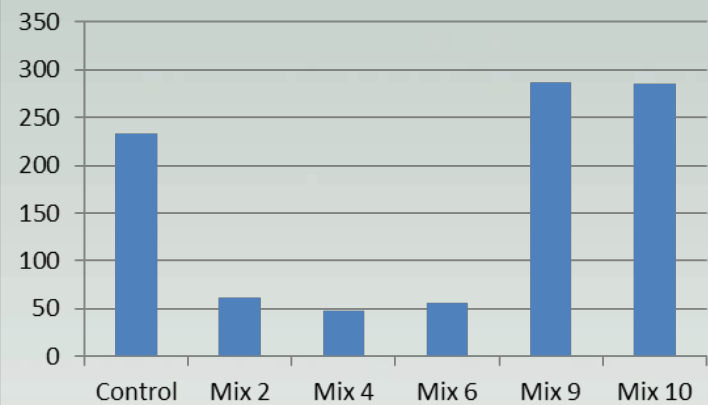




## Biomass in Drilled, Manured Plots with Spring Growth



## Biomass in Drilled, Manured Plots (different farm, 5/4/15)



Mix 9 & 10 showed promise in the fall and spring. Season length and termination date will affect biomass

Mix 9: Winter Rye, Austrian Winter Pea  
 Mix 10: Winter Rye, Crimson Clover, Rape  
 perform

Control

Mix 9

Mix 10

Manured, Drilled Plots on 5/14/15



Forage Turnip in





Broadcast

CIG Mix #6 2015:  
Rye + Oats + Radish

Broadcast 8/5/2015  
Drilled 9/23/2015  
Picture 10/14/2015

No manure

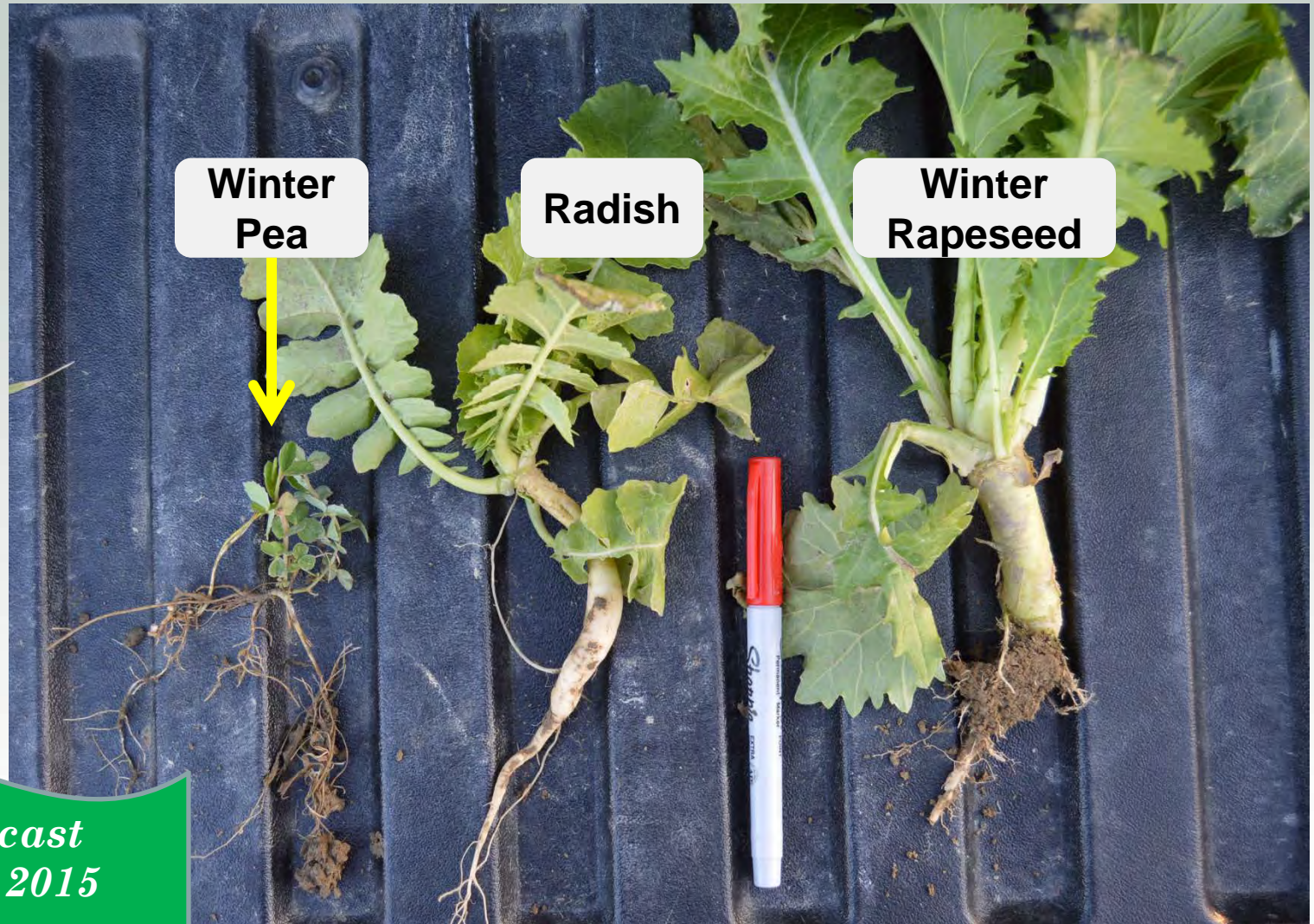
True in Fall 2015 also



Drilled



# Better Cover Crop Mixes for Vermont

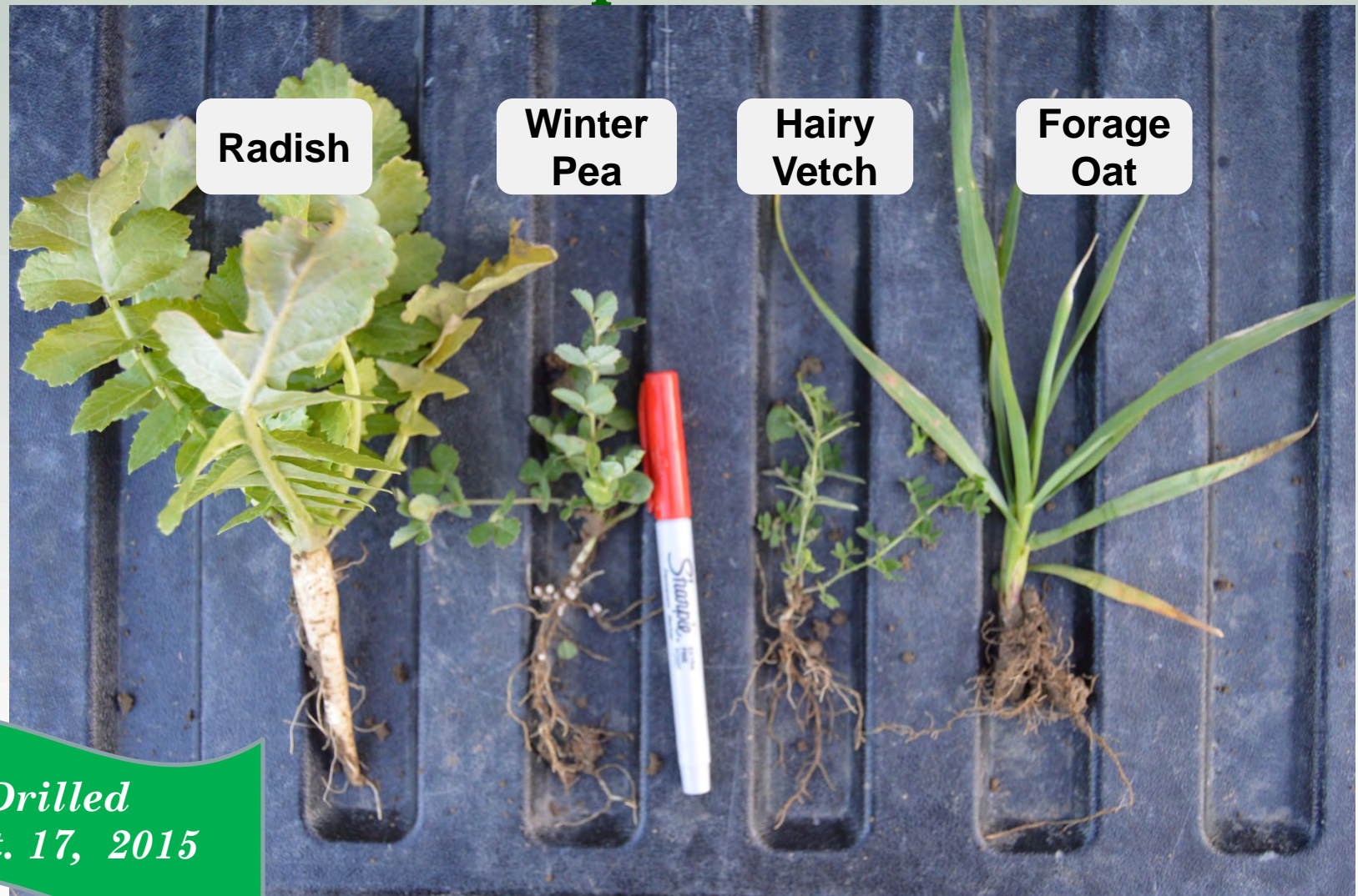


*Broadcast  
Aug. 5, 2015*

Picture: Dec. 11, 2015



# Better Cover Crop Mixes for Vermont



*Drilled  
Sept. 17, 2015*

Picture: Dec. 11, 2015



# OPENING A NEW WINDOW OF OPPORTUNITY FOR COVER CROP MIXES

## Cereal Grains in the Rotation & Prevented Plantings



Vorsteveld Farm,

Panton



### CROP ROTATIONS:

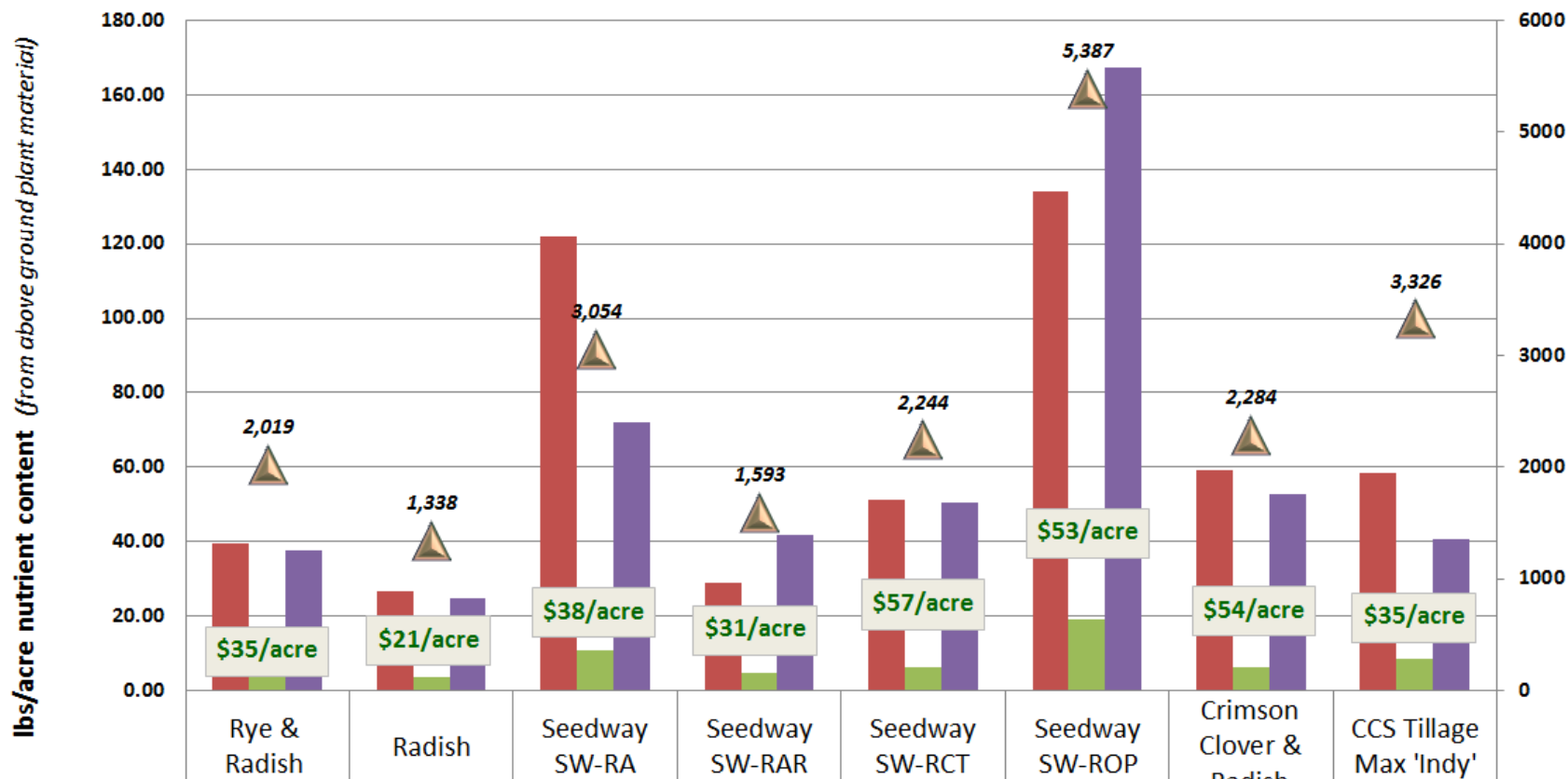
Add a cereal grain to your  
rotation...  
open up a great cover  
cropping or rotation  
opportunity



# Cover Crop Mixes

## After Winter Rye Harvest

Nutrient Uptake & Biomass of Cover Crop Mixes at Vorsteveld Farm - Planted on 08-12-2014, Sampled on 10-20-2014



■ Nitrogen (N)	39.56	26.57	121.95	29.04	51.13	134.11	59.31	58.37
■ Phosphorus (P)	5.25	3.60	10.86	4.84	6.11	19.09	6.27	8.40
■ Potassium (K)	37.56	24.72	71.88	41.72	50.60	167.37	52.80	40.63
▲ Dry Matter Biomass (lbs/ac)	2019	1338	3054	1593	2244	5387	2284	3326

# Cover Crops in Prevented Plantings



Winter Rye



Forage Oats



Buckwheat



Radish



Rye, Oat, Radish

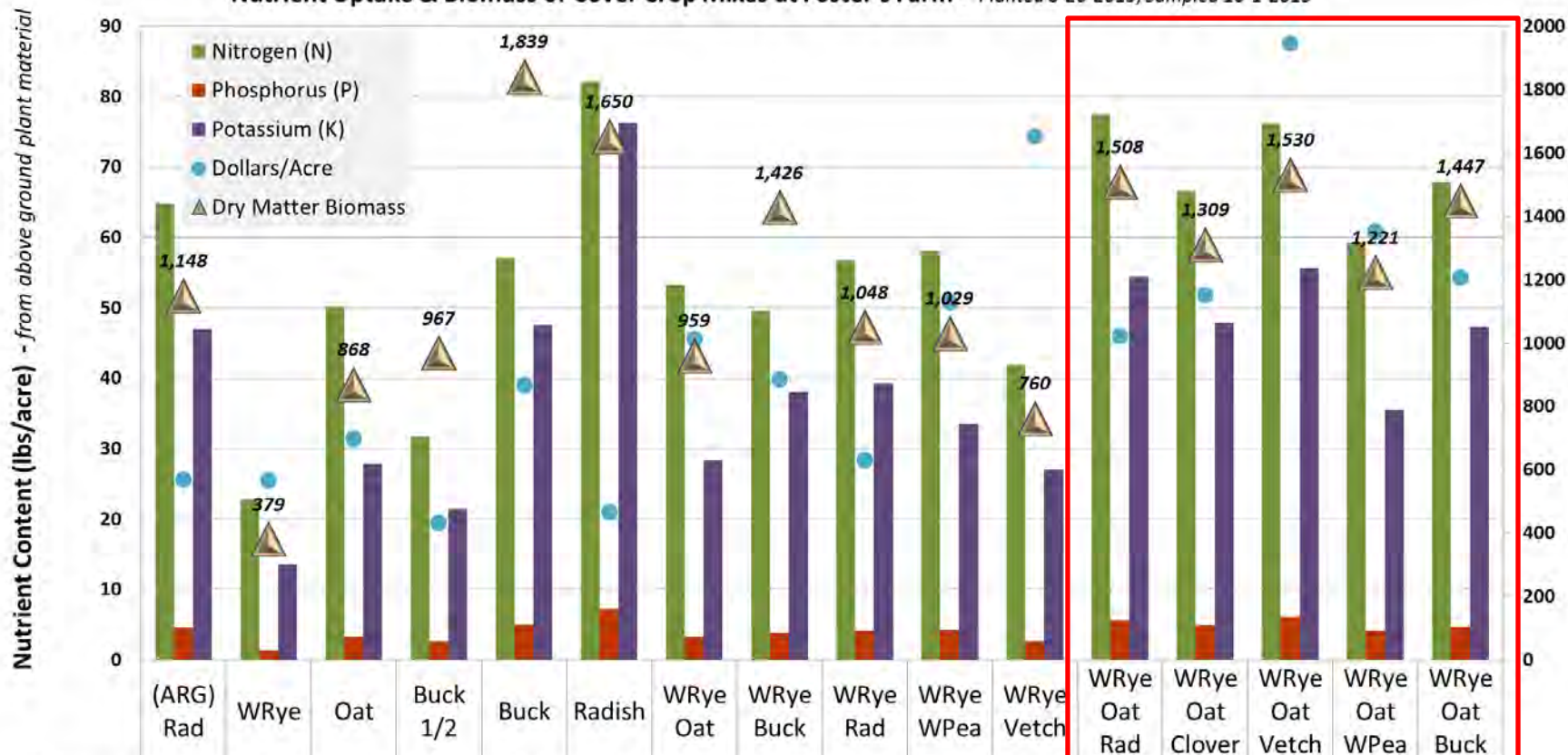
Foster Bros. Farm,  
Middlebury





# Cover Crop Mixes in Prevented Plantings

Nutrient Uptake & Biomass of Cover Crop Mixes at Foster's Farm - Planted 8-20-2015, Sampled 10-1-2015



	(ARG) Rad	WRye	Oat	Buck 1/2	Buck	Radish	WRye Oat	WRye Buck	WRye Rad	WRye WPea	WRye Vetch	WRye Oat Rad	WRye Oat Clover	WRye Oat Vetch	WRye Oat WPea	WRye Oat Buck
Nitrogen (N)	64.82	22.76	50.11	31.71	57.08	82.11	53.23	49.51	56.70	58.13	41.85	77.44	66.62	76.14	59.21	67.83
Phosphorus (P)	4.59	1.44	3.21	2.61	4.97	7.26	3.26	3.85	4.19	4.22	2.66	5.58	4.84	6.12	4.15	4.63
Potassium (K)	46.94	13.54	27.85	21.46	47.63	76.24	28.28	38.08	39.31	33.55	26.99	54.43	47.92	55.70	35.54	47.31
Dollars/Acre	\$26	\$26	\$32	\$20	\$39	\$21	\$46	\$40	\$28	\$51	\$74	\$46	\$52	\$88	\$61	\$54
Dry Matter Biomass	1148	379	868	967	1839	1650	959	1426	1048	1029	760	1508	1309	1530	1221	1447





**50 lbs Winter Rye**  
**50 lbs Forage Oat**  
**4 lbs Radish**

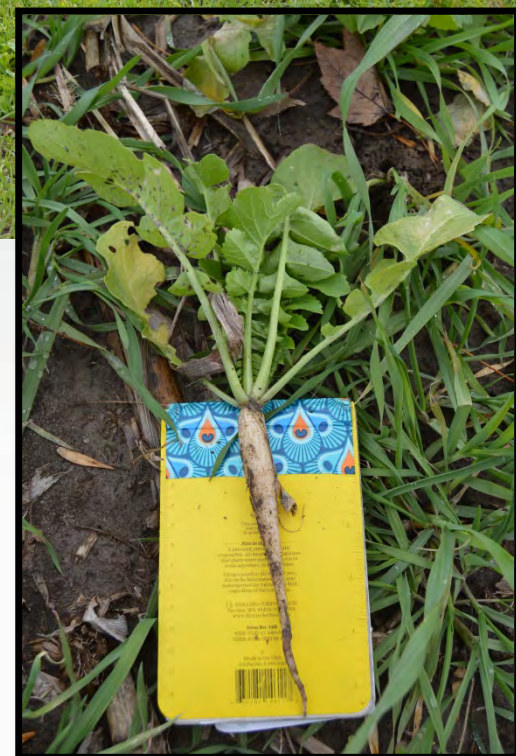
Elmwood Fine Sandy Loam

Vorsteveld Farm,

Panton

**Drilled September 10**  
**Picture October 29**

**Will get spring manure**





**50 lbs Winter Rye  
50 lbs Forage Oat  
4 lbs Radish**

**Broadcast seed Sept 10  
Incorporated with manure  
injection (low dist)  
Picture October 29**



Vergennes B Clay-undrained







Vorsteveld Farm,  
Panton

*Pictures  
Jan. 25, 2016*



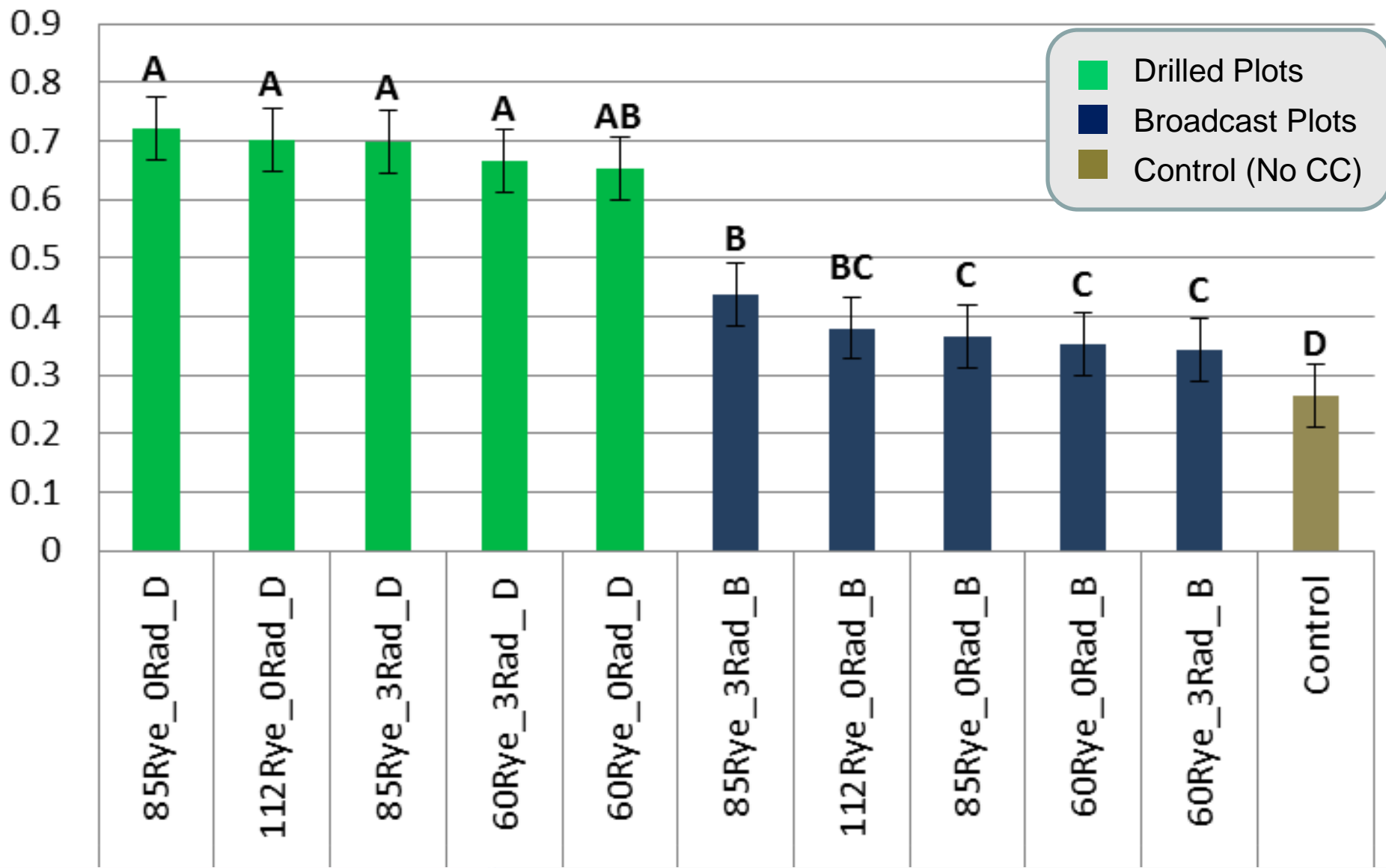


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under award number 2014-68006-21864.

# Rye-Radish: Percent Cover Fall 2014





**Broadcast**

85 lbs Winter Rye +  
3 lbs Radish

Planted 9/9/2015

**Picture 10/2/2015**

*4000 gallons/acre dairy  
manure*

*Vergennes B Clay*



**Drilled**



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68006-21864.





85 lbs Winter Rye +  
3 lbs Radish

Planted 9/9/2015

**Picture 11/6/2015**

*4000 gallons/acre dairy  
manure*

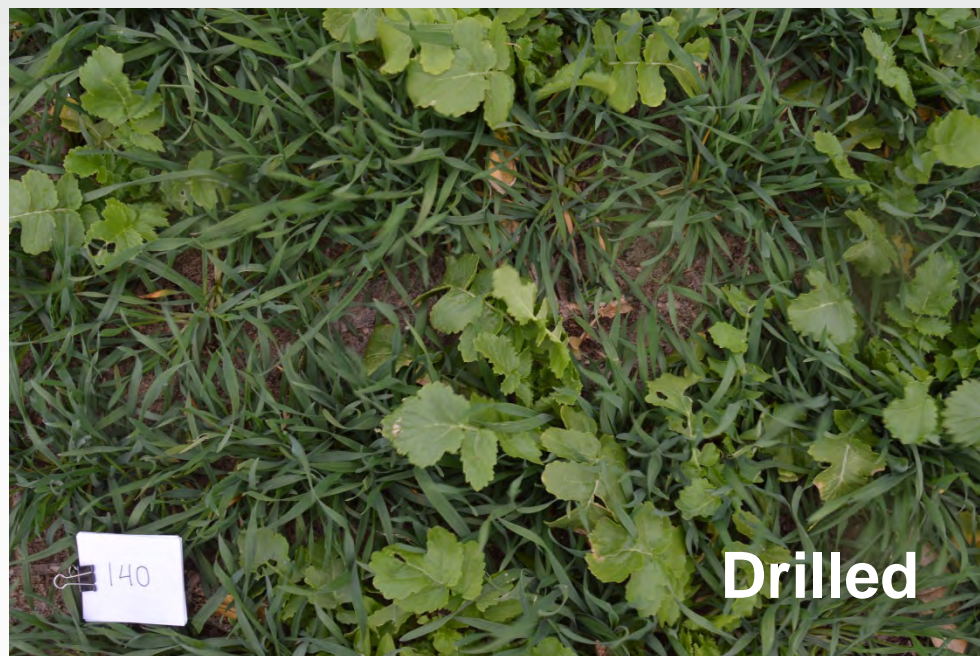
*Vergennes B Clay*



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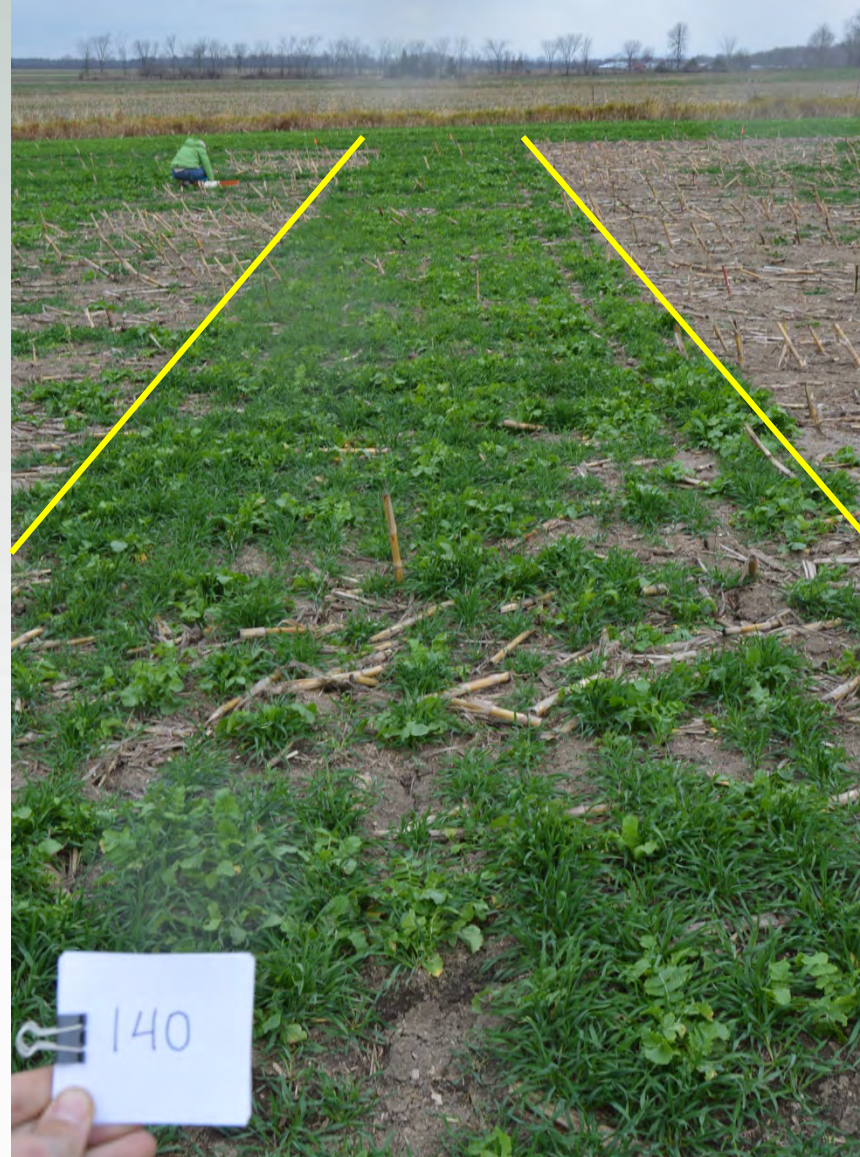




**Broadcast**



**Drilled**

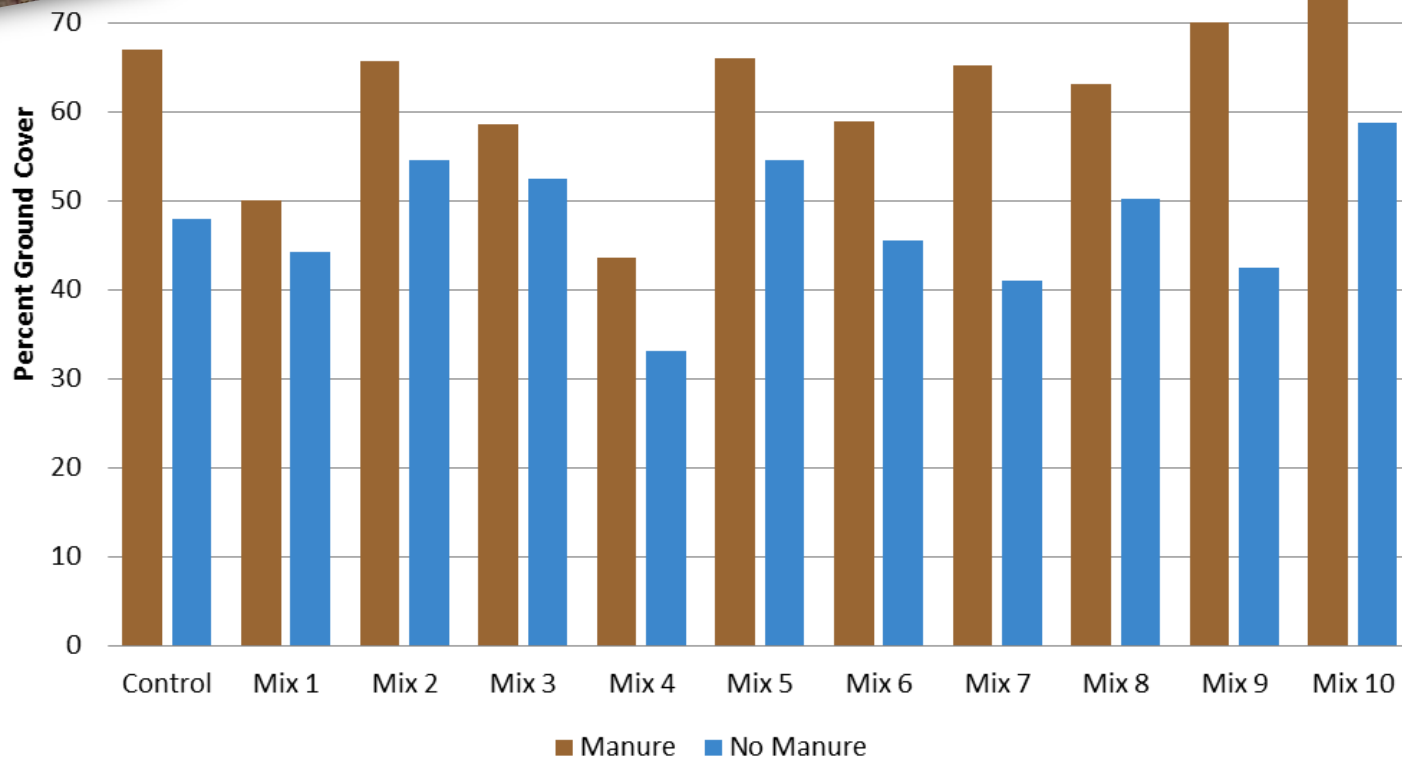






## Average Percent Cover of Cover Crops on Two Field Plots with Manure and Two Field Plots without Manure Drilled Plots Only (11/12/14)

**Manure...**  
makes  
plants grow  
more,  
particularly  
when  
plants were  
drilled



# COVER CROPS & MANURE: PERFECT PARTNERS

*Triticale/Hairy Vetch Cover Crop Plots with/without manure @ VYCC*

						FALL 2013 AVG % Cover	SPRING 2014 AVG % Cover
Hairy Vetch Treatment (lbs./ac.)	Manure	AVG DM Yield lbs/Ac	AVG lbs N/acre	AVG lbs P/acre	AVG lbs K/acre		
10	Yes	939.0	28.4	6.2	43.7	32%	62%
20	Yes	<b>1115.1</b>	<b>34.0</b>	<b>7.4</b>	<b>52.6</b>	<b>35%</b>	60%
30	Yes	1035.0	31.7	6.9	48.4	34%	<b>64%</b>
10	No	250.8	12.3	2.4	16.8	17%	42%
20	No	<b>522.8</b>	<b>17.1</b>	<b>3.5</b>	<b>24.2</b>	<b>21%</b>	37%
30	No	501.5	16.5	3.4	23.1	16%	<b>43%</b>

Manure

No  
Manure





# Manure Injection & Cover Crops

Cover Crop Broadcast

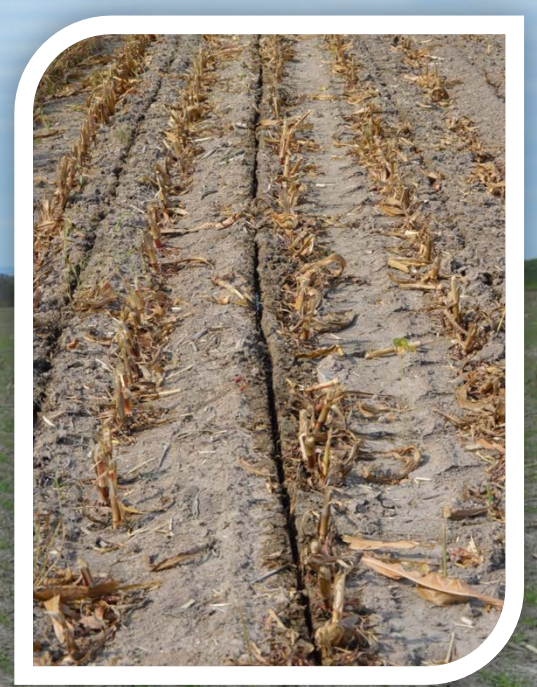
Manure Injected right after...helps incorporate seed.





# Blue Spruce Farm

Winter Rye No-Till Drilled into  
Injected Field  
October 6, 2015 (1 mo. After  
planting)





# Blue Spruce Farm

Winter Rye No-Till Drilled into  
Injected Field

November 18, 2015 (2+ mo. After  
planting)





# Nea-Tocht Farm

Fall Manure Injection into 4"

Winter Rye Cover Crop

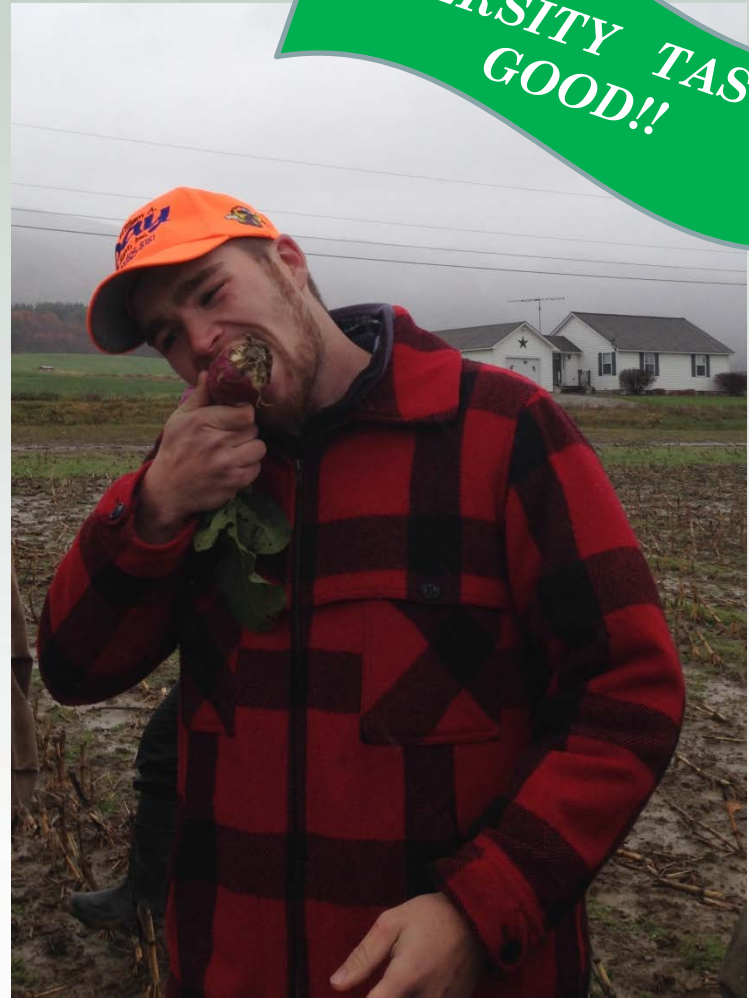






# QUESTIONS??

DIVERSITY TASTES  
GOOD!!





# MULTI-SPECIES COVER CROP MIXES



*For More Information:*

Jeff Carter \* Kirsten Workman  
Rico Balzano \* Cheryl Cesario \* Kristin Williams  
Dan Infurna \* Nate Severy

UVM Extension

23 Pond Lane, Suite 300

Middlebury, VT 05753

802-388-4969

[champlain.crops@uvm.edu](mailto:champlain.crops@uvm.edu)

<http://www.uvm.edu/extnsion/cvcrops>



*Champlain Valley Crop, Soil & Pasture Team*  
*Helping You Put Knowledge to Work*

