Cover Crop Challenges in Dryland Farming Systems

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• Review recent cover crops research at Dickinson
• Identify cover crop challenges in dryland cropping systems
• Describe ongoing research
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Dickinson

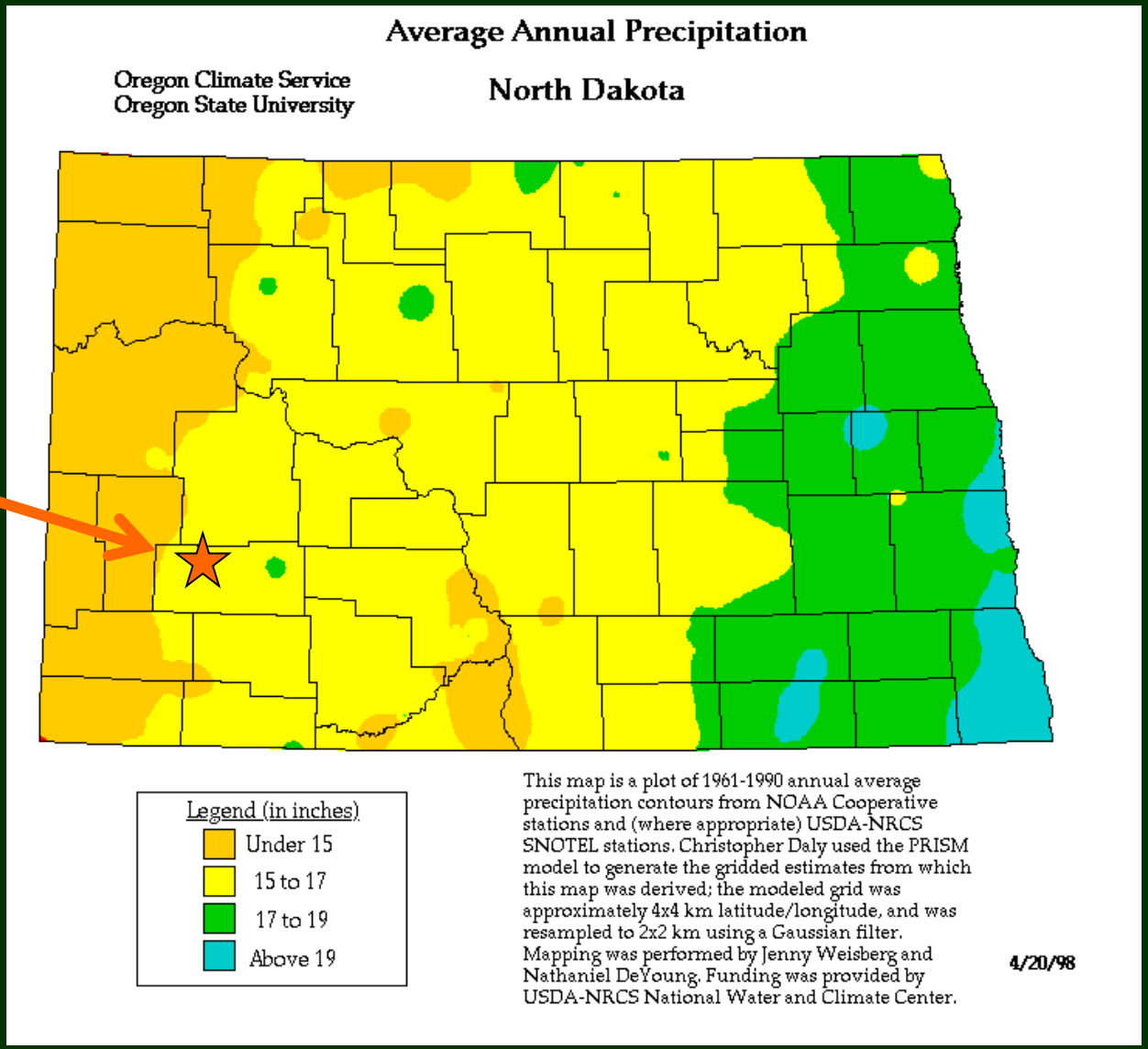

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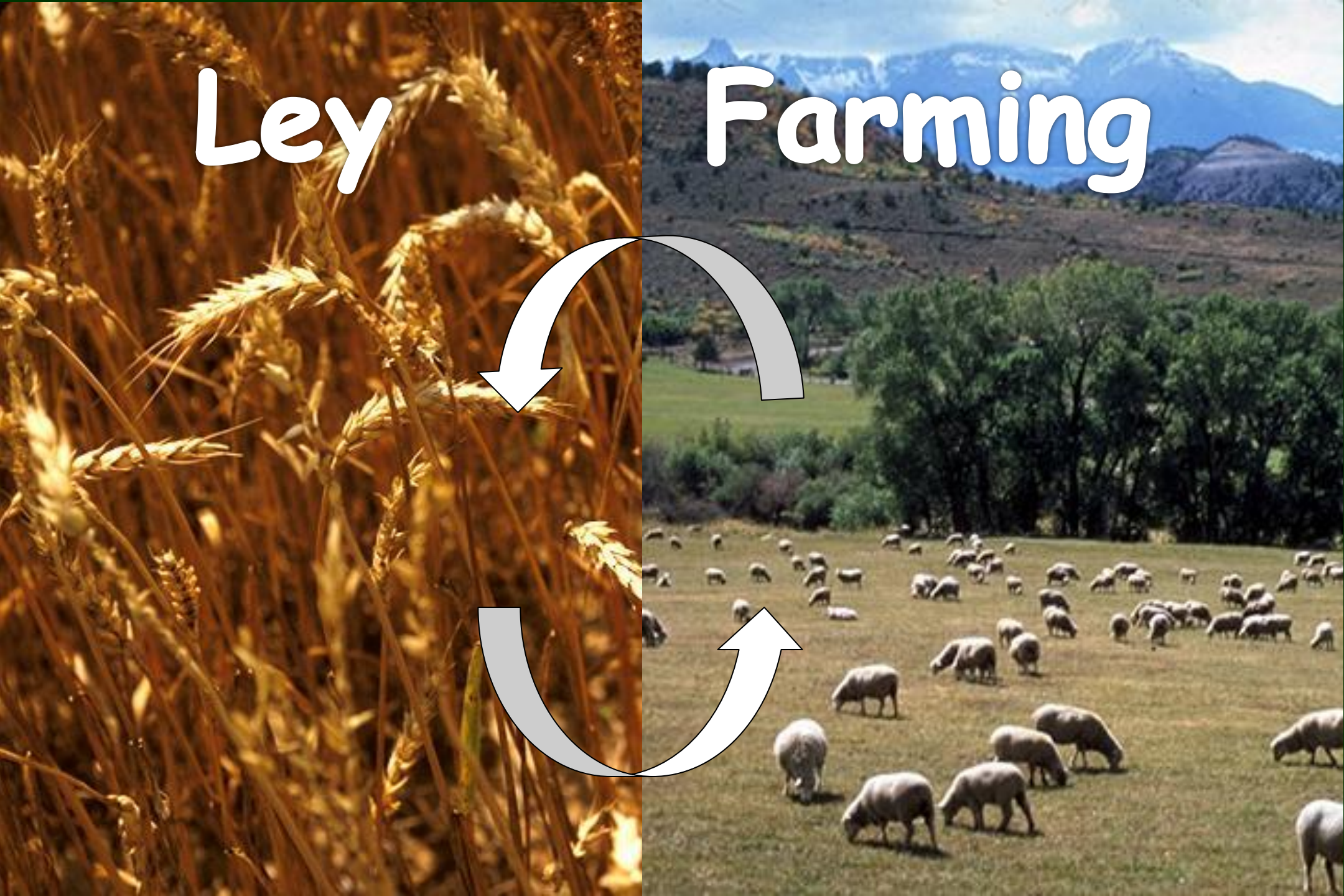
Image available at
http://www.ocs.orst.edu/pub/maps/Precipitation/Total/States/ND/nd.gif


Ley
Farming

A few Montana farmers were persuaded by Jim Sims to incorporate legume cover crops for use as early-spring pasture into their cropping systems.

Alfalfa

6 standard "purple"cultivars and 1 yellow-flowered

Clovers

alsike, arrowleaf, balansa, berseem, crimson, kura, ladino, Persian, red, yellow- and white-flowered sweetclover

Medics

barrel, black, burr, *M. rigulata*, snail

Vetches

chickling, cicer milk-, crown, hairy, purple, woolypod

Others

black lentil, Austrian winter pea, birdsfoot trefoil, foxtail dalea, fenugreek, roughpea, sainfoin

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Table 1. Dry matter yield of forage produced by legume forage crops in the seeding year & after natural reseeding at Dickinson, ND.

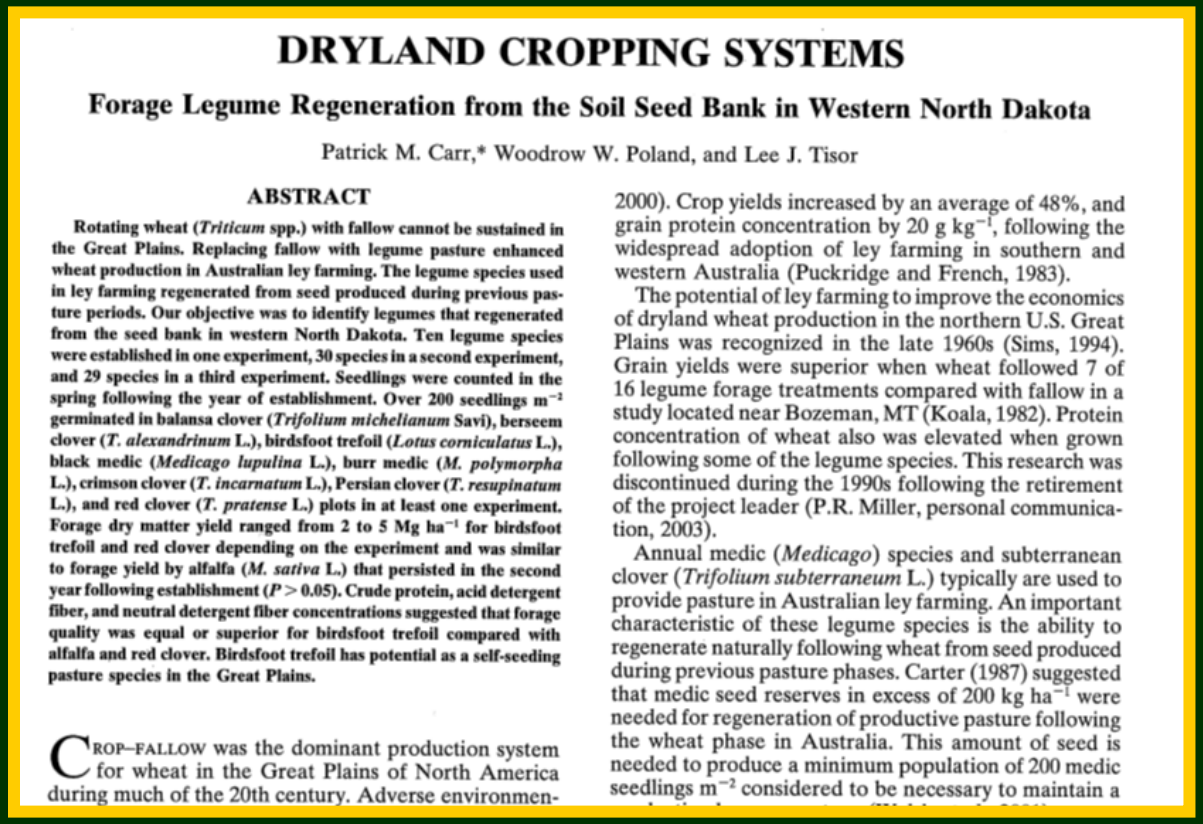
		Site 1			Site 2			Site 3		
Forage crop	Cultivar	1999	2000	Total	2000	2001	Total	2001	2002	Total
		---------- Mg/ha ----------								
Birdsfoot trefoil		2.3 a	2.0 ab	4.3	2.1 a	2.9 a	5.0	1.8 a	2.5 ab	4.3
Black medic	George	3.7 a	0.9 b	4.6	2.6 a	1.6 a	4.2	2.7 a	0.2 a	2.9
Red clover	Red Gold	--	--		2.6 a	1.9 a	4.5	2.6 a	4.9 b	7.5
Alfalfa	Ladak	3.6 a	3.8 a	7.4	2.6 a	5.9 b	8.5	3.1 a	4.2 b	7.3

Letters differing in columns indicate differences between forage crop treatments at $P < 0.05$ level using the REGW multiple range test.

Following-crop wheat yield reduced from 0 to 57%

Spring wheat grain yield following five forage legumes

Legume species	Cultivar	Yield 2001	Yield 2002	Yield 2003
		----------	kg/ha	----------
Austrian winter pea (fallow)	----------	3501 a	1007 a	2162 a
Alfalfa	Ladak	1381 b	1306 a	952 bc
Birdsfoot trefoil	Norcen	1944 b	884 a	1006 bc
Black medic	George	3634 a	1150 a	939 bc
Red clover	Red Gold	--	1203 a	1204 bc
Mean		2469	1194	1330
CV (%)		8.2	34.5	21.2



DRYLAND CROPPING SYSTEMS

Forage Legume Regeneration from the Soil Seed Bank in Western North Dakota

Patrick M. Carr,* Woodrow W. Poland, and Lee J. Tisor

ABSTRACT

Rotating wheat (*Triticum* spp.) with fallow cannot be sustained in the Great Plains. Replacing fallow with legume pasture enhanced wheat production in Australian ley farming. The legume species used in ley farming regenerated from seed produced during previous pasture periods. Our objective was to identify legumes that regenerated from the seed bank in western North Dakota. Ten legume species were established in one experiment, 30 species in a second experiment, and 29 species in a third experiment. Seedlings were counted in the spring following the year of establishment. Over 200 seedlings m^{-2} germinated in balansa clover (*Trifolium michelianum* Savi), berseem clover (*T. alexandrinum* L.), birdsfoot trefoil (*Lotus corniculatus* L.), black medic (*Medicago lupulina* L.), burr medic (*M. polymorpha* L.), crimson clover (*T. incarnatum* L.), Persian clover (*T. resupinatum* L.), and red clover (*T. pratense* L.) plots in at least one experiment. Forage dry matter yield ranged from 2 to 5 Mg ha^{-1} for birdsfoot trefoil and red clover depending on the experiment and was similar to forage yield by alfalfa (*M. sativa* L.) that persisted in the second year following establishment ($P > 0.05$). Crude protein, acid detergent fiber, and neutral detergent fiber concentrations suggested that forage quality was equal or superior for birdsfoot trefoil compared with alfalfa and red clover. Birdsfoot trefoil has potential as a self-seeding pasture species in the Great Plains.

CROP–FALLOW was the dominant production system for wheat in the Great Plains of North America during much of the 20th century. Adverse environmen-

2000). Crop yields increased by an average of 48%, and grain protein concentration by 20 g kg^{-1}, following the widespread adoption of ley farming in southern and western Australia (Puckridge and French, 1983).

The potential of ley farming to improve the economics of dryland wheat production in the northern U.S. Great Plains was recognized in the late 1960s (Sims, 1994). Grain yields were superior when wheat followed 7 of 16 legume forage treatments compared with fallow in a study located near Bozeman, MT (Koala, 1982). Protein concentration of wheat also was elevated when grown following some of the legume species. This research was discontinued during the 1990s following the retirement of the project leader (P.R. Miller, personal communication, 2003).

Annual medic (*Medicago*) species and subterranean clover (*Trifolium subterraneum* L.) typically are used to provide pasture in Australian ley farming. An important characteristic of these legume species is the ability to regenerate naturally following wheat from seed produced during previous pasture phases. Carter (1987) suggested that medic seed reserves in excess of 200 kg ha^{-1} were needed for regeneration of productive pasture following the wheat phase in Australia. This amount of seed is needed to produce a minimum population of 200 medic seedlings m^{-2} considered to be necessary to maintain a

- Carr, P.M., W.W. Poland, and L.J. Tisor. 2005. Forage legume regeneration from the soil seed bank in western North Dakota. Agronomy Journal 97:505-513.

- Carr, P.M., W.W. Poland, and L.J. Tisor. 2005. Natural reseeding by forage legumes following wheat in western North Dakota. Agronomy Journal 97:1270-1277.

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LEY FARMING: A SYSTEMS APPROACH TO INTEGRATING CROP AND LIVESTOCK ENTERPRISES

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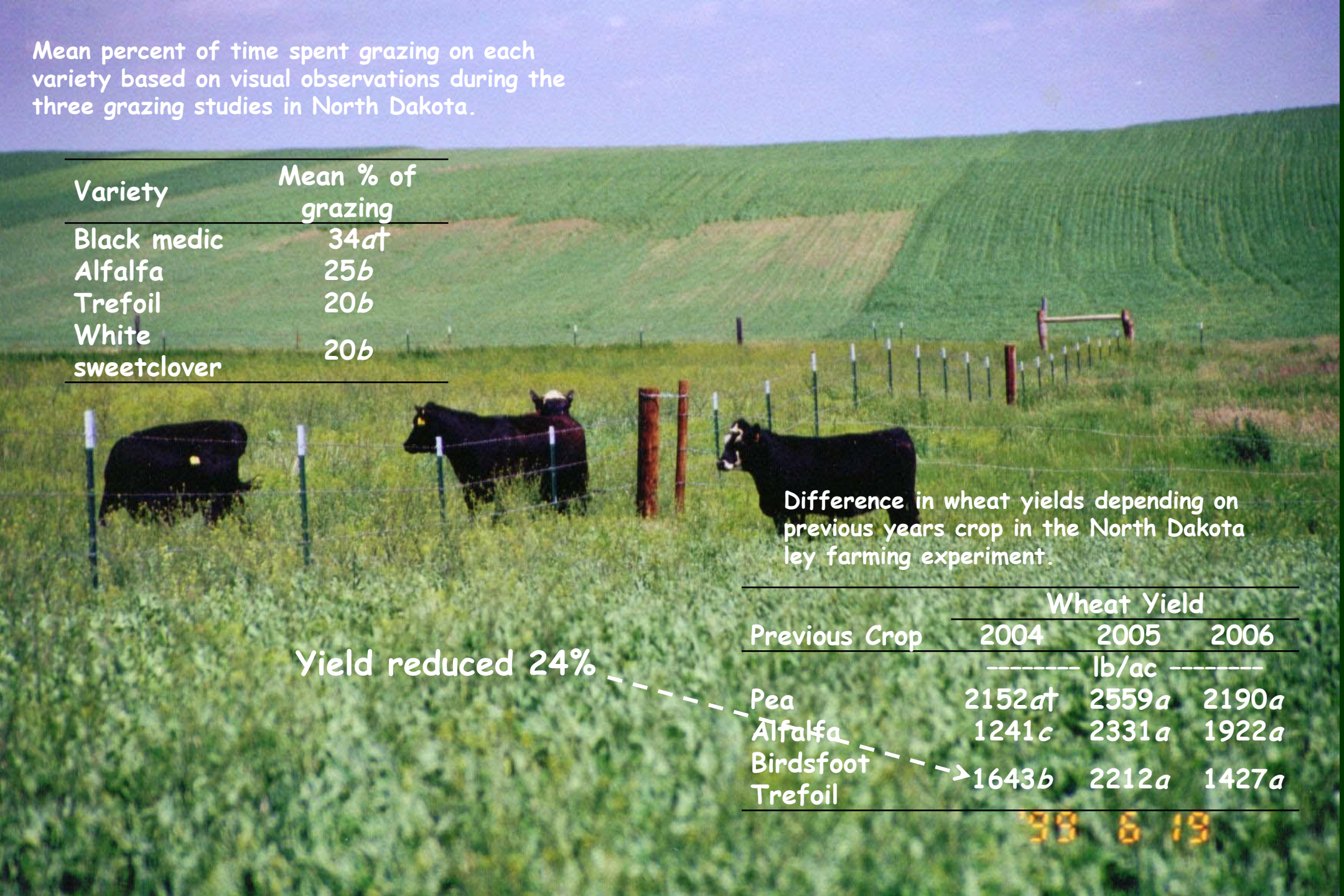
Mean rigid medic and birdsfoot trefoil (Trefoil) yields (lbs/ac) depending on tillage and seeding method for the four project locations.

Variety	North Dakota		South Dakota		Montana		Wyoming	
	2005	2006	2005	2006	2005	2006	2005	2006‡
Rigid Medic								
Till/Broadcast	0a§	2153a	1680a	--	497a	805a	--	2900a
No Till/Drilled	0a	1870a	2280a	--	1733a	1131a	--	3381a
Trefoil								
Till/Broadcast	146a	1139a	534a	--	1447a	169a	--	101b
No Till/Drilled	331a	1288a	1030a	--	1161a	258a	--	223a

†Rigid medic fall seeded and trefoil spring seeded, except in ND 2006 and MT and SD 2005, where all treatments were spring seeded.
‡Irrigated trial.
§Values with the same letter within each column and each variety are not significantly different at $p = 0.05$.

Mean percent of time spent grazing on each variety based on visual observations during the three grazing studies in North Dakota.

Variety	Mean % of grazing
Black medic	34*a*†
Alfalfa	25*b*
Trefoil	20*b*
White sweetclover	20*b*



Yield reduced 24%

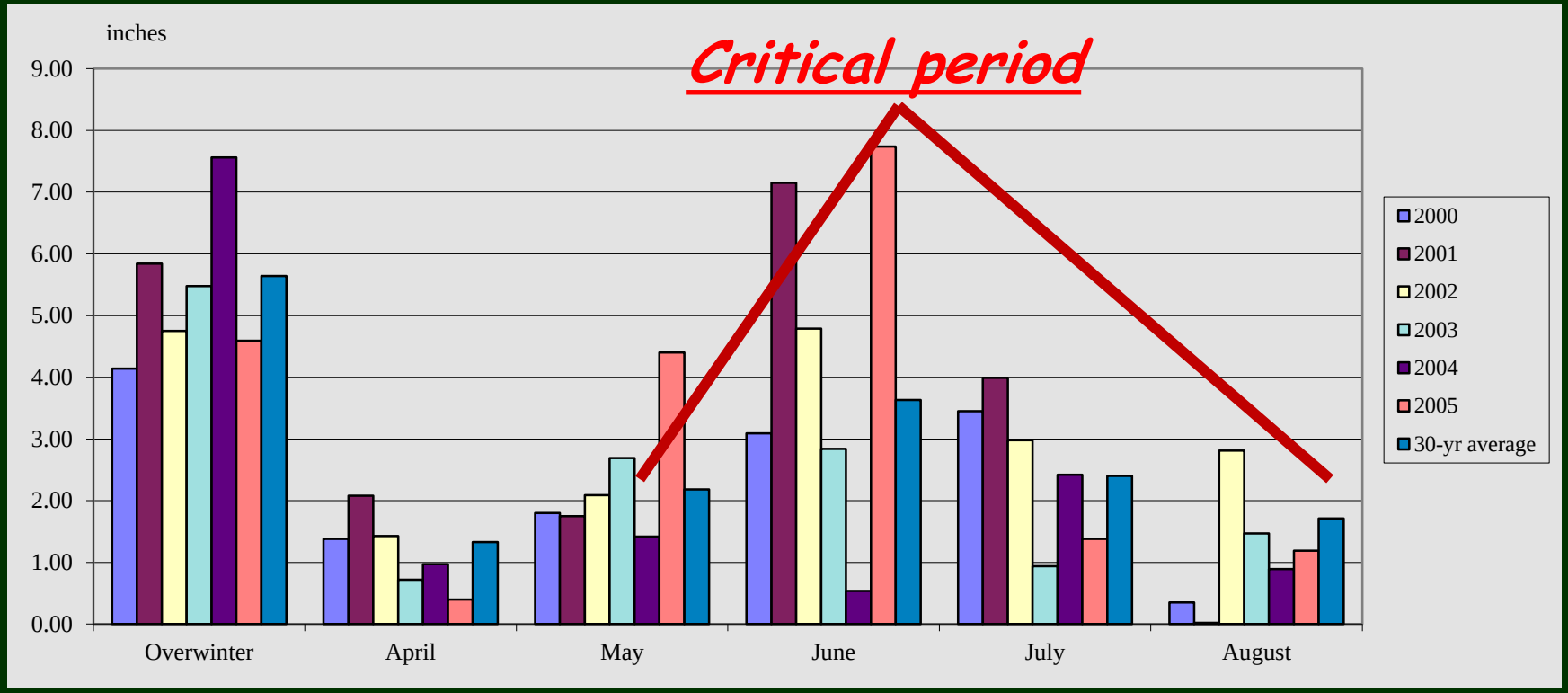
Difference in wheat yields depending on previous years crop in the North Dakota ley farming experiment.

	Wheat Yield		
Previous Crop	2004	2005	2006
	-------- lb/ac --------		
Pea	2152*a*†	2559*a*	2190*a*
Alfalfa	1241*c*	2331*a*	1922*a*
Birdsfoot Trefoil	1643*b*	2212*a*	1427*a*

Use of annual forages in beef cattle production systems: Effects on agronomics, livestock performance, and soil health

Treatment	Forage yield (lbs/acre) 2009	2010	2011
4-species mixture	0	0	162
5-species mixture	0	0	1080
9-species mixture	0	0	570
Mean	0	0	604
CV %	-	-	79
LSD	-	-	598

Adequate amounts of GSP *required*



- Total annual precipitation: < 15 inches in 2000, 2003, 2004); > 18 inches in 2001, 2002, and 2005
- 1.7 inches received between June 1 and August 1 in 2006, 2.5 inches in 2007, and 3.7 inches in 2008

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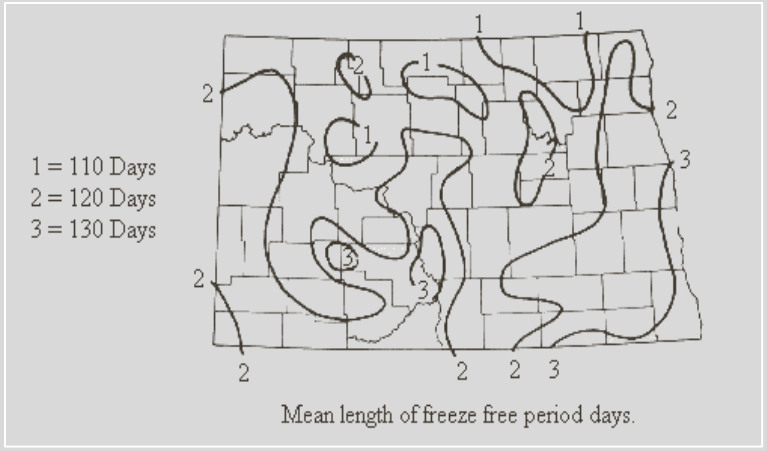
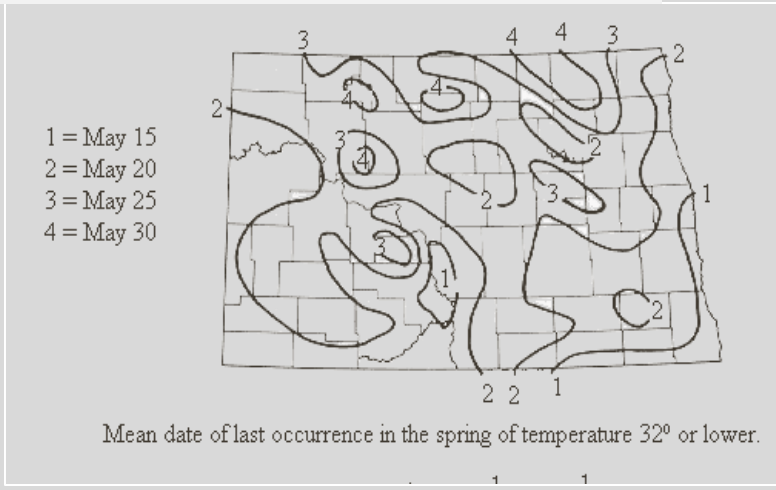
There are limited heat units available for growing cover crops in North Dakota when seeded after grain or seed harvest

- **Frost-free period (Padbury et al., 2002)**

➢ Dickinson, ND USA	124
➢ Brandon	123
➢ Lethbridge	117
➢ Swift Current	114



Mean length of freeze free period days.



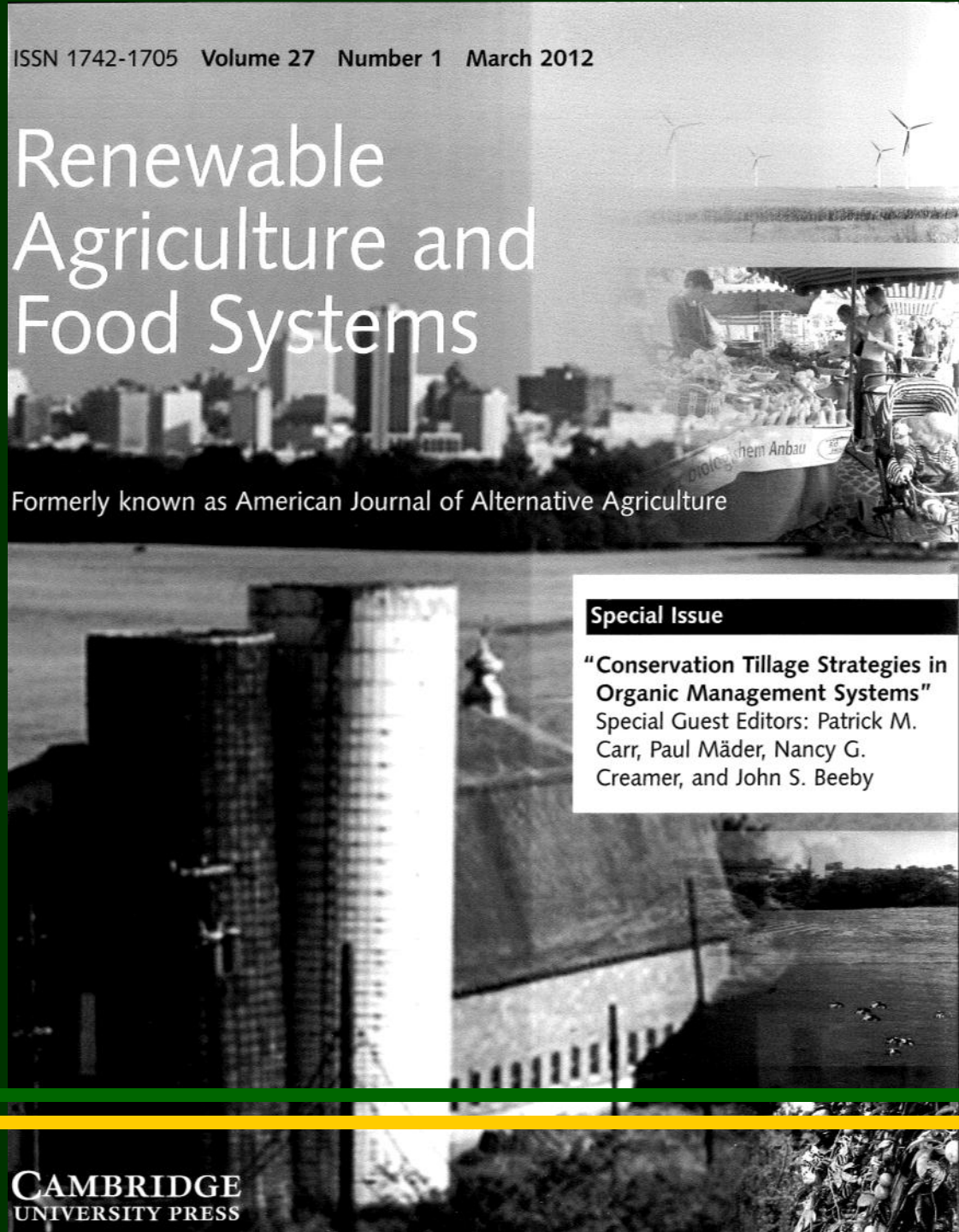
Mean date of last occurrence in the spring of temperature 32° or lower.

Organic Cover Crop Studies

Impact of cover crop termination method and species or species mixture on dry matter production of cover crops (CC) and weeds during over four years at Dickinson, North Dakota, USA.

	kg ha^{-1}					
	2007-08		2008-09		2009-10	
Tillage treatment	CC	Weed	CC	Weed	CC	Weed
Cover crop						
Hairy vetch (HV)	1728 c	584 a	702 c	1689 b	1633 a	2436 a
Winter rye (WR)	3615 a	153 b	4919 a	75 a	4052 b	640 b
Winter wheat (WW)	4113 a	274 b	3182 b	460 a	3821 b	800 b
HR + WR	3535 a	286 b	4716 a	297 a	4039 b	717 b
HV + WW	2765 b	172 b	3052 b	342 a	3554 b	991 b

Carr, P.M., W.W. Poland, and L.J. Tisor. 2012. Organic zero-till in the northern US Great Plains region: Opportunities and obstacles. Renewable Agriculture and Food Systems 27:12-20.



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Cover crop	Termination	Forage yield (lbs/acre) 2009-10	2010-11
		----- lb/ac -----	
Hairy vetch	Disk	3489	3987
Hairy vetch	Roller	6659	3716
4-crop mix	Disk	2828	2217
4-crop mix	Roller	2944	2539
Spring rye	Disk	3175	3757
Spring rye	Roller	2939	3414
Winter rye	Disk	5344	3498
Winter rye	Roller	6145	5280

Cover crop challenges in western North Dakota

- Consistent establishment
- Adequate growth

- Impact on subsequent crops

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Soil Health
Cover crop

	spring wheat	spring wheat	spring wheat	spring wheat	1
	spring wheat	cspulse/cc	spring wheat	cspulse/cc	2
	corn	corn	corn	corn	1
	corn	wspulse	corn	wspulse	2
	spring wheat	winter wheat	barley	cspulse	4
	spring wheat	barley	cspulse	corn	4
	spring wheat	winter wheat	corn	canola	4
	spring wheat	corn	corn	cspulse	4
	spring wheat	corn	cspulse	sunflower	4
	Market	Market	Market	Market	4
					30

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Long term Organic Tillage Study
LOTS
30 ft

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