K-State Cover Crop Update
Cover Your Acres

John Holman – Cropping Systems

Scott Maxwell & Tom Roberts – Cropping Systems

Kraig Roozeboom – Crop Production

DeAnn Presley – Environmental Soil Science

Dorivar Ruiz Diaz– Soil Fertility

Anita Dille – Weed Ecology

Alan Schlegel – Agronomy and Soils

Humberto Blanco – Soils

ARS Cover Crop Survey - Midwest

- 1,000 out of 3,500 responded (29%), (Singer, 2007)
- 18% use cover crops
- Perceived benefits:
  - Improved SOM and soil quality
  - Reduced soil erosion
  - Crop could be used as forage, N fixation, bio-fuel
  - Increased profits
- Perceived challenges:
  - Too expensive
  - Extra time required

Benefits of Diverse Cropping Systems

- More diverse rotations result in greater productivity
  - Especially important in no-till
  - More options for pest management
  - More years between same crop or crop type enhances benefits of rotation
- Diversifies production risk
  - Different growing seasons, rainfall distribution, temp, hail
- Diversifies marketing risk

Crop Types

	Cool Season	Warm Season
Grass	wheat, oats, barley, rye	corn, sorghums, millet
Broadleaf – Legume	field pea	soybean, cowpea
Broadleaf – Non-legume	canola	sunflower, cotton

- Cover Crop Chart, USDA-ARS, Northern Great Plains Research Laboratory, Mandan, ND:
  - http://www.ars.usda.gov/Services/docs.htm?docid=20323
    - Google "cover crop chart usda ars"

Cover Crop Chart

GROWTH CYCLE	RELATIVE WATER USE	PLANT ARCHITECTURE
A = Annual	= Low	♈ = Upright
B = Biennial	= Medium	✱ = Upright-Spreading
P = Perennial	= High	≈ = Prostrate

Cool Season							Warm Season		
---Grass---		Broadleaf						---Grass---	
A Barley ♈								A Pearl millet ♈	
A Oat ♈	A Phacelia ♈						A Amaranth ♈	A Foxtail millet ♈	
A/P Ryegrass ♈	A Flax ♈		Legumes				A Buckwheat ♈	A Proso millet ♈	
A Wheat ♈	A Spinach ✱	B Turnip ✱	A Field pea ♈	A Berseem clover ♈	A/P Medic ✱	A Chickpea ✱	A Sunflower ♈	A Sudan grass ♈	
A Cereal rye ♈	A Kale ✱	A Radish ✱	A Lentil ✱	B/P Red clover ♈	P Birdsfoot trefoil ≈	A Cowpea ✱	A Safflower ♈	A Teff ♈	
A Triticale ♈	A/B Canola ✱	B Beet ✱	A Lupin ♈	P White clover ♈	P Sainfoin ♈	A Soybean ✱	A Squash ≈	A Grain sorghum ♈	
A Annual fescue ♈	A/P Mustard ✱	A/B Carrot ✱	A/B Vetch ≈	A/B Sweetclover ♈	P Alfalfa ♈	A Mung bean ✱	P Chicory ✱	A Corn ♈	

V 1.2. December 2010

Additional Information

Western Kansas Results

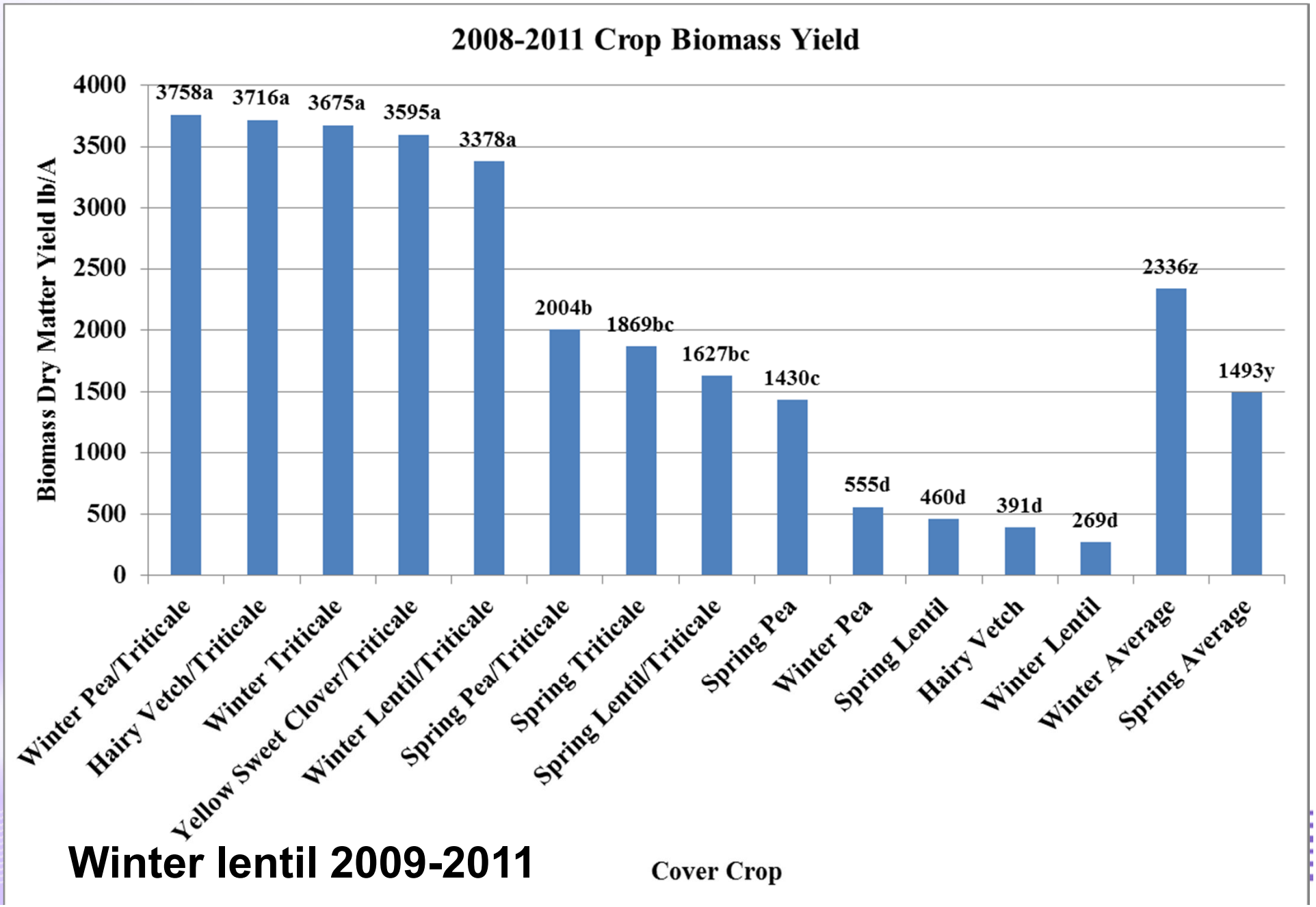
Fallow Treatments (Cover, Forage, Grain)

Season	Crop	Year Produced				
		2007	2008	2009	2010	2011
Winter	Yellow sweet clover	x	x			
""	Yellow sweet clover/Winter triticale		x			
""	Hairy vetch	x	x	x	x	x
""	Hairy vetch/Winter triticale		x	x	x	x
""	Winter lentil			x	x	x
""	Winter lentil/Winter triticale			x	x	x
""	Winter pea	x	x	x	x	x
""	Winter pea/Winter triticale		x	x	x	x
""	Winter triticale	x	x	x	x	x
""	Winter pea (grain)		x	x		x
Spring	Spring lentil	x	x	x	x	x
""	Spring lentil/Spring triticale		x	x	x	x
""	Spring pea	x	x	x	x	x
""	Spring pea/Spring triticale		x	x	x	x
""	Spring triticale		x	x	x	x
""	Spring pea (grain)				x	x
Other	Chem-fallow	x	x	x	x	x
""	Continuous winter wheat	x	x	x	x	x

Cover and Forage Crop Termination

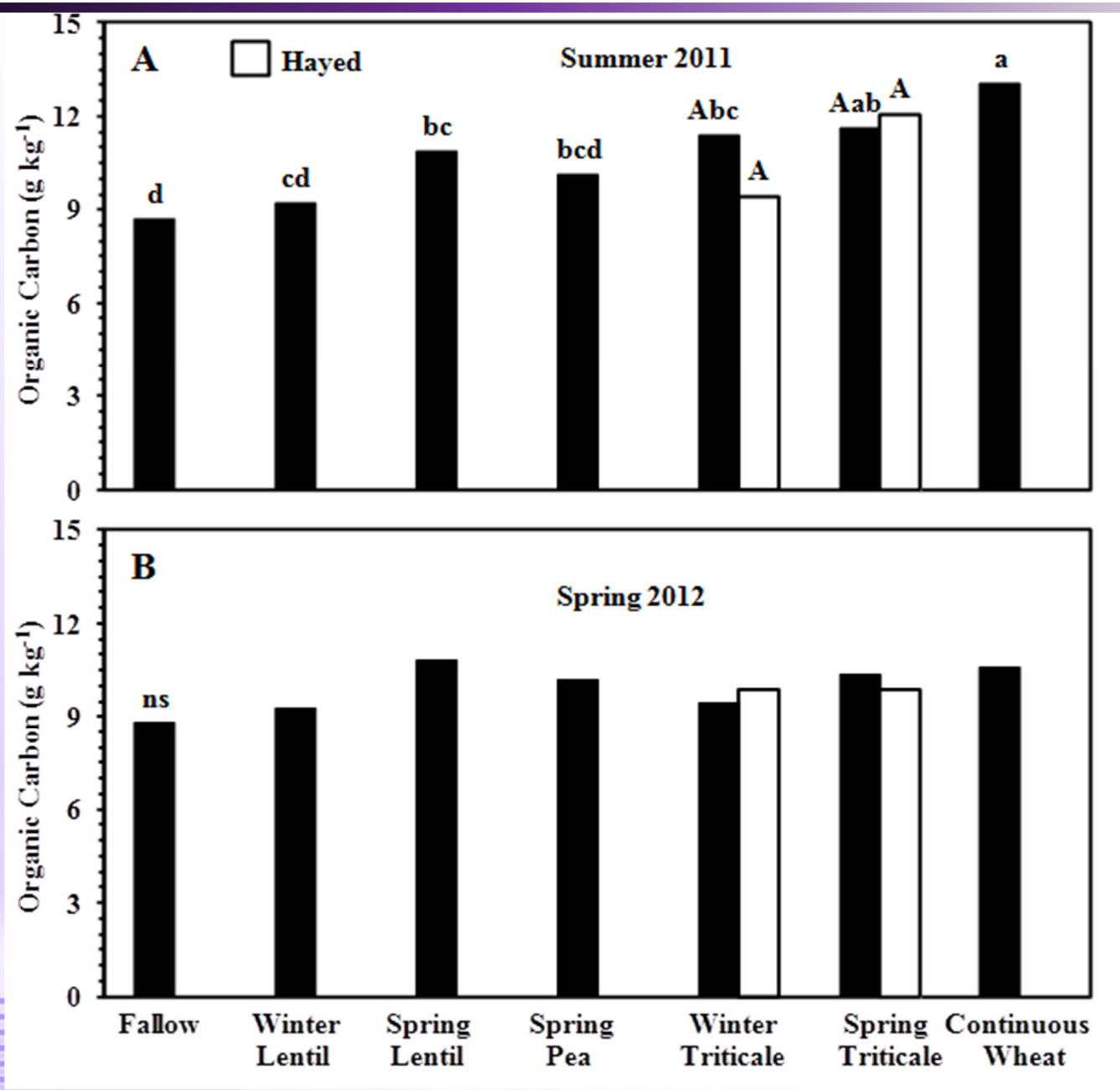
- Winter terminated ~May 15 (winter triticale heads)
- Spring terminated ~June 1 (spring triticale heads)
- Plots split: ½ hayed & ½ sprayed out and left standing

Crop Biomass (2008-2011)



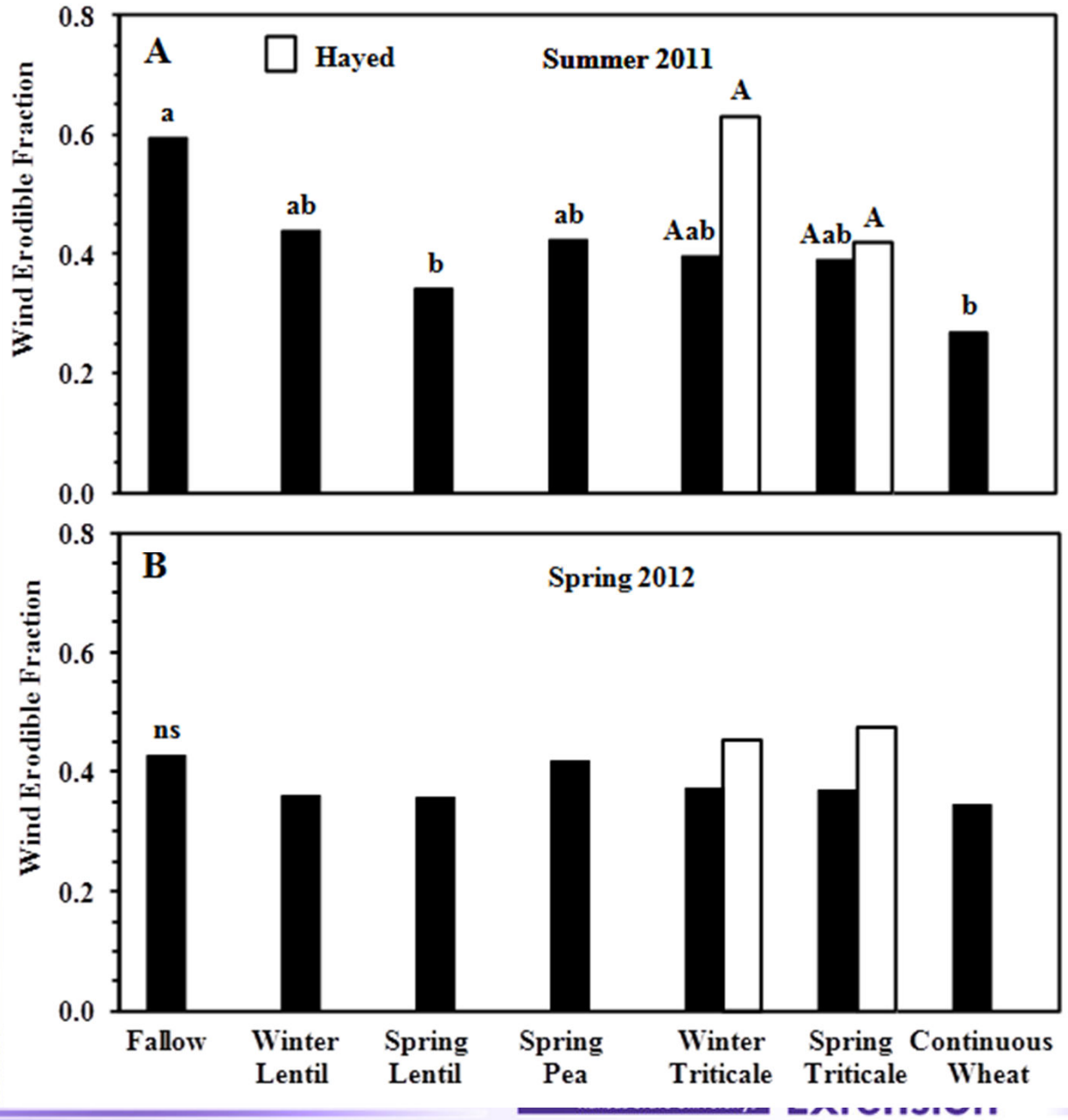
Winter lentil 2009-2011

Soil Organic Carbon



Wind Erosion

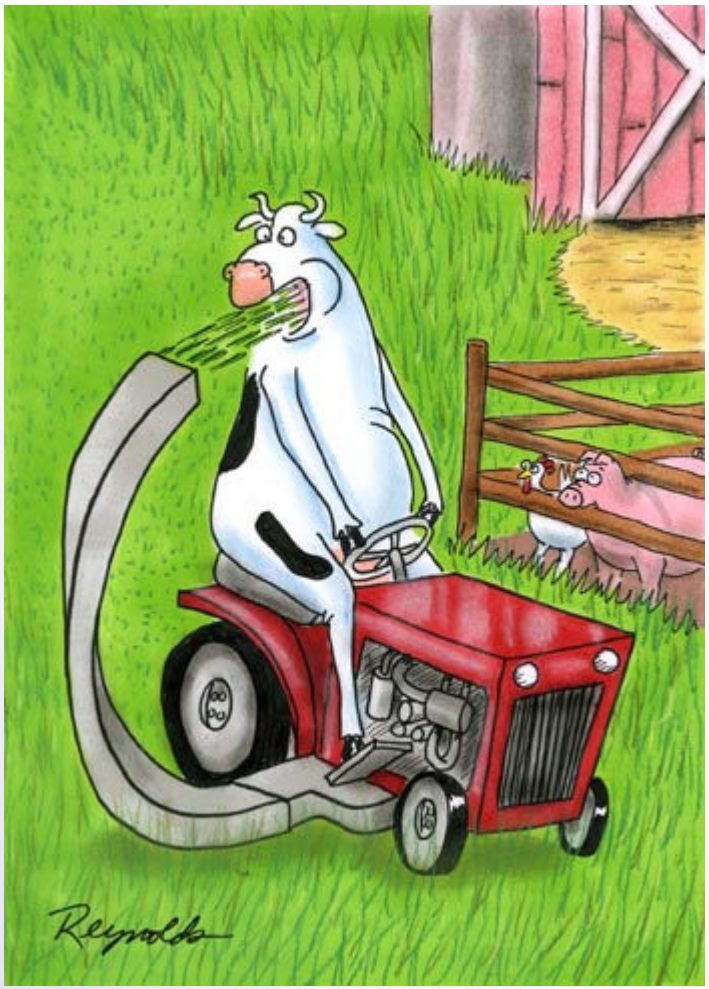
- **Wind erodible fraction (<0.84 mm aggregates)**



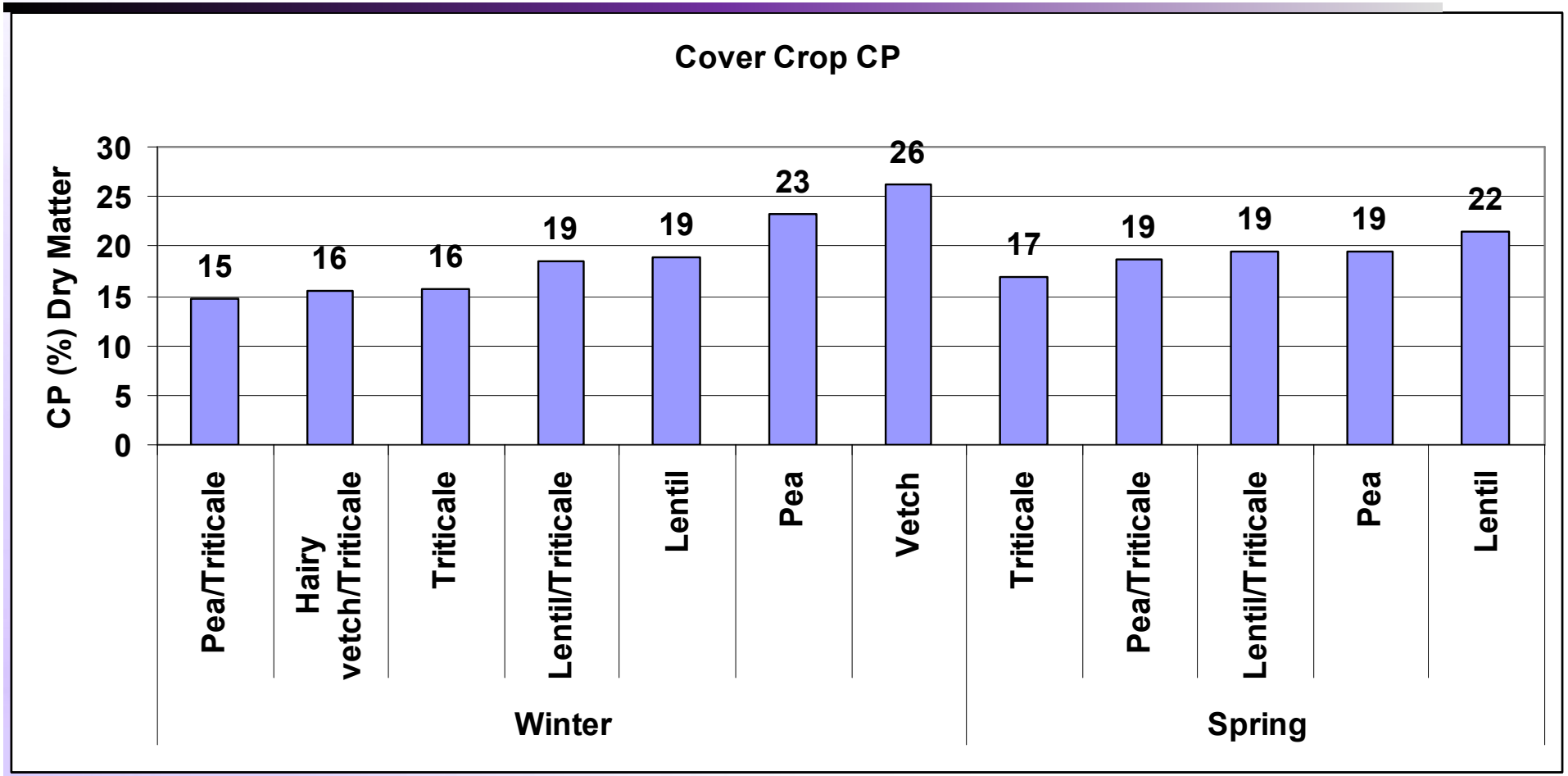
How Much Biomass to Change OM By 1%?

- The residue on top of the soil is not soil OM
- 0-3 inch soil depth - 1,000,000 lbs of soil
- Need 10,000 lbs of OM
- 10% of residue becomes OM, rest is decomposed
- Requires 100,000 lbs or 50 tons of residue
- 50 tons of residue/acre at $100/ton worth $5,000/acre

Residue or Forage Value?



Crude Protein (CP)



- **Microbial protein and amino acid production**
- **> 13% "premium" nutritive value**
- **Alfalfa 18-24% CP**

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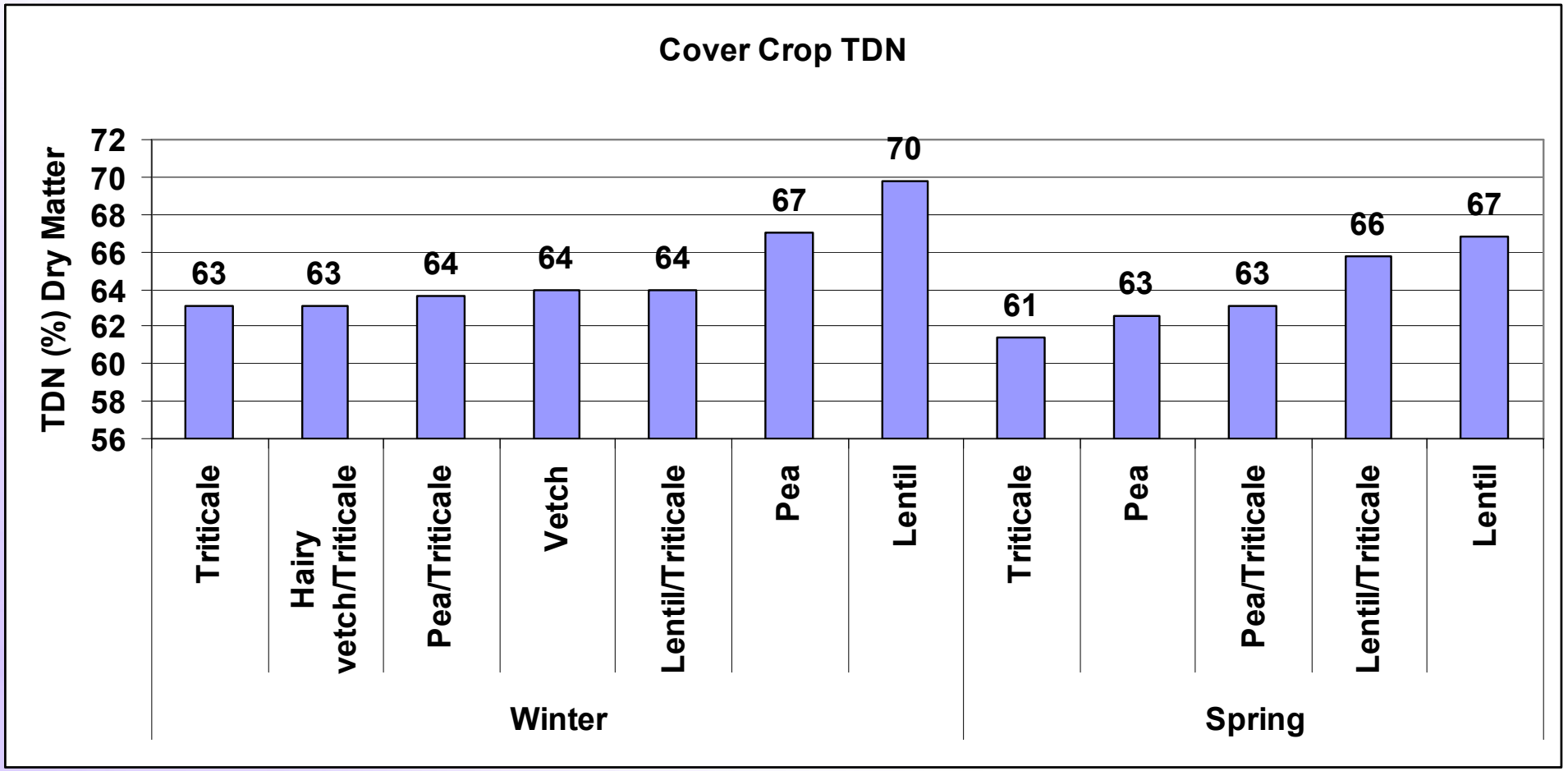
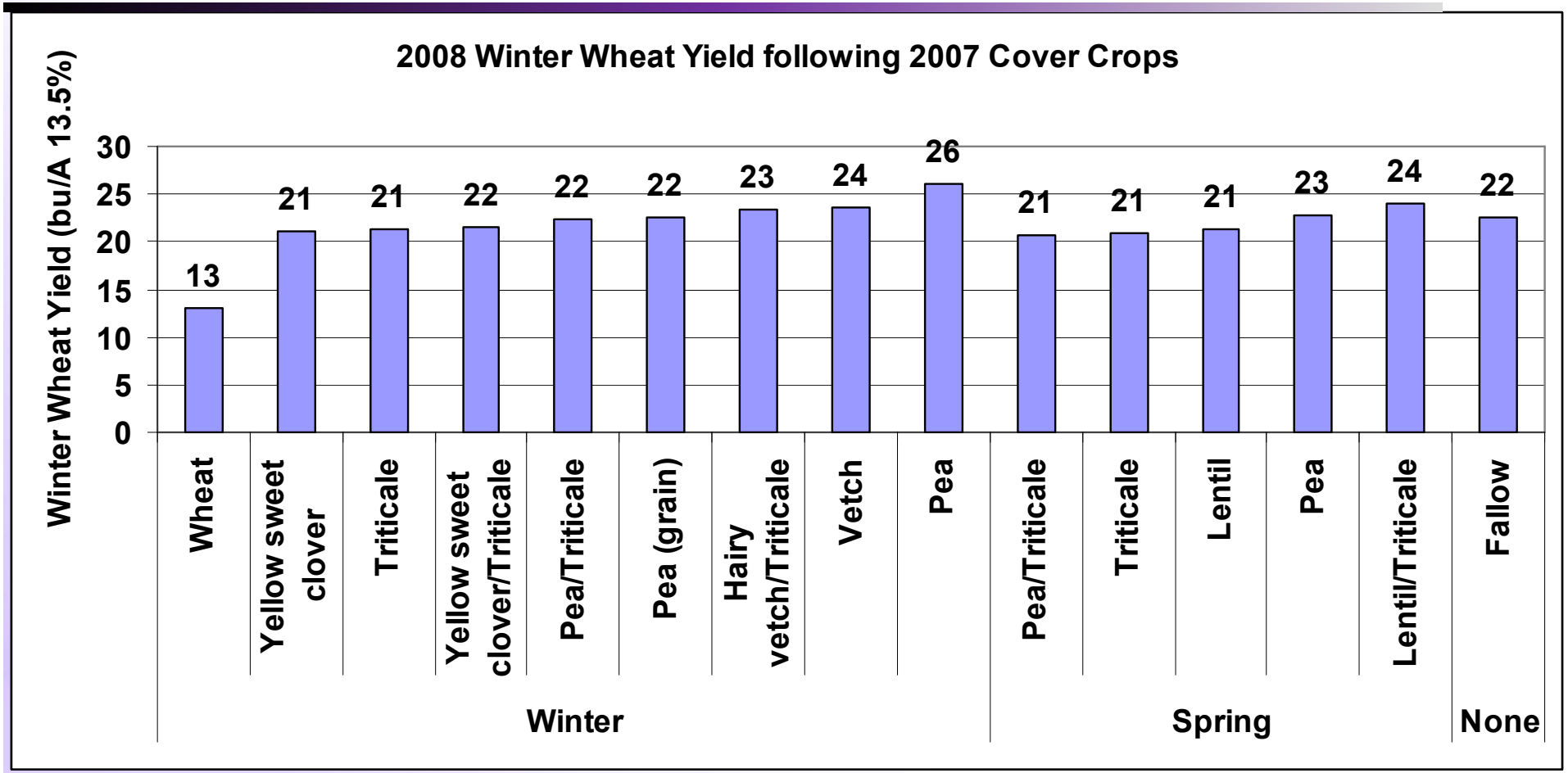
Total Digestible Nutrients (TDN)



- Energy available
- Alfalfa 61-67% TDN

2008 Yield Results



- Hail week prior to harvest
- Only visual difference was cont. wheat

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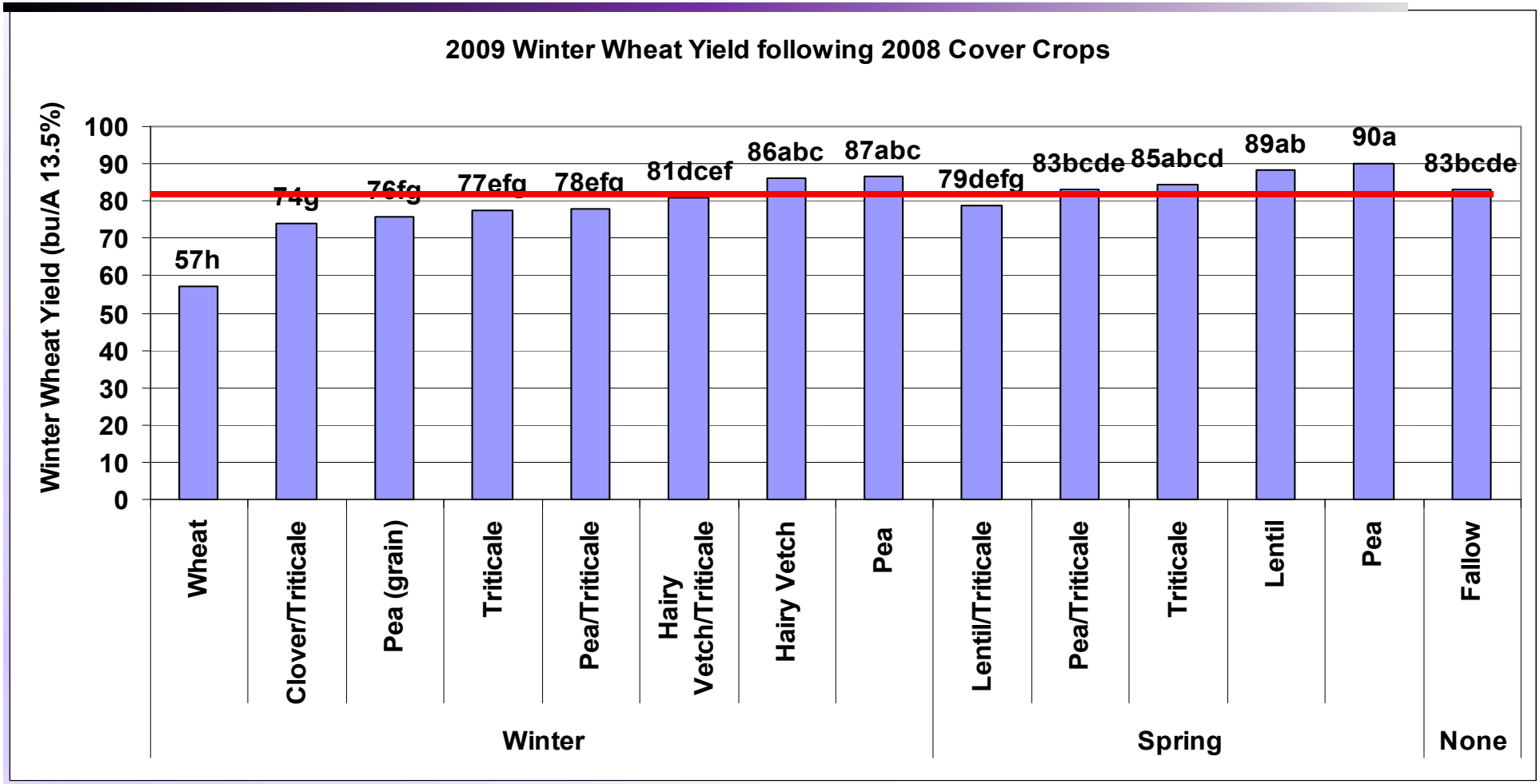
2009 Yield Results



- Good yields: 45 bu/A APH, visual diff with cont. wheat
- Residue management no effect

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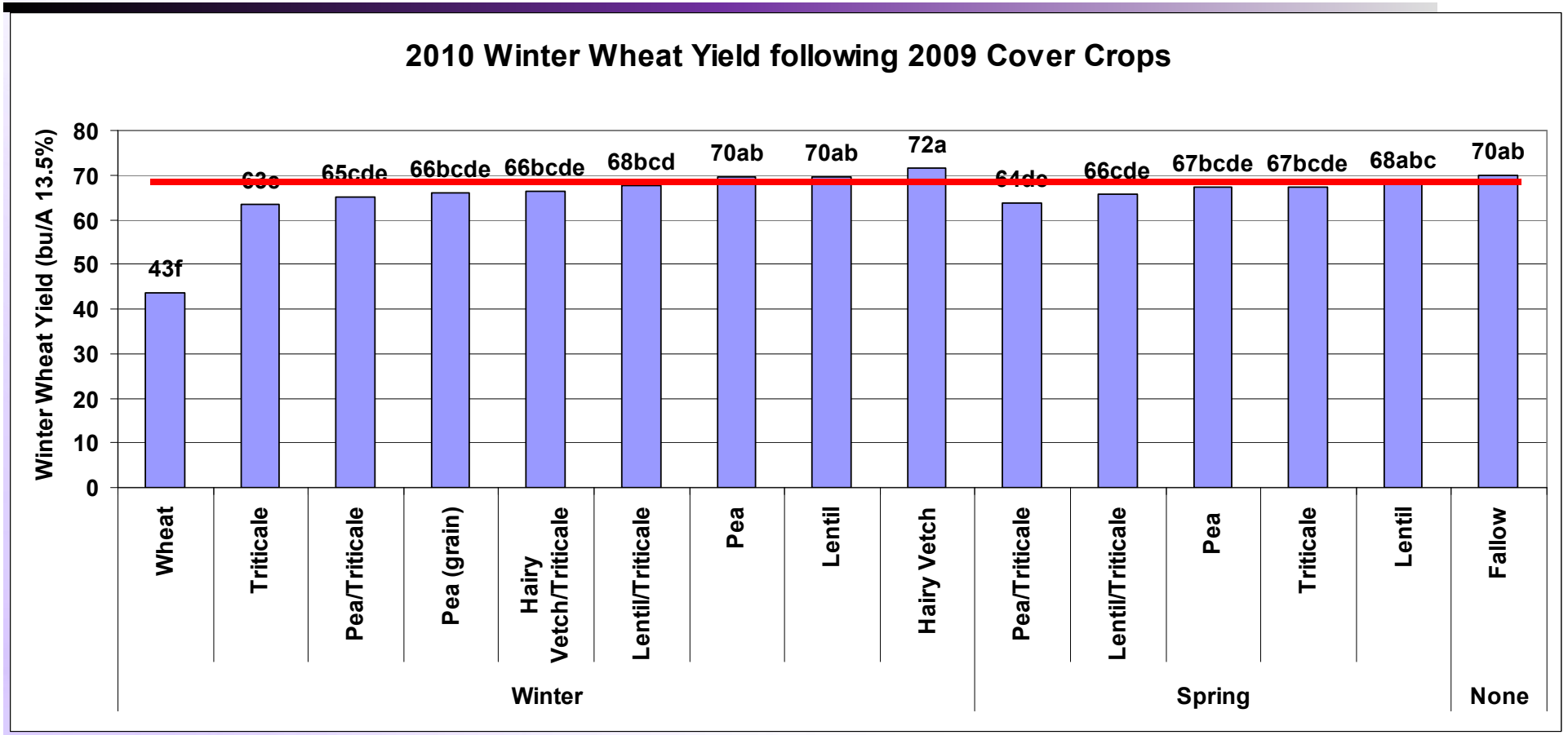
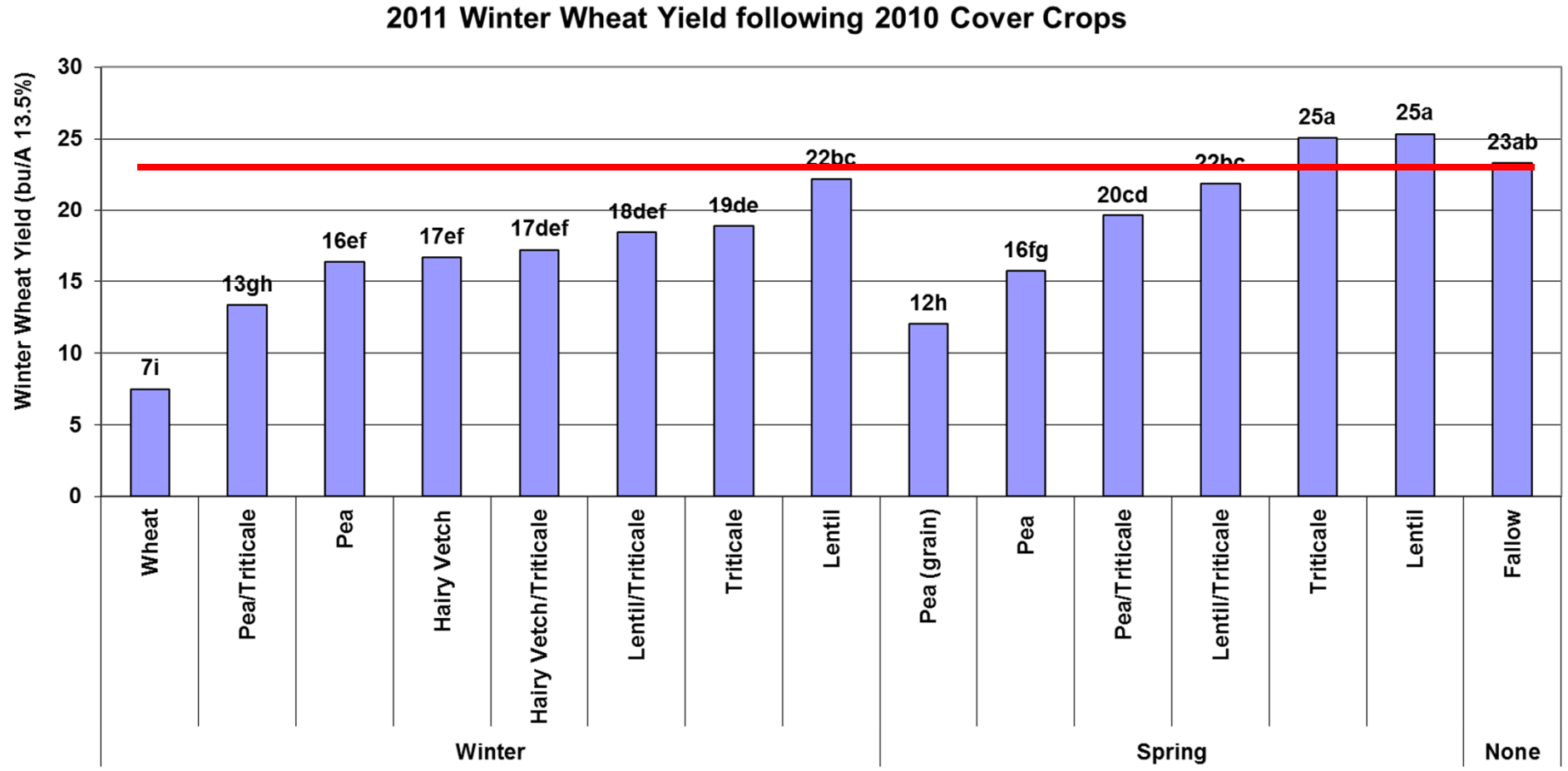
2010 Yield Results



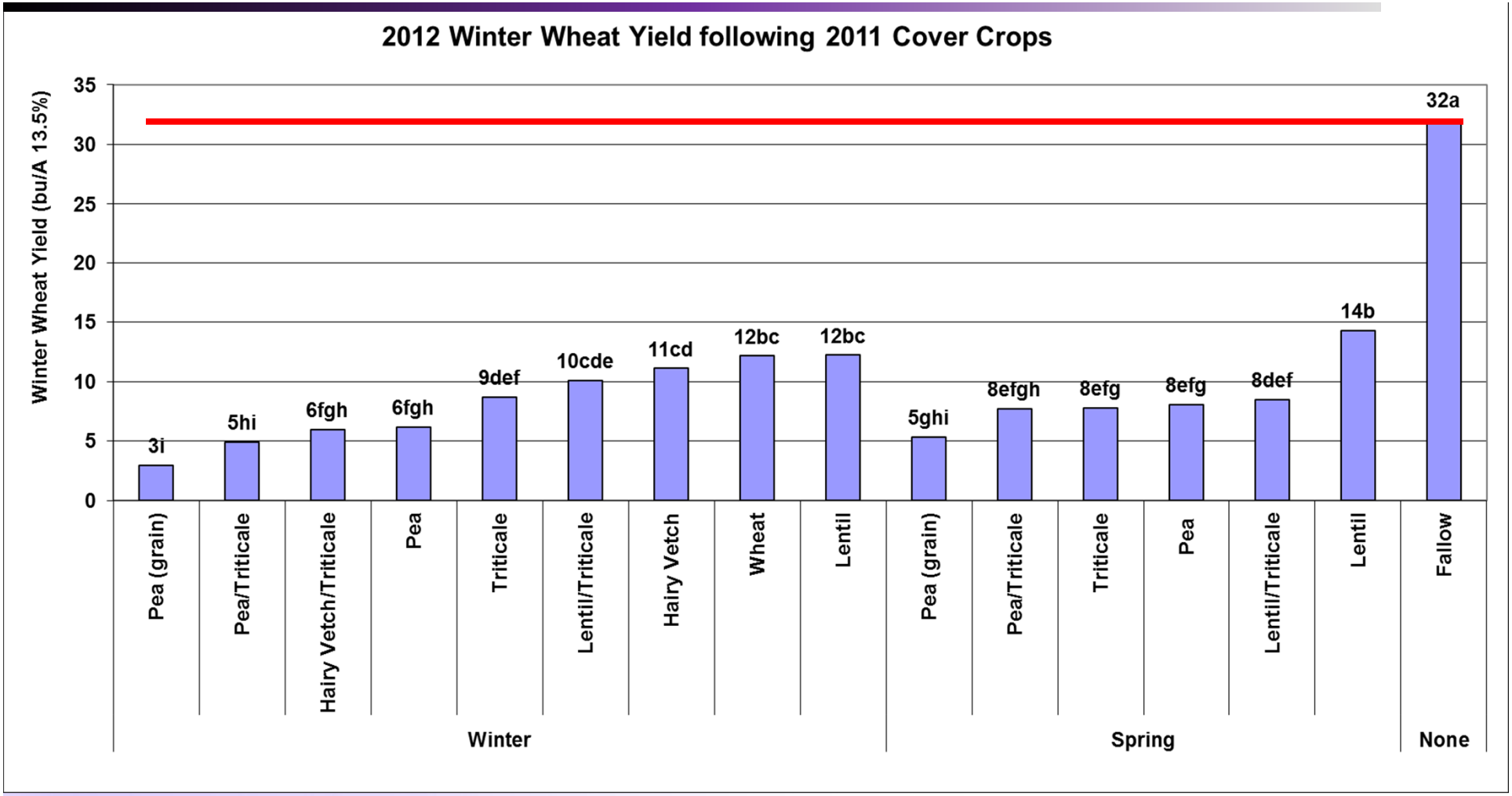
- **Good yields, only visual difference was cont. wheat**

2011 Yield Results



- **Very dry year, marginal wheat stands**
- **On average spring forage reduced yield 3 bu/A**

2012 Yield Results



- **Very dry year, marginal wheat stands**
- **All treatments reduced yield compared to fallow**

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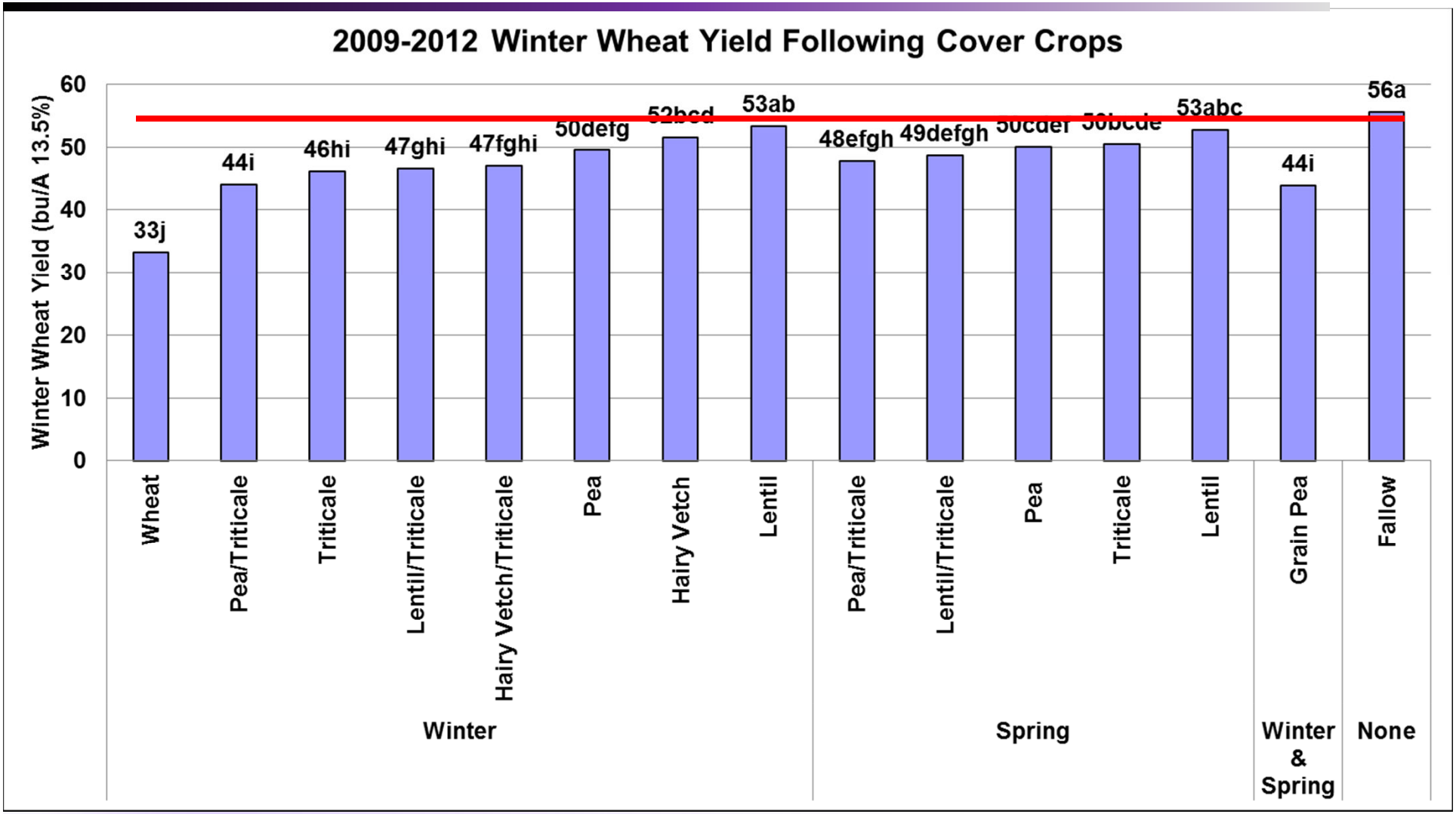
2009-2012 Yield Results



- 2 good years, 2 very poor years
- Residue management no effect

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Field Pea Yields

- Austrian winter pea (2006-2011): too much injury
- Spring pea (2010-2012): 0-2000 lb/A
- Feed pea: $7.00/bu (60 lbs/bu)
  - 0 yields?

Pea Grain Yields

Location	2010	2011	2012
		bu ac^{-1}	
Colby	33.5	7.1	2.8
Garden City		-	17.3
Tribune	26.7	-	18.9
Bushland		-	-

14 bu/A

Average yearly yield

Economic Results

	Winter								Spring						None
	Vetch	Vetch/ Trit	Lentil	Lentil/ Trit	Pea	Pea/ Trit	Trit	Wheat	Lentil	Lentil/ Trit	Pea	Pea/ Trit	Trit	Pea, grain	Fallow
Expenses															
Total seeding cost $/A	69	48	24	26	37	32	27	21	23	26	40	35	30	40	0
Total hay cost $/A	19	64	17	60	21	65	64	0	19	36	33	41	39	0	0
Grain harvesting $/A	0	0	0	0	0	0	0	30	0	0	0	0	0	30	0
Fallow spray cost $/A	36	36	36	36	36	36	36	36	36	36	36	36	36	36	48
In-crop spray cost $/A	0	0	0	0	0	0	0	11	0	0	0	0	0	11	0
Total Expense (cover)	**104**	**83**	**60**	**61**	**73**	**68**	**63**	**-**	**59**	**62**	**76**	**71**	**66**	**-**	**-**
Total Expense (hay)	**123**	**148**	**77**	**121**	**94**	**133**	**126**	**-**	**78**	**98**	**109**	**111**	**104**	**-**	**-**
Total Expense (grain)	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**98**	**-**	**-**	**-**	**-**	**-**	**117**	**48**
Returns															
Yield ton/A or bu/A	0.2	2.2	0.2	2.0	0.3	2.2	2.2	33.0	0.3	1.0	0.8	1.2	1.1	14.0	0.0
Price $/ton or $/bu	110	110	110	110	110	110	110	7	110	110	110	110	110	7	0
Yield Return $/A	25	240	17	219	36	243	238	216	30	105	93	130	121	92	0
N Return $/A	20	20	20	20	20	20	0	0	20	20	20	20	0	0	0
Impact on wheat bu/A	-4	-9	-2	-9	-6	-12	-9	-22	-3	-7	-6	-8	-5	-12	0
Impact on wheat $/A	-26	-59	-13	-59	-39	-78	-59	-144	-20	-46	-39	-52	-33	-78	0
Net Return (cover)	**-111**	**-122**	**-53**	**-100**	**-92**	**-126**	**-121**	**-**	**-58**	**-88**	**-95**	**-103**	**-98**	**-**	**-**
Net Return (hay)	**-124**	**9**	**-73**	**14**	**-97**	**7**	**28**	**-**	**-68**	**-51**	**-55**	**-47**	**-29**	**-**	**-**
Net Return (grain)	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-46**	**-**	**-**	**-**	**-**	**-**	**-38**	**-48**
Net Return (alt vs fallow)	**-76**	**56**	**-25**	**61**	**-50**	**55**	**75**	**2**	**-20**	**-3**	**-8**	**1**	**19**	**10**	

*Assumption: N contribution from legume 0 when hayed, 50 lbs N add for winter trit, and 25 lbs N add for spring trit.

Economic Results Summary

Return	Winter								Spring						None
	Vetch	Vetch /Trit	Lentil	Lentil /Trit	Pea	Pea /Trit	Trit	Wheat	Lentil	Lentil /Trit	Pea	Pea /Trit	Trit	Pea, grain	Fallow
Cover crop	-111	-122	-53	-100	-92	-126	-121	-	-58	-88	-95	-103	-98	-	-
Hay	-124	9	-73	14	-97	7	28	-	-68	-51	-55	-47	-29	-	-
Grain only	-	-	-	-	-	-	-	-46	-	-	-	-	-	-38	**-48**
Best alternative	**-76**	56	**-25**	**61**	**-50**	**55**	**75**	**2**	**-20**	**-3**	**-8**	**1**	**19**	**10**	

- **Fallow cost $48/A**
- **Returns include any reduction of following wheat yield**
- **Winter and spring triticale hay, grain peas, cont. wheat**

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Results

- **Impact on wheat yield and profitability**
  - **Depends on wheat yield potential**
  - **Wet years little to no impact on yield (yield ≥ 70 bu/A)**
  - **Dry years**
    - **2011: dry year (WF yielded 23 bu/A)**
      - **Spring crops < 3 bu & winter crops < 6 bu**
    - **2012: second dry year (WF yielded 32 bu/A)**
      - **Spring crops < 23 bu & winter crops < 24 bu**
  - **"Average" year?**
  - **IF you knew you were going to be in a drought W-F best**
  - **What is the best choice long-term?**
  - **How much weight do you put on a record drought year?**

Results

- **Spring triticale forage**
  - 4 years of no yield impact & 1 year yield reduced
    - 2008, 2009, 2010, & 2011 no impact
    - 2012 -24 bu
  - On average wheat yield -2.5 to 5 bu/A (range: +2 to -24)
  - 1 ton forage @ $110/ton
    - Net $19 to 36/A more than chem-fallow long-term
    - Net $54/A more than chem-fallow without 2012
  - Break-even yield reduction of 7.5 bu/A @ $7.00/bu
    - Wheat-fallow yield potential of <25 bu requires fallow

Future Direction (W-S-F)

- Spring oat versus triticale?
- Radish or turnip planted with wheat ?
- Clover planted with sorghum?
- Cocktail mixes?

Crop	Hay	Cover	Grain
Fallow			
Spring pea			x
Spring pea/Spring oat	x	x	
Spring pea/Spring triticale	x	x	
Spring oat	x		x
Spring triticale	x		
Yellow sweet clover (planted with sorghum)	x	x	
Daikon radish (planted with wheat)		x	
Shogoin turnip (planted with wheat)		x	
Cocktail mix	x	x	

(oat, triticale, pea, buckwheat, forage brassica & forage radish)

Conclusion

- It is only sustainable if it is profitable
  - Graze it, bale it, or combine it!
  - No difference if grown as forage or cover
- High seed cost, offsets N contribution- grow own seed
  - More economical to apply N
- Select fallow replacement crop adapted to region
- Terminate cover crop prior to June 1 for winter wheat
- If moisture is available consider double-crop after wheat
- Harvesting crop as forage or grain in place of fallow can increase profitability

Mixtures?

- A lot of interest in mixtures
- Some species more competitive
  - Oat, triticale, pea, buckwheat, forage brassica & radish
- Select based on need, <u>more is not necessarily better</u>
  - Spring forage: legume increase forage CP and N fixation + grass for biomass (ex: spring pea and oat)
  - Summer forage: (ex: cowpea and sorghum sudangrass)

Mixtures?

- New rumor: “More species are better. More than 8 is best. Science has proven this”
- What article?
- Wortman et al. 2012. Agronomy Journal. 104:3 & 104:5
- Compared NC, weeds, single, & 2, 4, 6, and 8 species mixture
- Rainfed field experiment, Mead, NE, in 2010 & 2011
- Organic rotation of sunflower-soybean-corn
- CC planted March and terminated May
- Measured:
  - CC biomass
  - Grain crop yield
  - Profit

Whortman et al.

- "Best CC treatment"
  - Biomass & Stayability (CV)
  - #1: Oilseed radish (single species)
  - #2: 6 species mixture (contained oilseed radish, 2 & 4 species mixtures did not)
  - Worst low biomass producing cover crops
  - So how do we jump to the conclusion that more is best?
  - Choose a mixture based on your needs
  - A mixture can provide some protection against adverse weather conditions adversely affecting one species over another

Whortman et al.

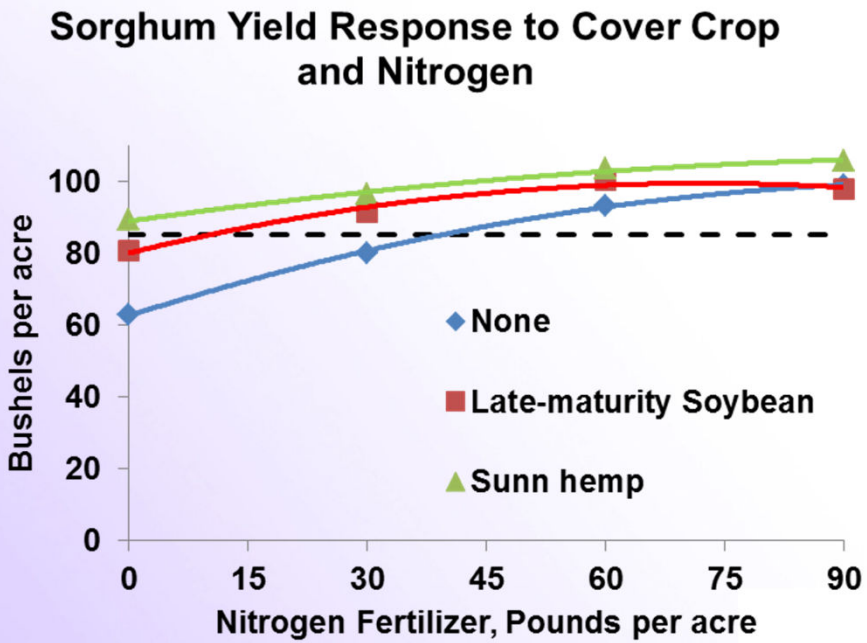
- Grain crop yields
  - CC or weeds no effect
  - Alfalfa had been grown previously + manure added
    - K-State research has shown yield advantage to CC when moisture is plentiful and N is limiting
- Profit
  - Weeds undercut most profitable (no CC seed cost and less tillage inputs)
  - CC undercut more profitable than CC disked

Eastern Kansas Results

Hesston (15 years)

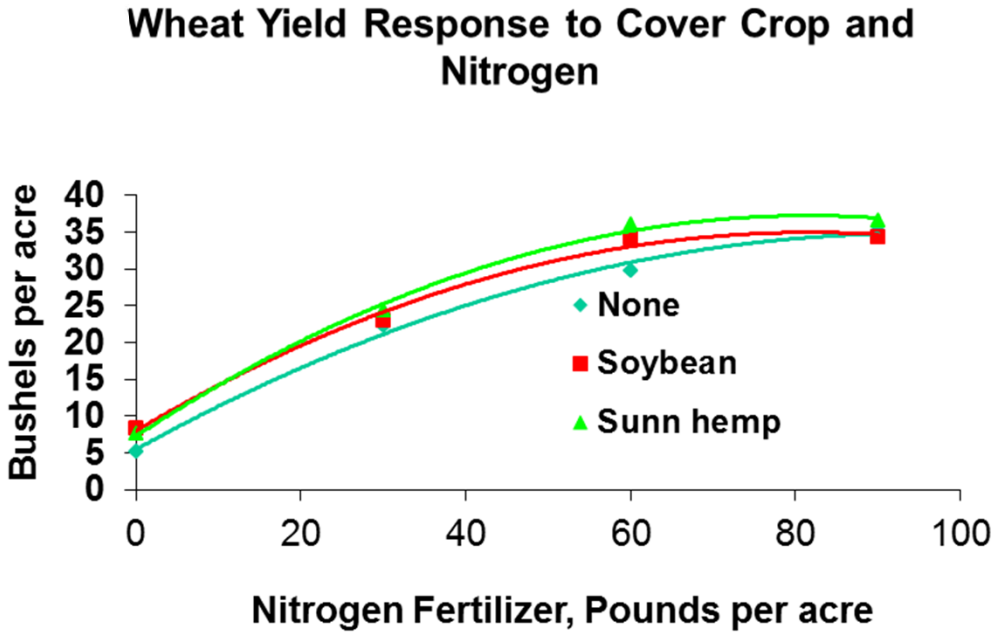
- Wheat/sorghum rotation
- 1995-2010
- Cover crop between wheat and sorghum
  - No cover crop
  - Late-maturing soybean
  - Sunn hemp
- Four nitrogen rates (0, 30, 60, & 90 lbs) applied to sorghum and wheat

Hesston: Sorghum & Wheat Yields

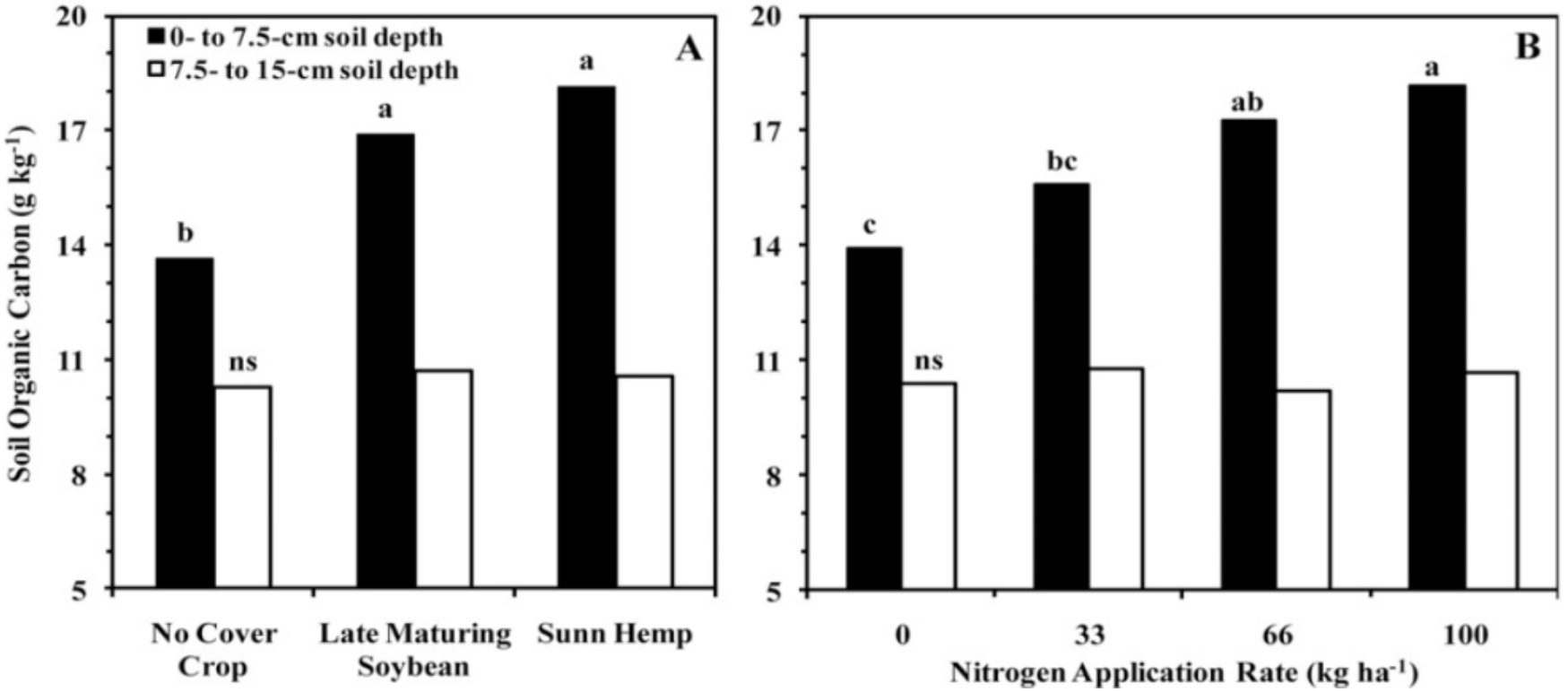


Blanco-Canqui, H. et al. 2011. SSSAJ 75:1471-1482

- **↑ Crop yield at low N rate only**



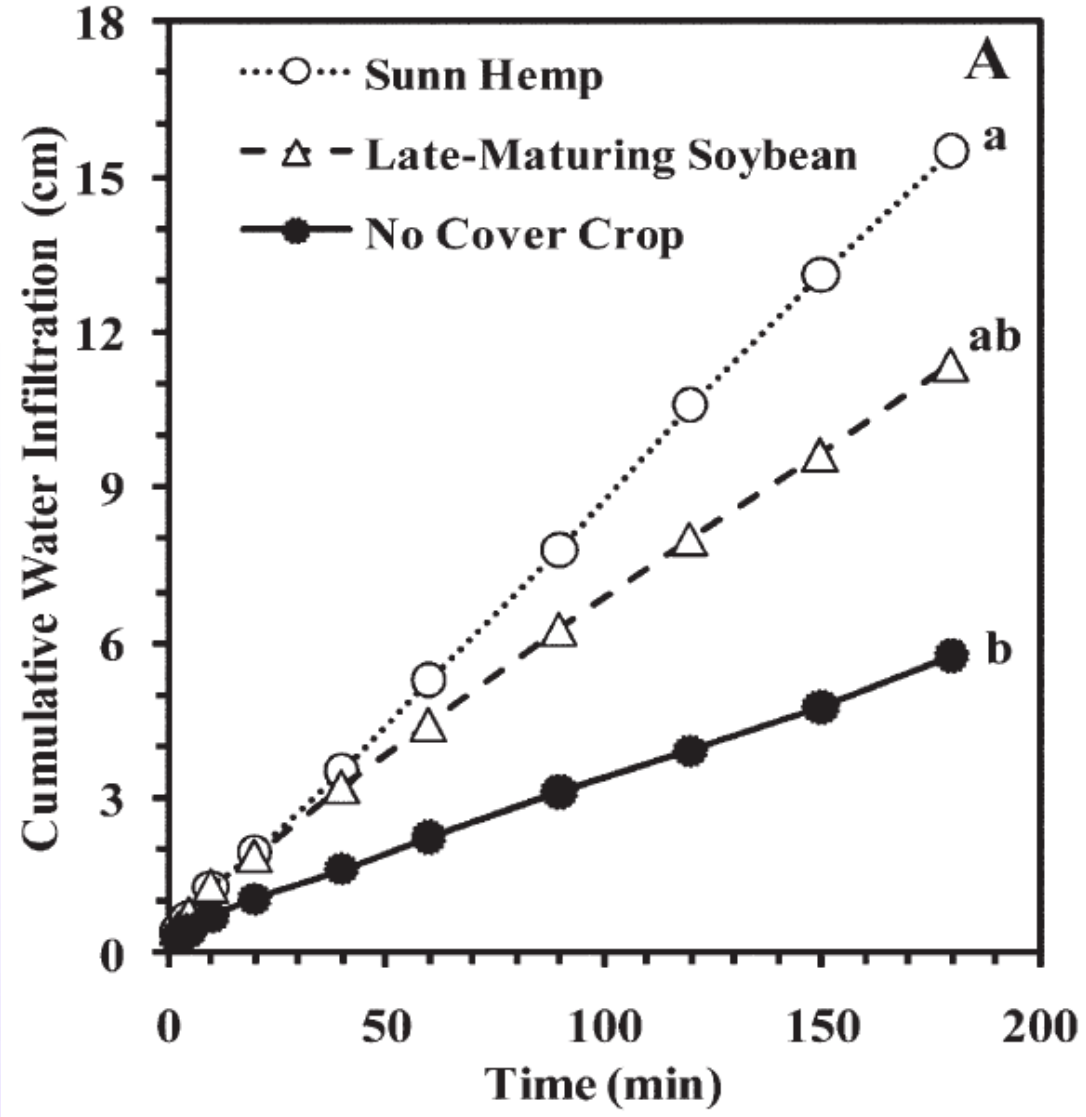
Hesston: Soils



- ↑ Soil C (0-3 in) with cover crop & nitrogen
- = Soil aggregate stability w/N
- = Soil compaction (0-3 in) w/N
- ↑ Soil ag. and comp. wo/N

Hesston: Soil Water Infiltration

- ↑ Water infiltration with cover crops



Eastern KS Results

- **With sufficient moisture**
  - CCs can be grown without reducing crop yield
- CC legumes can increase crop yield when N is limiting
  - Western KS study, N was not limiting
- CC canopy and its residue can suppress weeds
  - Possibly eliminating one herbicide application
- Ongoing use of CC can have a positive impact on soil (e.g. more soil carbon, greater infiltration, soil cover)

Questions?