Work with No-Till, Cover Crops, & Rye at the Southeast Research Farm

1

2

SDSU Southeast Research Farm, Beresford, South Dakota

3

No-Till plot

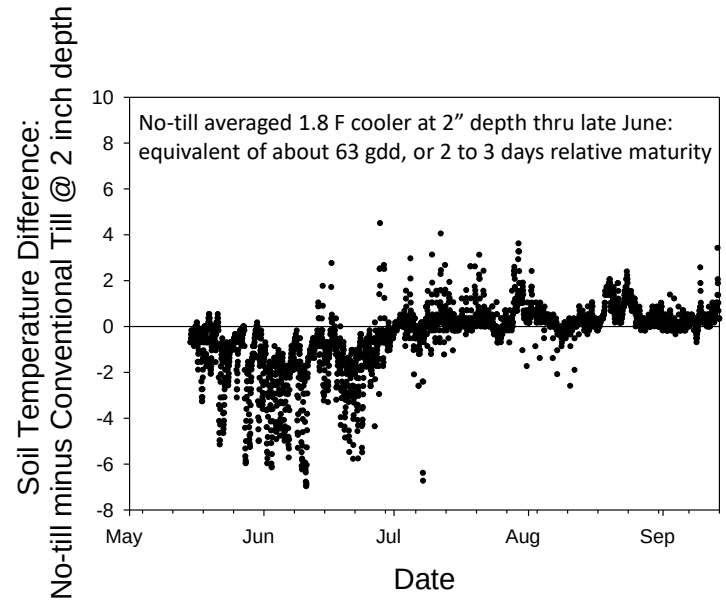
Advantages:
Decreased cost
Stronger soil structure
Conserves moisture for later in the season
Favors mycorrhizal fungi association
Less prone to erosion

Tilled plot

Advantages:
Soil warms faster in the spring
Controls winter annual weeds
Less material for pathogens to overwinter on
Faster nutrient release

4

Hourly Difference in Soil Temperature at 2” Depth
- No-till versus Conventional Till -

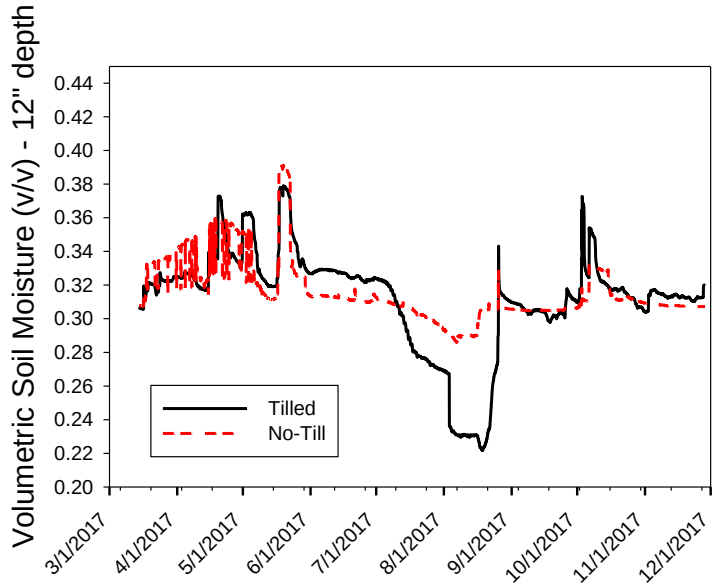


5

April 5, 2019 – side by side plots – Southeast Research Farm

6

Volumetric soil moisture – comparison of tilled and no-till corn plots at a 12” depth – 2017 season – Southeast Research Farm



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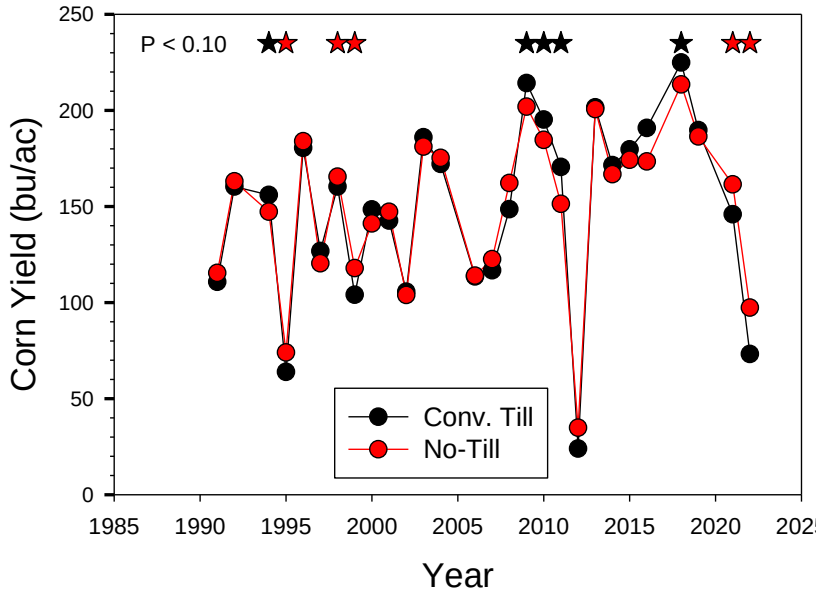
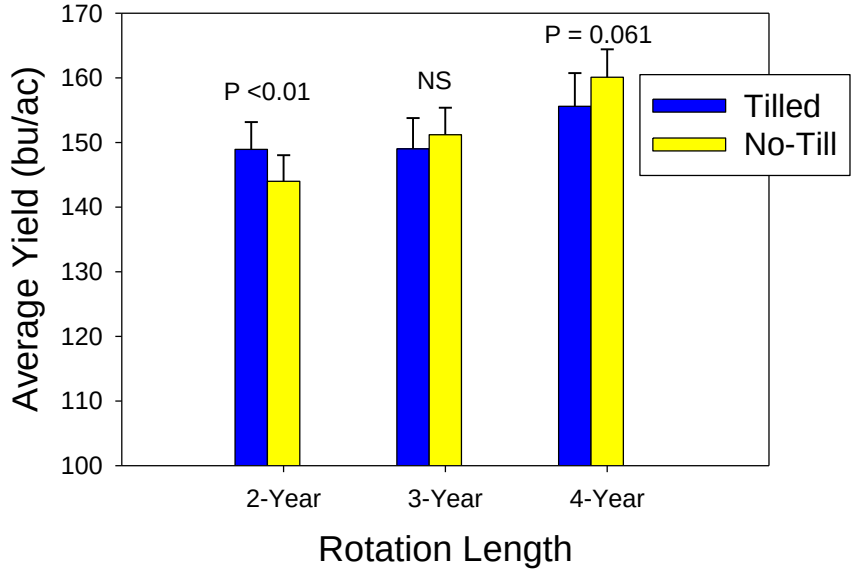
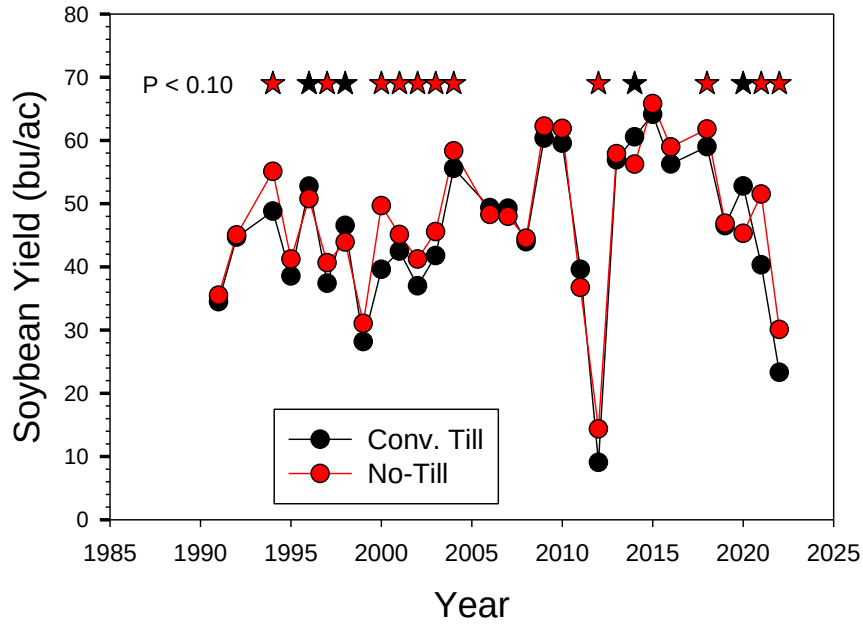

P < 0.10
Corn Yield (bu/ac)
Year
Conv. Till
No-Till
0
50
100
150
200
250
1985
1990
1995
2000
2005
2010
2015
2020
2025

9

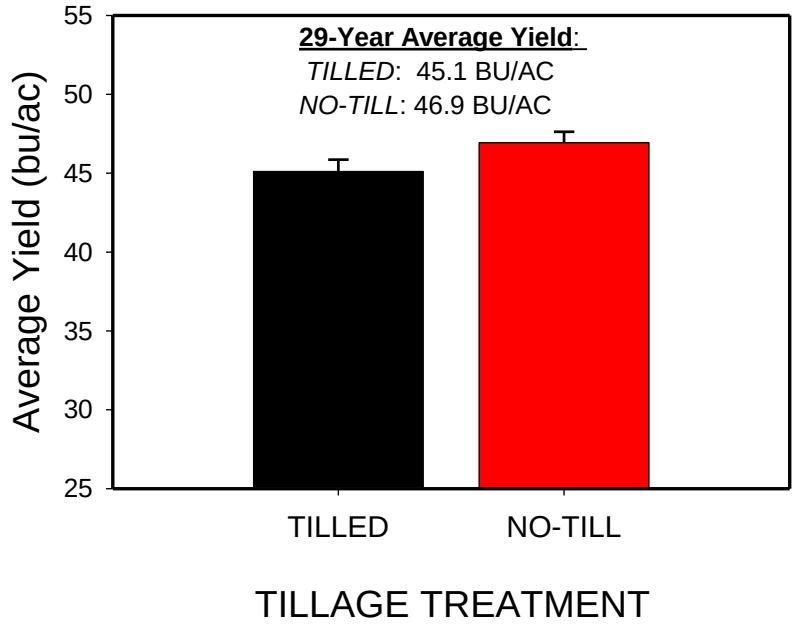

P <0.01
NS
P = 0.061
Tilled
No-Till
Average Yield (bu/ac)
Rotation Length
2-Year
3-Year
4-Year
100
110
120
130
140
150
160
170

10

11


P < 0.10
Soybean Yield (bu/ac)
Year
Conv. Till
No-Till
0
10
20
30
40
50
60
70
80
1985
1990
1995
2000
2005
2010
2015
2020
2025

12



13

Stepwise Regression Analysis: 26 Years of Soybean Yield Data at the Southeast Farm

Rank	Variable	Coefficient	Partial R2	Model R2	F-Value	P > F
1	July-Sept. Stress-Degree-Days	-0.236	0.638	0.638	801.4	<.0001
2	June-Sept Precipitation	0.042	0.084	0.722	137.7	<.0001
3	July-Sept ET	0.216	0.017	0.739	29.1	<.0001
4	**Tillage**	**-2.435**	**0.007**	**0.746**	**12.5**	**0.0004**
5	May Stress-Degree-Days	0.237	0.006	0.752	10.9	0.001
	Intercept	-43.6	---	---	8.6	0.0035

14

Some cost estimates on tillage operations from Lazarus (2022).

Field Operation	**cost**
Chisel Plow	$18.35/ac
Tandem Disk	$18.26/ac
Field Cultivator	$8.92/ac

Ownership cost for a 200 HP tractor

Overhead	$12,468/yr
Depreciation	$37.14/hr of use
w/ 500 h/yr use	$59,459/yr

15

No-Till Transition – some points to consider:

- Distribution of residue behind the combine
- Extra N is needed to build soil organic matter
- Proper planter adjustment
- Weed populations may shift towards more winter annuals
- Some long-term no-tillers advocate banding fertilizer
- Crop diversification is especially valuable in no-till systems

It may be prudent to start gradually and/or start on a limited area until you find a system or combination that works for you.

Keep in mind it is a long-term adjustment for the soil.

16

17

Seven Dimensions of Cover Crops:

1. Ease of establishment and competitiveness with weeds

2. Temperature adaptation
   - heat vs. frost tolerance; ability to overwinter
3. Persistence of residue (amount and quality/fiber content)
4. Interactions with the following crop
   - *especially* ***moisture*** and pathogens
5. Livestock involvement (utility as a forage)
6. Timing – cropping pattern, period of growth, herbicides
7. Cost

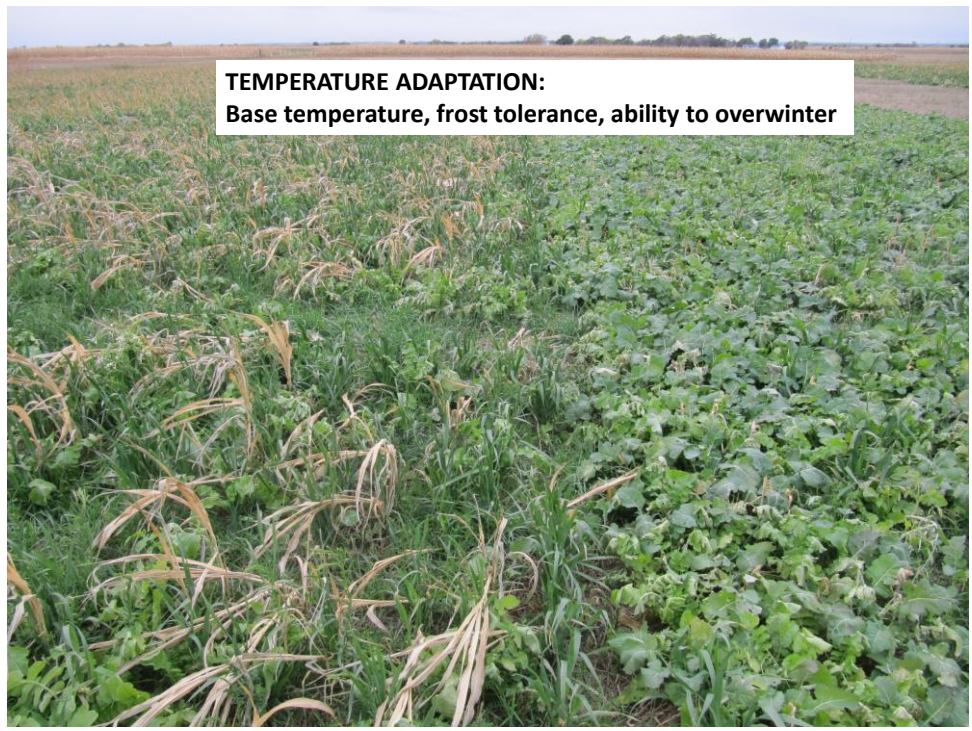
18

EASE OF ESTABLISHMENT, COMPETITIVENESS

Crimson Clover

Dwarf Essex rapeseed

19



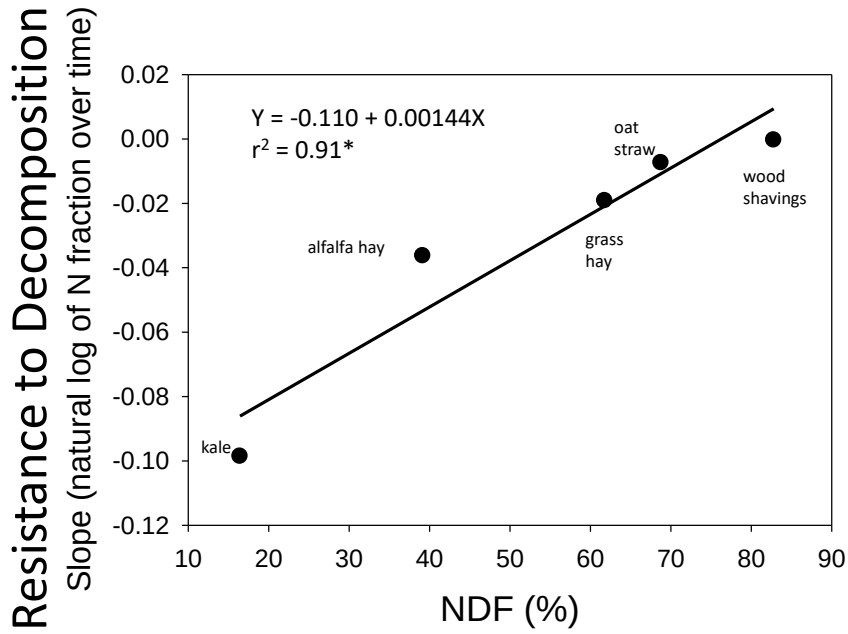
20

Comparison of Broadleaf and Grass Cover Crop Blends vs Control Across Seasons and Trials – Southeast Research Farm

Numeric Yield Differences			
Season	Broadleaf (bu/ac)	Grass (bu/ac)	Sept-Aug rainfall (inches)
2012	11	1.4	13.7
2013	n/a	n/a	n/a
2014	7	-1	27.2
2015	14	-1	27.5
2016	8	5	27.6
2020	8	-13	21.1
2021	-10	-13	18.0
2022	-7	-9	18.3
Average	4.4	-4.4	
wet years	9.2	-2.6	
dry years	-2.0	-6.9	

21

PERSISTANCE OF RESIDUE: Fiber is important



22

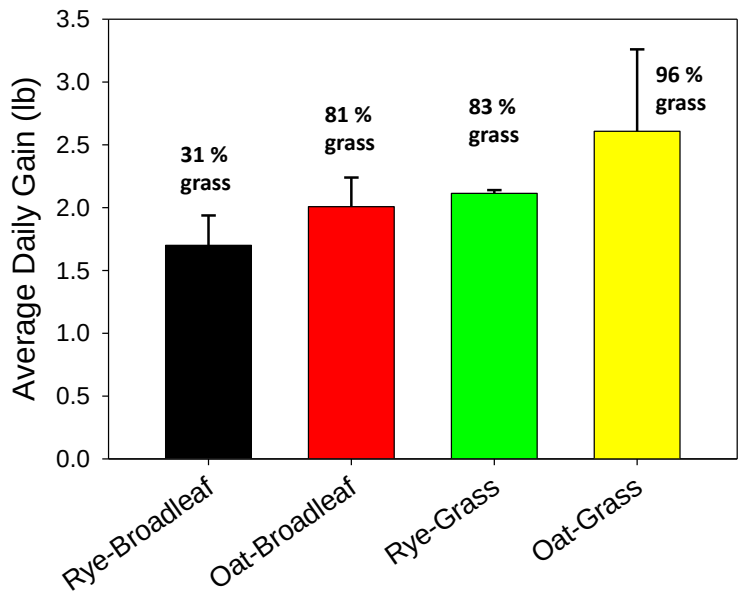
Textbook Values of Crude Fiber and Crude Protein
From M.H. Jurgen's ***Animal Feeding & Nutrition***:

Material	**crude fiber**	**crude protein**
	(%)	(%)
Potato tubers	2	10
Turnip roots	11	13
Dwarf Essex	15	18
cowpea hay	27	20
ryegrass hay	25	11
Barley hay	27	9
Wheat hay	29	9
Pearl Millet fresh	31	10
Rye silage	35	12
sorghum-sudan (bloom)	36	9
corn stalks	36	6

23

24

Observed Average Daily Gain for Different Cover Crop Blends



25

Forage sorghum and sudangrass are great warm-season forages, but remember they will produce prussic acid after a frost.

26

Pete's Opinion & Review

Blends are better than single species as cover crops. Choose cover crops that are quick to establish and that differ from the next crop. Weight the blend to match anticipated temperatures – consider biomass and moisture use.

Composition matters, more fiber=more residue. Low fiber means less residue in the spring, and more rapid nutrient cycling.

At Beresford, corn tends to do better following a blend of predominately cool-season broadleaf species, provided moisture is adequate.

We have not seen a significant impact on N requirements for the following corn crop at Beresford.

Weak trend for soybeans to do better following brassica & sorghum cover crops. Rye gives potential for spring grazing.

27

28

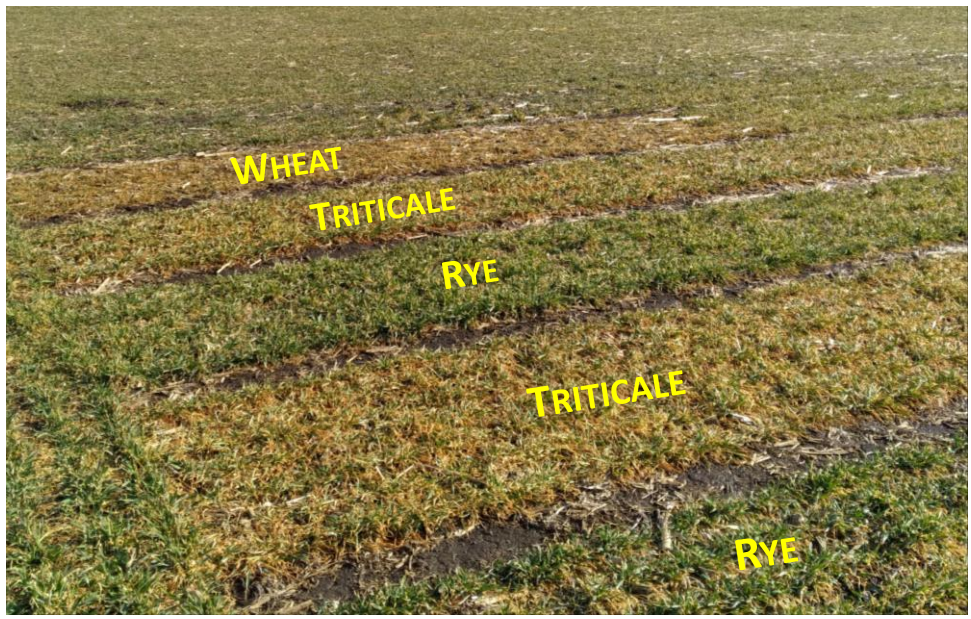
Forage Rye

Biomass Production:

- Has varied from 1580 to 4700 lb dry matter per acre at the Southeast Farm – typically 2000 to 3000 lb per acre
- Depends on fall planting date and moisture, and spring burndown timing
- Later burndown means more biomass, and more nutrients taken up by the rye, and more water use.

29

Winter-Annual Forage Variety Trial – SDSU Southeast Research Farm, Beresford, South Dakota – April 1, 2022.



30

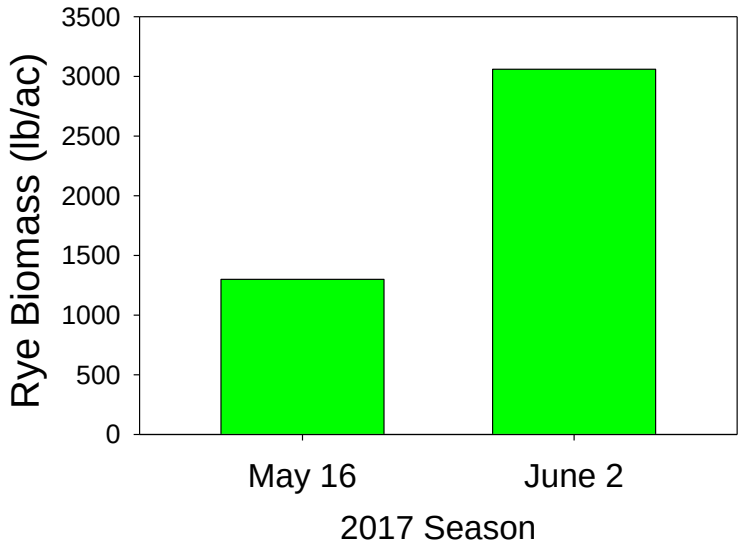
Line	Type	2019 Dry Matter		Line	Type	2020 Dry Matter
		(ton/ac)				(ton/ac)
Hazlet	OP-rye	**2.36**		Bono	HY-rye	**4.51**
Rymin	OP-rye	**2.34**		Hazlet	OP-rye	**4.23**
Daniello	HY-rye	**2.23**		Propower	HY-rye	**4.06**
Rymin/Icecle (50/50)	OP-rye/pea	**2.15**		Elbon	OP-rye	**3.94**
Binnitto	HY-rye	**2.11**		Berado	HY-rye	**3.90**
Bono	HY-rye	**2.10**		Tayo	HY-rye	3.69
Lon	OP-rye	**2.07**		Brasetto	HY-rye	3.60
Rymin/Icecle (75/25)	OP-rye/pea	**2.05**		Progas	HY-rye	3.47
Propower	HY-rye	**2.02**		Serafino	HY-rye	3.47
Serafino	HY-rye	**2.00**		Lon	OP-rye	3.39
Brasetto	HY-rye	**1.99**		Gardian	OP-rye	3.26
Progas	HY-rye	**1.95**		Daniello	HY-rye	3.22
Tayo	HY-rye	**1.95**		Fridge	Trit.	3.10
Rymin/Icecle (25/75)	OP-rye/pea	1.67		Rymin	OP-rye	3.09
Sam's DQ Mix	trit/pea/vetch	1.42		718 trical	Trit.	3.09
Willow Creek	winter wheat	0.64		Nitrous	Trit.	2.95
719-Flex/Ice. (50/50)	trit/pea	0.56		Rymin8	OP-rye	2.61
Fridge	Triticale	0.53		Nitrous8	Trit.	2.57
719-Flex	Triticale	0.47		Sy-912	wheat	2.53
719-Flex/Ice. (75/25)	trit/pea	0.42		HyOctane	Trit.	2.06
Hy-Octane	Triticale	0.38				
	Mean	*1.59*		*Mean*		*3.34*
	LSD (0.05)	*0.59*		*LSD(0.10)*		*0.77*

31

LINE	Type	2021 Dry Matter		Line	Type	2022 Dry Matter
		(tons/ac)				(ton/ac)
Progas	HY-rye	**3.43**		KWS Aviator	HY-rye	**2.96**
Daniello	HY-rye	**3.25**		Hazlet	OP-rye	**2.72**
Hazlet	OP-rye	**3.19**		Elbon	OP-rye	**2.70**
Rymin	OP-rye	**3.12**		KWS Propower	HY-rye	**2.70**
Propower	HY-rye	**3.08**		KWS Progas	HY-rye	**2.67**
Problend	HY-rye	**3.06**		Fridge	Trit.	**2.65**
Nitrous Trit.	Trit.	2.75		Forage FX 1001	Trit.	2.48
Willow Creek	wheat	2.10		Tulus	Trit.	2.36
SamsDQ	blend	1.94		Nitrous Trit.	Trit.	2.34
				Jerry	Wheat	2.29
	Mean	*2.88*		Willow Creek	Wheat	2.11
	CV (%)	*11.8*				
	LSD (0.10)	*0.41*			*Mean*	*2.54*
					CV (%)	*11.3*
					LSD(0.10)	*0.34*

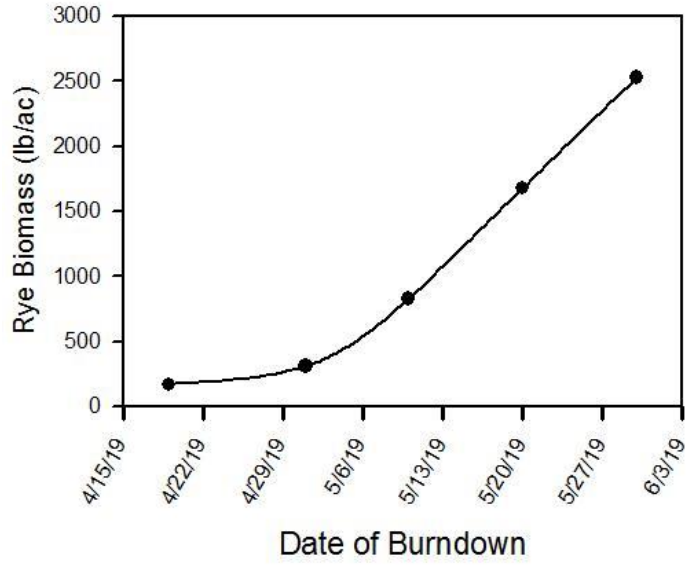
32

Rye biomass at two dates in the spring of 2017.
SDSU Southeast Research Farm, Beresford, South Dakota.



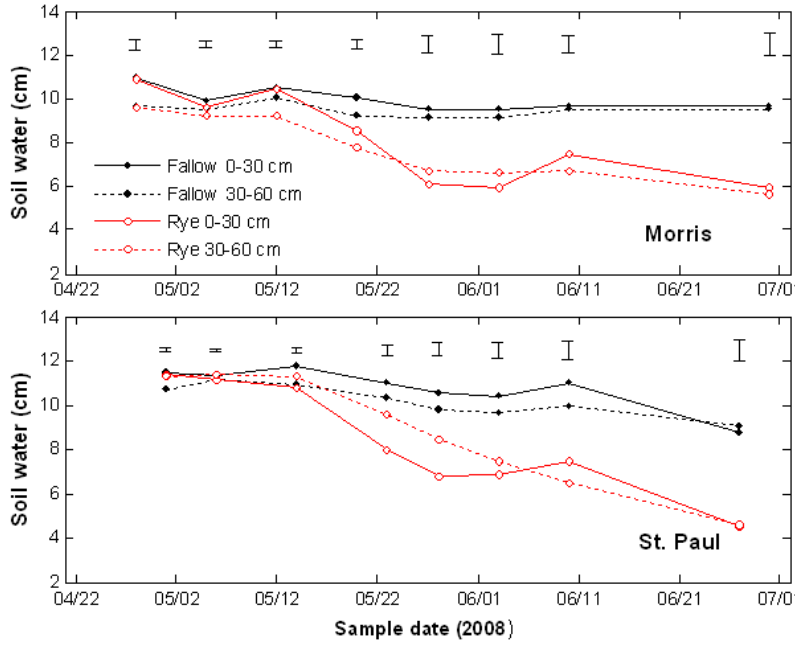
33

Rye biomass at approximately 10 day intervals in the spring of 2019. SDSU Southeast Research Farm, Beresford, South Dakota.



34

Soil moisture over time with and without a winter rye cover crop – by June 1, the difference was greater than 2.3" at both sites; data from a MN study (Krueger et al., 2010).



35

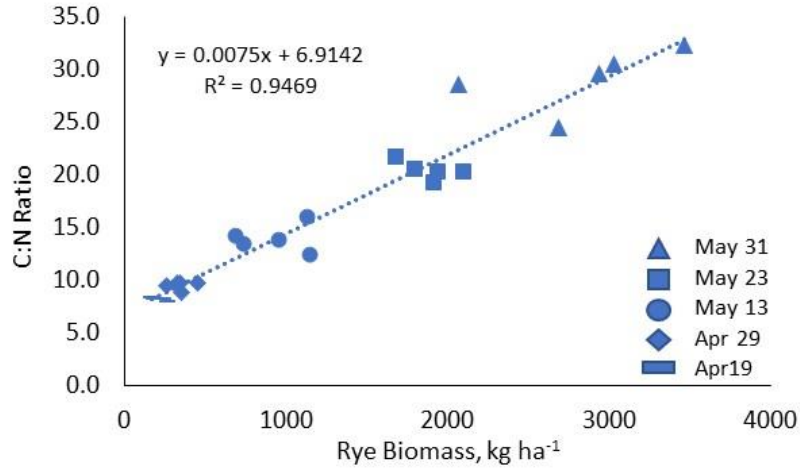
Shoot nutrient content from a rye cover crop measured on May 31, 2019 in a trial conducted at the Southeast Research Farm in Beresford, South Dakota. Shoot biomass was 2830 lb/ac on a dry matter basis in this trial.
'High-end' nutrient removal estimates nutrient removal using the average yield from the best line in rye forage trials (6630 lb/ac) over four seasons.

Element	Observed Nutrient Content	Estimated High-end Nutrient Removal
	(lb/ac)	(lb/ac)
N	36	84
P_2O_5	20	48
K_2O	72	168
S	3	8

Data from Ben Brockmueller's Masters Thesis.

36

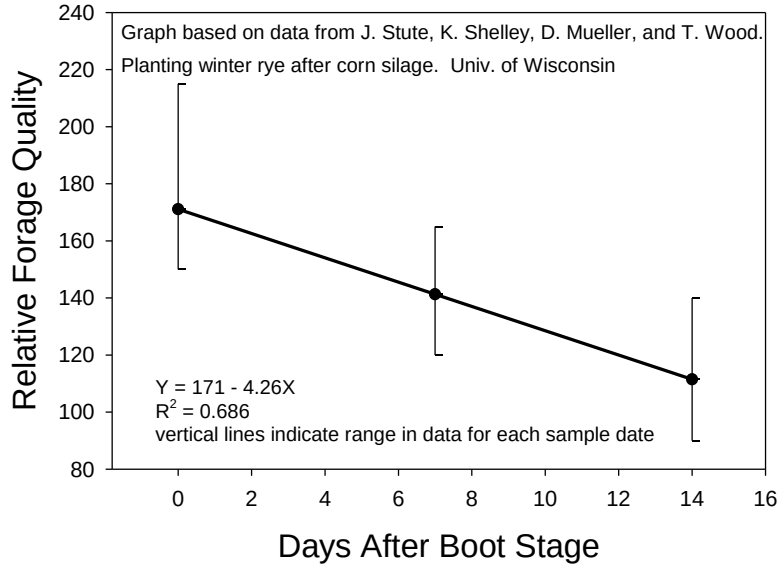
C:N ratio of rye in relation to crop biomass across five sample dates in a trial conducted at the SDSU Southeast Research Farm in 2019. Note that fiber content will tend to track the C:N ratio.



Data from Ben Brockmueller's Masters Thesis.

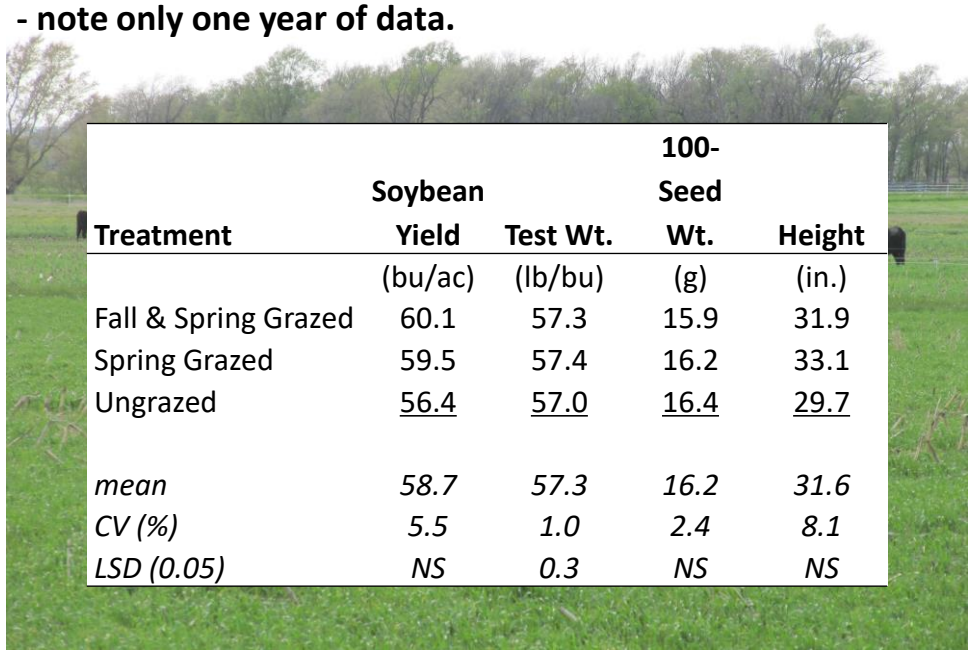
37

Rye forage quality versus days after boot stage. Data from Wisconsin.



38

Grazing trial at the Southeast Farm – 2014 Season
- note only one year of data.



Treatment	Soybean Yield	Test Wt.	100-Seed Wt.	Height
	(bu/ac)	(lb/bu)	(g)	(in.)
Fall & Spring Grazed	60.1	57.3	15.9	31.9
Spring Grazed	59.5	57.4	16.2	33.1
Ungrazed	56.4	57.0	16.4	29.7
mean	*58.7*	*57.3*	*16.2*	*31.6*
CV (%)	*5.5*	*1.0*	*2.4*	*8.1*
LSD (0.05)	*NS*	*0.3*	*NS*	*NS*

39

Decision Points

1. Preplant: am I managing for high forage production or low-input, low risk? - determines planting date, seed rate, and fertilizer use

2. Late April: If it looks like we might be short of moisture, is the rye valuable enough for me to put my next crop at risk? Should it be kept or sprayed out? Think about K as well as moisture.

3. Late May: After rye, should one go with soybeans, or go to forage sorghum, or perhaps millet?

40

41

Yield of different maturity soybeans planted after rye silage – 2017 Season – Southeast Farm. Soybeans were planted on June 12, 2017. Forage sorghum planted at the same time had a silage yield of 18 tons per acre. Rye silage yield was about 4 tons per acre in this study.

Line	Stand	Moisture	Test Wt.	100-Seed Wt.	Yield
	(plants/ac)	(%)	(lb/bu)	(g)	(bu/ac)
P25T1R	109626	11.8	55.7	19.4	62.8
P28T08R	110352	14.0	55.2	19.7	61.2
P18T26R	122694	10.0	55.2	16.1	59.6
P22T69R	119427	10.3	55.5	17.9	57.8
Mean	115520	11.5	55.4	18.2	60.3
CV (%)	5.4	13.2	2.1	2.8	4.2
LSD (0.10)	8080	2.0	NS	0.7	NS

42

Yield of soybeans, full season and short season corn, and forage sorghum planted after rye silage – 2021 Season – Southeast Farm. This was a drought year. Rye was cut for silage on May 26th and the following crop was planted on May 28th, 2021.

Crop	Maturity	Yield		Nearby Checks
Soybean	2.4 MG 'Z2401E'	29.3 bu/ac		63.3
Corn	104 day	56.0 bu/ac		-----
Corn	96 d	73.1 bu/ac		157.8
Forage Sorghum	Pioneer '821FBMR'	16.1 tons/ac	silage	-----

43

Average yield of forage sorghum, sorghum-sudangrass, and corn silage following a rye silage crop in 2022 from a forage variety trial conducted at the SDSU Southeast Research Farm. As a check, soybean and corn plots for grain production were also included in the trial – those yields are in the table to the right.

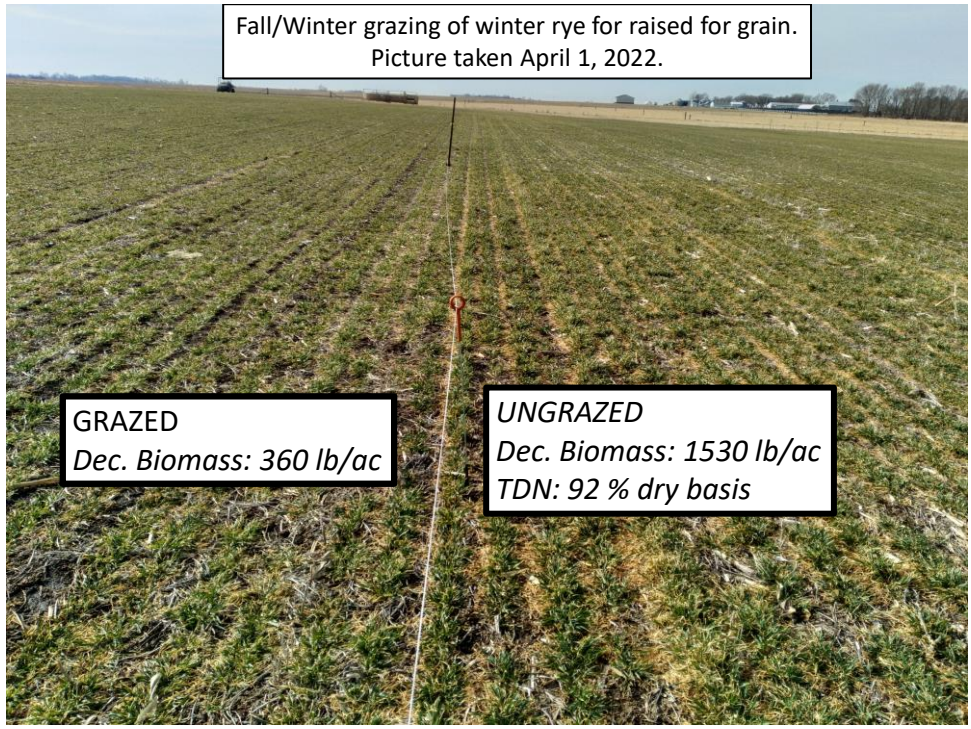
Forage Crops	Dry Matter	Silage
	(lb/ac)	(ton/ac)
Forage Sorghum	9120	13.0
Sorghum-Sudan	3580	5.1
Corn Silage	5720	8.2

Estimated Gross Revenue:
Forage Sorghum = 13 ton/ac x $60 per ton = $780/ac

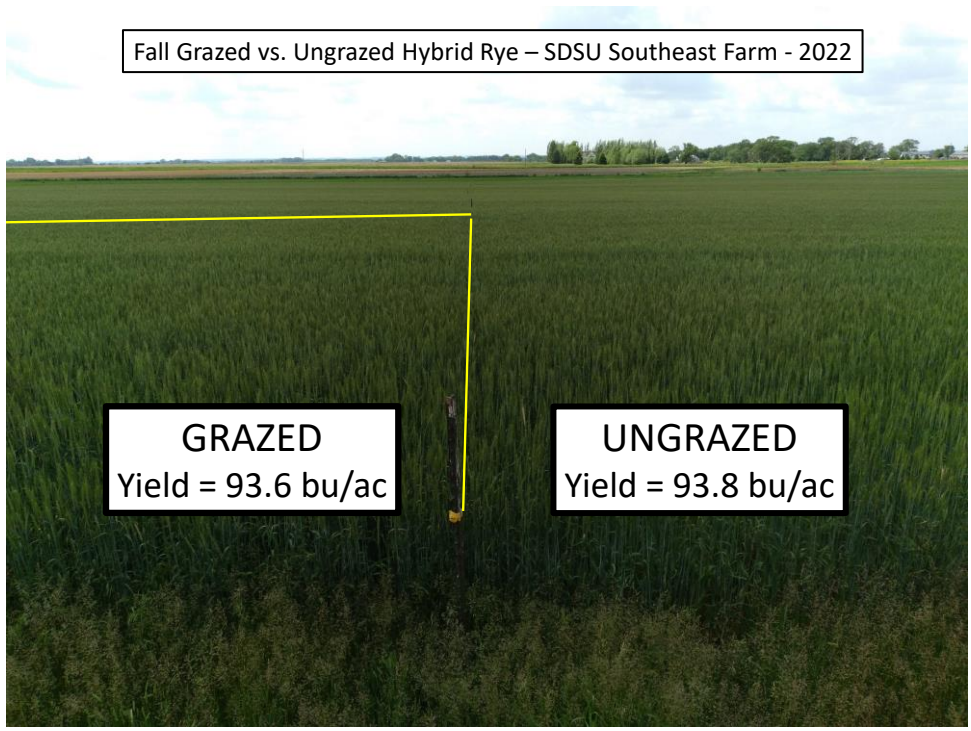
Grain Crops	Yield
	(bu/ac)
Early Soybean	19.9
Late Soybean	< 5
Corn Grain	< 25

Estimated Gross Revenue:
Early Soybean = 20 x $14/bu = $280/ac

44


Fall/Winter grazing of winter rye for raised for grain.
Picture taken April 1, 2022.
GRAZED
Dec. Biomass: 360 lb/ac
UNGRAZED
Dec. Biomass: 1530 lb/ac
TDN: 92 % dry basis

45


Fall Grazed vs. Ungrazed Hybrid Rye – SDSU Southeast Farm - 2022
GRAZED
Yield = 93.6 bu/ac
UNGRAZED
Yield = 93.8 bu/ac

46

47

Yield comparison (average vs. average, and best vs. best) of hybrid versus open-pollinated lines of rye from trials conducted over four years in southeastern South Dakota.

AVERAGE vs. AVERAGE

Year	Hybrid Average	OP Average	Difference
	(bu/ac)	(bu/ac)	(bu/ac)
2019	84.0	49.0	35.0
2020	105.3	67.7	37.6
2021	54.8	38.7	16.1
2022	76.6	53.2	23.4
Mean	80.2	52.2	28.0
Hybrid vs. OP			
P-value	0.011		
CV (%)	10.8		

BEST vs. BEST

Year	Best Hybrid	Best OP	Difference
	(bu/ac)	(bu/ac)	(bu/ac)
2019	105.0	61.0	44.0
2020	125.0	77.3	47.7
2021	58.4	43.8	14.6
2022	80.2	55.0	25.2
	92.2	59.3	32.9
Hybrid vs. OP			
P-value	0.025		
CV (%)	14.6		

48

Competitive Ability of Rye vs. Wheat: weed biomass in an organic winter wheat variety at the Southeast Farm in Beresford, South Dakota, conducted in the 2011/12 and 2012/13 growing seasons.

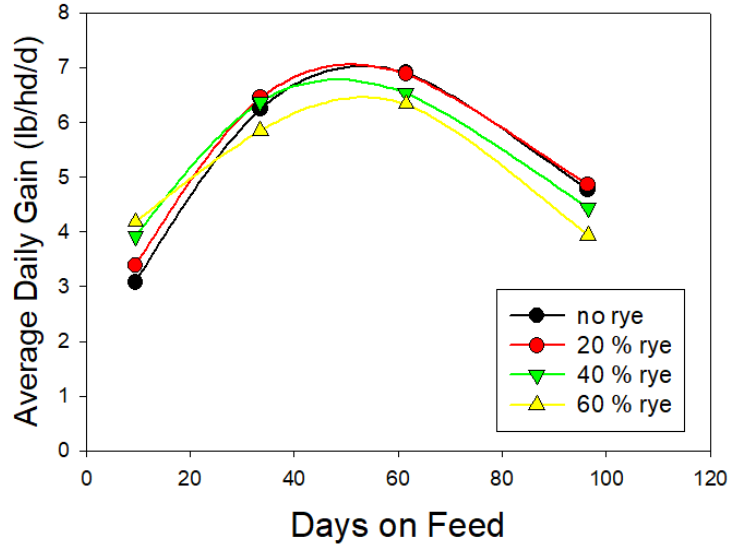
	Weed Biomass	
Crop	2012	2013
	(lb/ac)	(lb/ac)
Wheat average	574	1118
Triticale average	384	397
Rye	301	20
	crop	***crop***
Rye biomass	*5504*	*12106*

49

50

51

Average daily gain plotted against days on feed for four rations utilizing different amounts of rye versus corn in the diet from a trial conducted at the Southeast Research Farm in 2019/2020. Data from Rusche et al., 2020.



Data compliments of Warren Rusche, Zach Smith, and Julie Walker

52

53

Southeast Research Farm – Beresford, South Dakota – 2022 Season
Long-term plots with and without cover crops.

Rotation	Tillage	Cover Crop	Yield
(yr)			(bu/ac)
4	NT	Y	118.5
4	NT	N	109.7
4	CT	Y	79.9
4	CT	N	70.3
3	NT	Y	92.2
3	NT	N	87.1
3	CT	Y	64.8
3	CT	N	60.6
2	NT	Y	80.4
2	NT	N	95.0
2	CT	Y	86.8
2	CT	N	88.8

54