Cover Crop Management

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EXTENSION

Cover crops

Katja Koehler-Cole

Postdoctoral Research Associate, UNL Cover Crop Project

What are cover crops?

- **"A cover crop is any living ground cover that is planted into or after a main crop and then commonly killed before the next crop is planted."**

(Ammon & Hartwig, 2002)

- Cover crops are not a new concept
  - Replaced fallow in European farming systems in 16th and 17th century
- In US, they have been used to provide erosion control
- For grain production, winter annual cover crops most common

Why grow cover crops?

- Benefits for soil quality
  - Reducing erosion
  - Increasing organic C
  - Aggregation
- Nutrient management
  - N addition
  - Preventing N leaching
- Biodiversity and habitat
- Weed suppression
- Forage

Forage radish

Red clover

What are reasons against growing CC?

- Water use
- Can tie up N
- Can lower crop yields
- Labor and cost

Corn grown after red clovr

Corn after control (no clover)

Benefits can be hard to quantify and put into economic terms

Long-term benefits vs short-term effects

Soil organic matter increases take decades.

Production costs increase right away!

Selecting cover crops – consider your goals, cropping system, climate

- More benefits the longer cover crops can grow
- But time for cover crop growth is limited

Cropping system	Relative ease of establishment	Probability of production success
Wheat	Very easy	Very high
Hybrid seed corn	Very easy	Very high
Corn/Sorghum (silage)	Easy	High
Soybean	Easy/Difficult	High
Corn/Sorghum (grain)	Difficult/Impossible	Low/Moderate

Selecting cover crops – consider your goals, cropping system, climate

Goal	Cover crop characteristics	Species
Erosion control	Fast-growing, extensive root system that can hold soil in place, winter hardiness	Cereal rye and other grasses
Take up unused N	Fast-growing, extensive root system, high dry matter production	Cereal rye and other grasses, radish, turnips
Add N	Leguminous, high dry matter production, fast-growing	Sunnhemp grows fast, clovers and alfalfa (slow)
Weed control	Fast emergence and growth, tall, allelopathic	Rye (is also allelopathic), red clover, alfalfa

RES

Cover crop research in Nebraska

Following Wheat – North Platte

43 days after planting on September 4, 2009 (top left)
77 days after planting on October 8, 2009 (bottom left)

Mix of sorghum and pearl millet (warm-season grasses), radish, turnip, cowpea, lentils

J. D. Volesky

Following Hybrid Seed Corn – Central Nebraska

Slide 11

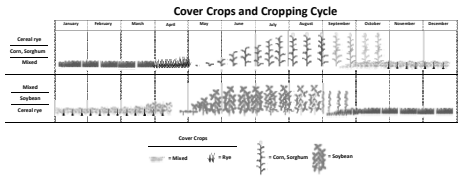
RE5 note mix species perhaps in note area
Roger Elmore, 12/17/2015

Undersowing legumes into winter wheat in Eastern Nebraska

Red clover in winter wheat | White clover in winter wheat | Wheat "only" plot (no we

Following Corn and Soybean

UNL Cover Crop Project



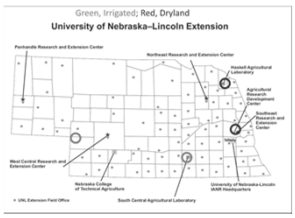
Soybeans Nebraska Soybean Board

Diagram by Justin McMechan

Nebraska Corn Board

UNL Cover Crop Project

- Testing the suitability of a range of cover crops for Nebraska corn and soybean systems
- Measurements
  - Crop yields, soil properties and farm economics
- 2014 – 2017
  - 2015 data presented



Cover crop fall growth

Rye on 10/27. Planted 9/3

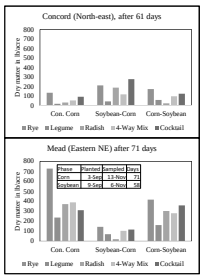
Radish on 10/13. Planted 9/10

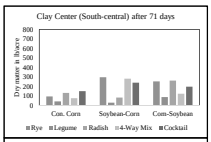
Field pea + hairy vetch on 10/13. Planted 9/10

Rye+radish+pea+vetch on 10/13. Planted 9/10

7-species mix on 10/13. Planted 9/10

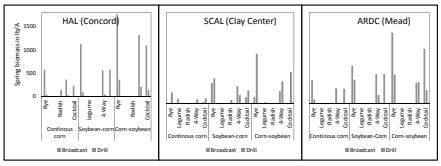
Cover crop fall growth





- Rye, oats, and radish most productive
- Corn phase of rotation better than continuous corn or soybean
- Western site (Brule) had little growth

Cover crop spring growth



- **Rye was predominant**, including in mixes whereas legumes and radish winterkilled.
- Early planted cover crops more productive (longer growing period)
- At Clay Center, late planted cc were more productive (better seed-soil contact by drilling)

Corn yields after cover crops

- Corn yields were lower in the continuous corn rotation and this difference was large
- Corn yields were lower after highly productive cover crops, but this difference was small

Soybean yields after cover crops

- Soybean yields were not affected by the species or planting date of the previous cover crops at two sites
- At the north-east site, soybean yields were 4 bu/ac lower after early-planted cover crops

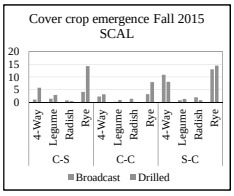
What have we learned so far?

- **Cover crops grow successfully in Eastern/Central NE**
- **For high cover crop productivity, plant early!**
- **Increase seeding rate for broadcasting**
- **Rye, radish, oats have rapid fall growth, but only rye survives winter**
- **If drilling after corn/soybean harvest, use rye**
- **Small yield reductions after cc at some sites**

Questions?

Results: Fall 2015 cover crop emergence

- Drilled cc had higher emergence than broadcast
- Why?
- CC planted in the corn phase of a C-S rotation had highest emergence
- Why?
- Rye had highest emergence
- Interactions



How can cover crops be integrated into a farming/gardening situation?

Farm situation	CC purpose	Planting time	CC species
Corn-soybean farm			
Corn-soybean-wheat farm			
Vineyard			

Forage Cover Crops

Daren Redfearn

Nebraska Extension Forage and Residue Systems Specialist

Department of Agronomy and Horticulture

Presented to:
31st Annual Nebraska Women in Agriculture Conference
Kearney, NE
February 25, 2016

Topics

- Cover crop/Forage cover crop comparison
- Grazing effects
- Importance of planting date
- Incorporating forage cover crops into cropping systems
  - Soybean
  - Wheat
- Trade-offs

EXTENSION

What do we want to accomplish?

- **Cover crops and Forage cover crops**
  - Different end-uses
  - Same species, similar management
- What are the **risks**?
  - Establishment/planting date (more control)
  - Production risks (less control)
    - Drought
    - Early freeze, late freeze
  - Increased management/skills
- **Species**
  - Small grains
    - Oats
    - Cereal rye
    - Triticale
    - Wheat
    - Barley
  - Brassicas
    - Turnips
    - Radishes
    - Hybrids

Initial Responses to Grazing Forage Cover Crops

- I don't want to lose the benefit(s) of the cover crop by grazing livestock.
- When can I begin grazing without harming cover crop function?

Can I graze forage cover crops without harming cover crop function?

- Canadian study (Mapfumo et al., 2002) examined grazing intensity on root growth in triticale.
- Australian experiment (Kerkegaard et al., 2015) looked at grazing effects on wheat root growth.
- Georgia study (Franzluebbers and Stuedemann, 2015) evaluated grazing effects on soil C and soil N.
- Root mass production under light, moderate, and heavy grazing intensity was not different.
- Grazing had no substantial effect on rooting depth or root mass in wheat unless it was grazed during early growth.
- Soil C and soil N were not different whether cover crops were grazed or not.

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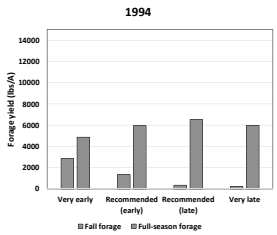
- Root mass production under light, moderate, and heavy grazing intensity was not different.
- Grazing had no substantial effect on rooting depth or root mass in wheat <u>unless</u> it was grazed during early growth.
- Soil C and soil N were not different whether cover crops were grazed or not.

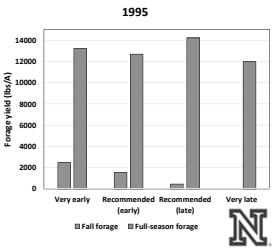
Grazing did not reduce any plant or soil response important improving soil quality.

Planting date differences

- September 5th (left)
- August 25th (right)
- Harvested on October 16th

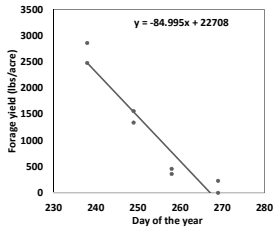
Wheat Forage Yield at Four Fall Planting Dates in Sidney, NE





Adapted from Holman et al. (2011)

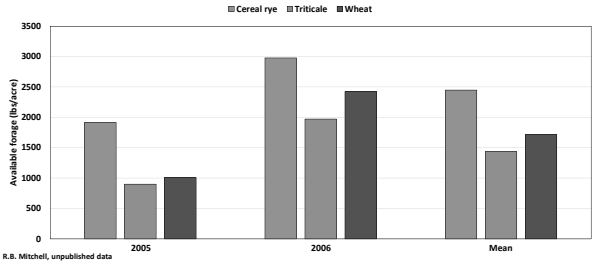
Planting Date Affects Fall Forage Production of Winter Wheat



Adapted from Holman et al. (2011)

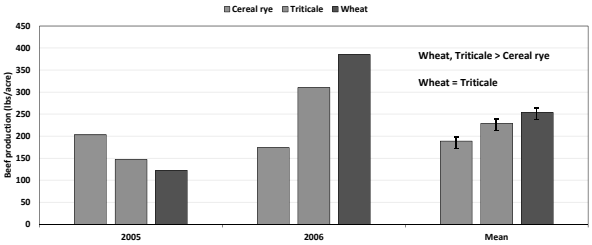
For each day planting is delayed, **fall forage** production potential is **reduced** by 85 lbs/acre.

Mean Spring Forage Yield of Cereal Rye, Triticale, and Wheat following Soybean in Eastern Nebraska



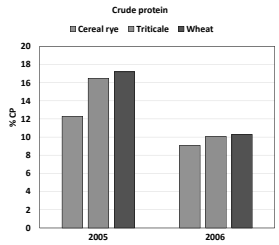
R.B. Mitchell, unpublished data

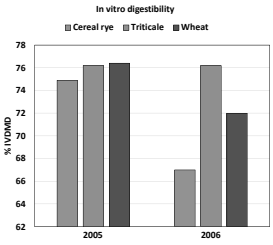
Beef Production Potential from Small Grains following Soybean



R.B. Mitchell, unpublished data

Importance of Forage Nutritive Value





R.B. Mitchell, unpublished data

Small Grains following Soybean

- Spring grazing only (small window of opportunity)
  - 2005 (17 days)
  - 2006 (32 days)
- Variable forage production
  - Cereal rye > Wheat, Triticale
- Forage quality may have offset lower forage yield
  - Wheat, Triticale > Cereal rye

RE4

Beef Production from Forage Cover Crops following Wheat

	Forage production (Tons/A)	Grazing days	Beef gain (lbs/A)
2013	**1.1**	**48**	**97**
2014*	**2.4**	**52**	**137**

*Manure application

Forage cover crops (Oats, Purple top turnips, and sorghum)

2014-greater forage production, higher stocking rate, lower daily gain, but greater total beef gain

Mary Drewnoski, unpublished data from ARDC, Mead, NE

Slide 39

RE4 when was manure a[pplied?
Roger Elmore, 12/17/2015

RE3

Subsequent Soybean Yield After Grazing Forage Cover Crops Following Wheat

Treatment	Soybean yield (bu/acre)
No cover crop	**64**
Cover crop (not grazed)	**64**
Forage cover crop (grazed)	**62**

Treatment effect, NS

Mary Drewnoski, unpublished data from ARDC, Mead, NE

Forage Cover Crops Following Wheat 2013

	Cost per acre	
Herbicide	$13.00	
Seed	$11.00	
Planting	$12.00	
TOTAL	**$36.00**	
		with yardage
Calves/A	1	
Cost, $/calf	$36.00	$43.20
Cost, $/lb gain	$0.38	$0.46

Begin 450 lb ($941)
End 544 lb ($1077)
$136 increase in calf value
$100/calf or $100/A

Forage Cover Crops Following Wheat 2014

	Cost per acre	
Herbicide	$13.00	
Manure	$70.00	
Seed	$25.85	
Planting	$12.00	
TOTAL	**$120.85**	
		with yardage
Calves/A	1.7	
Cost, $/calf	$71.09	$78.89
Cost, $/lb gain	$0.52	$0.62

Begin 585 lb ($1579)
End 665 lb ($1784)
$204 increase in calf value
$125/calf or $213/A

Slide 40

RE3 as in last slide
Roger Elmore, 12/17/2015

Summary

- No negative effects on soil quality from grazing forage cover crops.
- Variable (forage) production - Planting date
  - Moisture availability
- Variable nutritional value – Plant maturity
  - Species in the mix
  - Growth of each species
- Variable animal gain
  - Animal selection

Where's the free lunch?

Major trade-offs

- Forage/livestock production or crop production?
- Grazing and/or hay?
  - Variable forage production (risks of failure)
  - Seasonality of production (fall; spring; fall/spring)
- Forage quality balance with available forage
- Subsequent crop production
  - Growing season
  - Soil moisture

Questions

- Email dredfearn2@unl.edu
- Website agronomy.unl.edu/range-pasture-forages
- Twitter @UNLRangeForage

Small Grain Forage Establishment Costs

	Forage production[6]		
	Fall	Spring	Fall + Spring
	---------- Cost per acre ----------		
Seed costs[1]	$27.00	$27.00	$27.00
Planting costs[2]	$15.00	$15.00	$15.00
Fertilization[3,4]	$22.00	$33.00	$55.00
Application costs[5]	$5.40	$5.40	$10.80
Total	$69.40	$80.40	$107.80
Cost/ton	$46.27	$32.16	$26.95

[1] (90 lbs seed per acre @ $0.30 per lb.
[2] Average custom rate for no-till wheat.
[3] 40 lbs N per acre (urea @ $460 per ton)
[4] 60 lbs N per acre (urea @ $460 per ton)
[5] Average custom rate for dry fertilizer application
[6] Fall-only yield (1 ⅗ tons/A), Spring-only yield (2 ⅗ tons/A), Fall + Spring yield (4 tons/A)

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Cover Crop Research Continues at UNL

Cropping systems	Current	Previous reports
Wheat	Drewnoski et al.; Redfearn et al.; Jasa et al.; Blanco-Canqui et al.; Proctor, Elmore et al.	Lyon, Hergert, et al. 2015; Koehler-Cole, 2015
Hybrid seed corn	Irmak	
Corn (silage)	Drewnoski et al.	
Sorghum (silage)		
Soybean	Elmore et al.; Proctor; Jasa et al.	Kessavalou, A., and D.T. Walters. 1997; S. Wortman, 2012
Corn (grain)	Elmore et al.; Jasa, Blanco-Canqui et al.; Proctor; Krantz, Krull.	Wortman, 2012
Sorghum (grain)		
On-Farm Research	Glewen, Thompson et al.	
Cover Crops Species	Most of the above	Power & Koerner, 1994

What Katja and Daren shared:

Cover crops when used…..

- For cover:
  - Short-term:
    - May affect main-crop yields
    - Will increase production expenses.
- As a forage crop:
  - Short-term:
    - May result in variable forage production
    - May result in variable nutritional value
    - May result in variable animal gain
    - May increase net profitability
- Long Term – for both uses:
    - May enhance soil quality.
    - May enhance crop productivity and land value

What we're saying: "*There is a place for Cover Crops…*"

Cover crops when used for <u>either</u> **forage** or **soil quality** ***may***…

- Increase system profitability --- short term
- Enhance soil quality --- long term
- Sustain crop productivity and land value --- long term

Cover Crops and Scientific Evidence

Potential advantages	**Is this a correct assumption based on research?**
Soil erosion reduction	
Increased water infiltration	
Nutrient sequestration and thus reduces nutrient needs of succeeding crop.	
Increase in organic matter	
Alleviate soil compaction – increase porosity	
Aids in weed management	

Cover Crops and Scientific Evidence

Potential advantages	Is this a correct assumption based on research?
Breaks disease cycles	
Provides nematode control	
Nitrogen fixation	
Increases biodiversity	
Attracts beneficial insects	
Enhances mycorrhizal numbers	
Develops wildlife habitat	
Provides grazing for livestock	

Potential disadvantages of cover crops	Is this a correct assumption based on research?
Water use	
Herbicide application limitations	
Increased management	
Increased input costs	
Livestock compaction	
N immobilization with late termination	

Cover Crops and Scientific Evidence

Potential Advantage and Disadvantage of cover crops	Is this a correct assumption based on research?
	15 Studies
Yield	

Concerns: There is a Bigger Story!

- 9 x 10^9 by 2050
- Climate variability
- Resistance
- Resources in common:
  - Water
  - Soil
  - Air

"It makes you realize that we all are just small, passing players in a very long-running story."
Don Walker, Archeologist - bone specialist. On examining bones from medieval cemeteries under London. P. 96 Nat'l. Geographic, Feb 2016.

"Don't judge each day by the harvest you reap, but by the seeds that you plant."
Robert Louis Stevenson

An illustration from a "Commons"

- What is a commons?
- Characteristics of a commons?
  1)
  2)
  3)
  4)

[1] http://www.thefreedictionary.com/commons

Tragedy of the Commons

Hardin (1968): *Science*

Other examples of resources that we share in 'the Commons'

What type of 'Commons' are easily managed?[1]

1. Resources with definable boundaries – e.g. land - are managed more easily.
2. Those with a perceptible threat of resource depletion; it's difficult to find substitutes.
3. The presence of community; small and stable populations with a thick social networks and strong social norms promote conservation better.
4. Appropriate community-based rules and procedures must be in place with built-in *incentives* for responsible use and *punishments* for overuse.
5. "…even self-interested individuals will often find ways to cooperate, because collective restraint serves both the collective and individual interests.

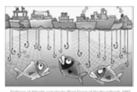
[1]https://en.wikipedia.org/wiki/Commons

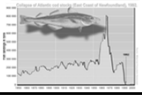
"The Commons"
= *Any limited, shared resource*

- Unregulated exploitation leads to resource depletion

  "A class of problems to which there is no technical solution"
- What is in my personal best interest may not be in my neighbor's best interest

  OR
- What is in my SHORT TERM best interest may not be in my long term best interest.





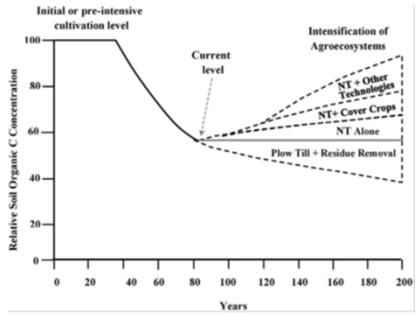
Examples of Tragedies……..

- Insect management
  - Western Corn Rootworm
- Weed resistance
- Fungicide resistance
- Soil Erosion

"…everybody's property is nobody's property"

"…the most common good is the least guarded". [1]

[1] https://en.wikipedia.org/wiki/Commons



Blanco-Canqui et al., 2015

Tragedy of the Commons

"Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all."

Hardin (1968, p. 1244. *Science*)

Concerns:

- 9 x 10^9 by 2050
- Climate variability
- Resistance
- Resources in common:
  - Water
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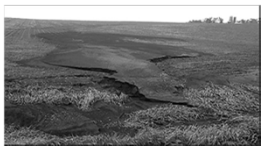
  - Air



What we've discussed:

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What we've shared today: "*There is a place for Cover Crops…"*

Cover crops when used for <u>either</u> **forage** or **soil quality**
may*… *or may not

- Increase system profitability --- short term
- Enhance soil quality --- long term
- Sustain crop productivity and land value --- long term

This is a call for careful Stewardship!

And Now… the bottom line!
How are you going to respond?

Discussion

What did you **learn** of interest regarding cover crops?

What are your **reactions** to this information? Are you considering adding cover crops to your farming operation?

What **questions** do you have regarding cover crops?

What **ideas** regarding cover crops do you have? How will you use this information in the future?

Adapted from "Windows to…" Jan Wiersema, ISU Project LEA/RN