

# **Soil Health Small Farms and Gardens**



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Marion County Soil and Water Conservation District**



— MARION COUNTY —  
**SOIL AND WATER**  
— CONSERVATION DISTRICT —



[Facebook.com/SoilHealthGarden](https://www.facebook.com/SoilHealthGarden)

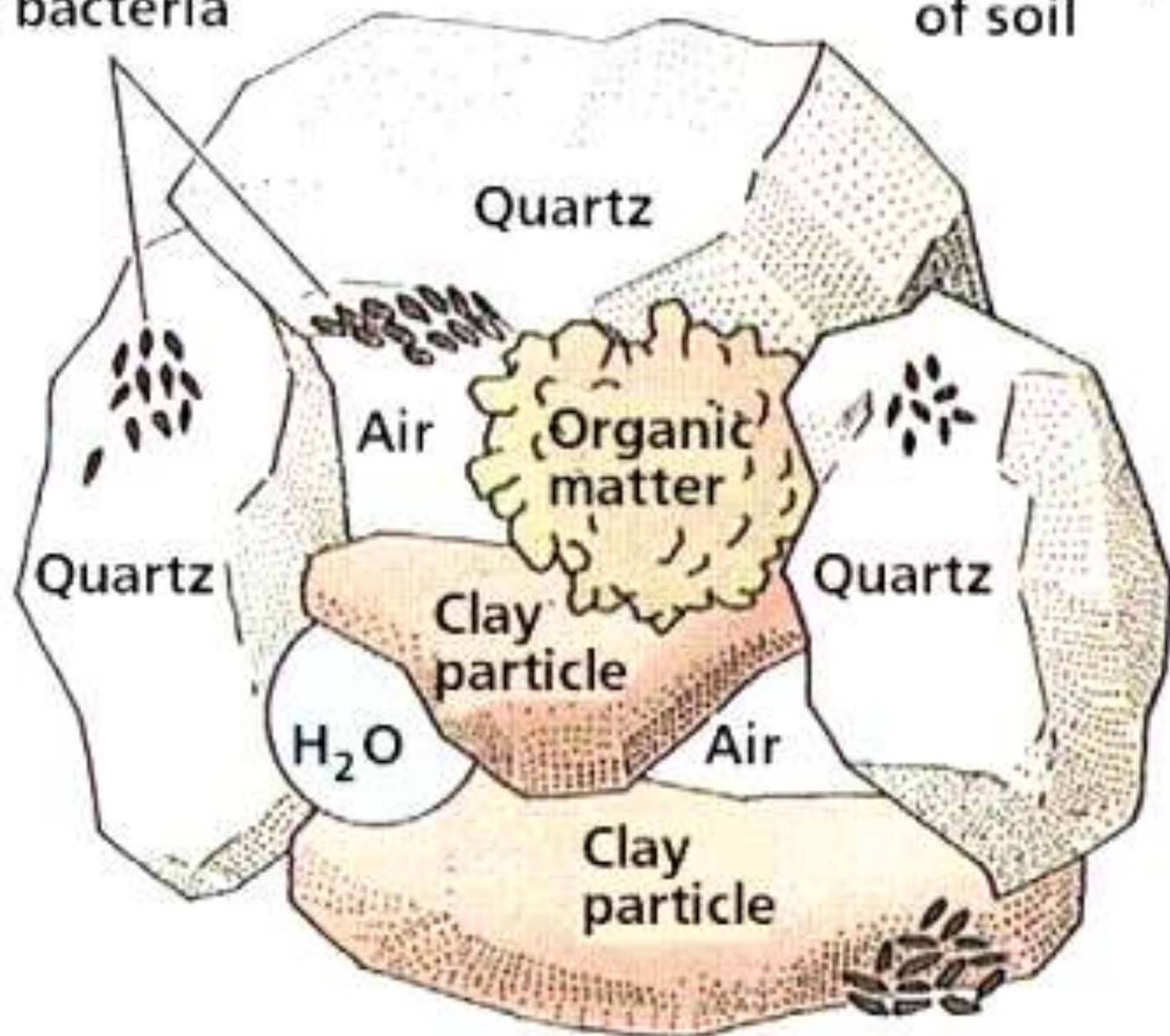
# **Soil Health and Tactics**





Microcolonies  
of bacteria

The complexity  
of soil





























# Biomimicry with Soil Health Principles

Disturb the soil as little as possible

Keep the soil **covered**

Keep plants **growing** throughout the year to **feed** the soil.

**Diversify** as much as possible





Healthy vegetables in  
no-till cover crop  
residue and mulch.





# Keep the Soil Covered!

**Living Plant**



**30% crop residue**

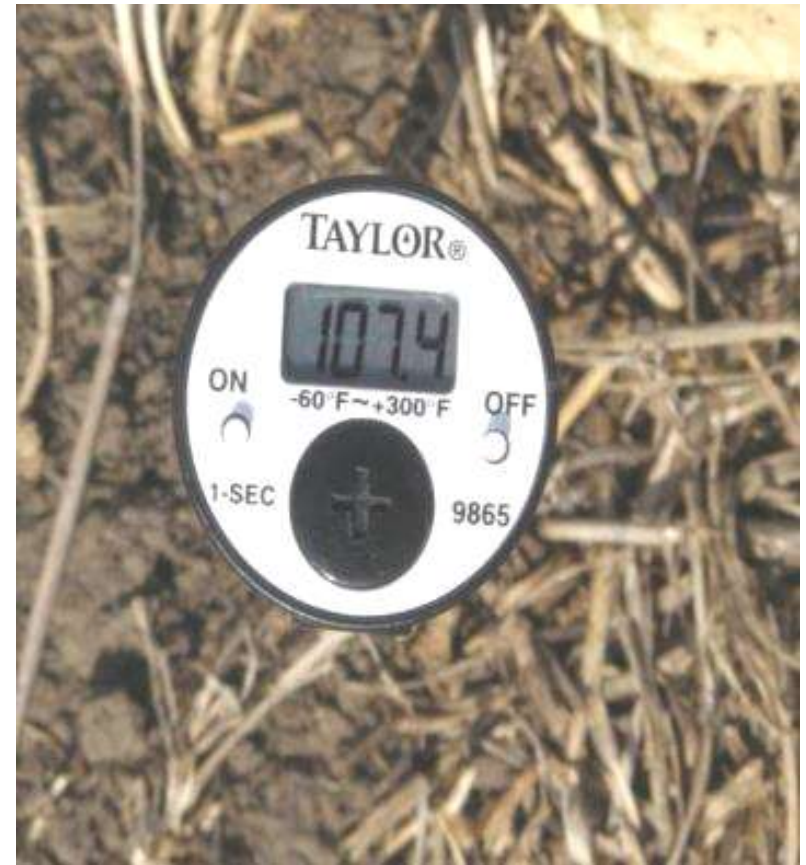










Photo credit: Dan Perkins



Cover crops continue photosynthesis in the garden, using energy from sunlight to produce sugars and plant food in the soil ecosystem. They are biologically, chemically, and physically improving the soil for next year's crop.











Tilth

No Tilth

March, 2016: Hairy Vetch and Cereal Rye transforming the root zone



# Soil Health Benefits



- Increased organic matter
- Increased aggregate stability
- Increased water infiltration
- Increased water-holding capacity
- Improved nutrient use efficiency
- Enhanced and diversified soil biology





# Biomimicry and Soil Health Principles

Disturb the soil as little as possible

Keep the soil **covered**

Keep plants **growing** throughout the year to **feed** the soil

**Diversify** as much as possible



# Mulching up





Mulching up after tillage  
2 – 3 layers of newspaper + 2 – 3" of vegetative mulch



2017/05/09





2017/05/13





2017/05/13





2017/05/13















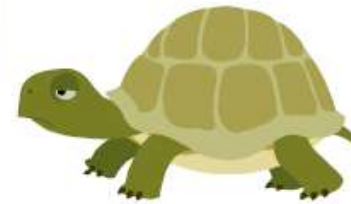
# **Balancing Carbon and Nitrogen**





**Table 1.** Carbon to nitrogen ratios of crop residues and other organic materials

Material	C:N Ratio
rye straw	82:1
wheat straw	80:1
oat straw	70:1
corn stover	57:1
rye cover crop (anthesis)	37:1
pea straw	29:1
rye cover crop (vegetative)	26:1
mature alfalfa hay	25:1
<b>Ideal Microbial Diet</b>	<b>24:1</b>
rotted barnyard manure	20:1
legume hay	17:1
beef manure	17:1
young alfalfa hay	13:1
hairy vetch cover crop	11:1
soil microbes (average)	8:1



↑  
slower

Relative  
Decomposition  
Rate

↓  
faster







**Too much C for Annual Vegetables**



# **Planting Cover Crops**

- **Growing Mulch**
- **Biological Priming**
- **Weed Suppression**





# **Winterkilled Cover Crop**






A photograph showing a dense field of green oat plants. The plants are tall and have long, narrow leaves. A blue oval text box is overlaid at the top center of the image.

Fall growth of Oats suppressing  
weeds and increasing organic matter



A close-up photograph of a field of dead, golden-brown oat plants. The plants are densely packed and have a dry, brittle appearance, with some leaves curled and broken. The overall color is a warm, yellowish-brown, typical of dried plant matter. The background is slightly out of focus, showing more of the same dead plants.

Oats die in the winter  
and its mulch residue  
provides cover and  
food for soil life.





Fall Cover Crop	Spring Planting Options	Early Vegetables
Oats	Strip till rows into residue, seed, and cover	Beats / Carrots / Onions / Spinach / Kale / Early Greens / Leeks
Radish		
Soybean	Rake off residue, add compost, seed, and cover	


















If left untilled, residue will decompose in place. Strip furrow or plant vegetables into the mulch

Or add extra mulch like alfalfa, straw, or compost to prepare for spring transplants







# **Planting Cover Crops**







# Cover Crop Chart

### GROWTH CYCLE

- A = Annual
- B = Biennial
- P = Perennial

### RELATIVE WATER USE

- ☾ = Low
- = Medium
- = High

### PLANT ARCHITECTURE

- ∩ = Upright
- \* = Upright-Spreading
- ≡ = Prostrate

-----Cool Season-----

-----Warm Season-----

---Grass---

---Grass---

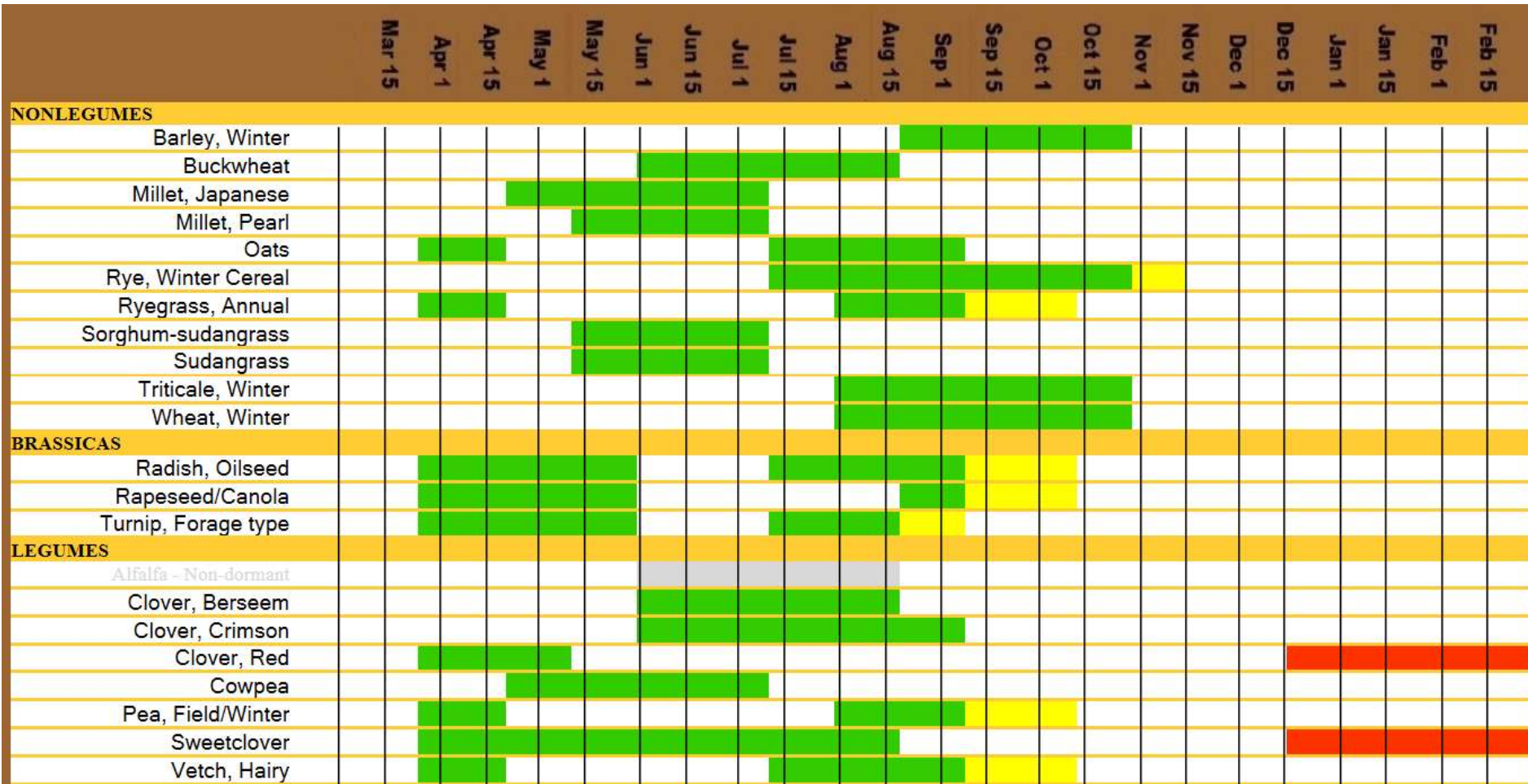
-----Broadleaf-----									
A <b>Barley</b> ∩									A <b>Pearl millet</b> ∩
A <b>Oat</b> ∩	A <b>Phacelia</b> ∩							A <b>Amaranth</b> ∩	A <b>Foxtail millet</b> ∩
A/P <b>Ryegrass</b> ∩	A <b>Flax</b> ●							A <b>Buckwheat</b> ●	A <b>Proso millet</b> ∩
-----Legumes-----									
A <b>Wheat</b> ∩	A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







# Seeding Windows



Source: <http://mccc.msu.edu/covercroptool/covercroptool.php>



# Cover Cropping

- What's your next crop?
- What are its nutrient requirements?
- Do you transplant or direct seed that crop?
- What cover crop will best prepare for that cash crop?
- Can you get that cover crop planted in or after your preceding crop?
- How are you going to kill the cover crop?
- How will you manage the residue?
- What will you need to do to manage weeds?
- Consider allelopathy
- When and where might you need additional inputs like compost, fertilizer, vegetative mulch?
- *RRRR: Right place, Right time, Right source, Right rate!*



*Fall*

***Oats + Crimson Clover***

*Spring*

***(Chop/Drop) Peppers + Alfalfa hay***

*Fall*

***Oats***

*Spring*

***Lettuce + Spinach + Peas***

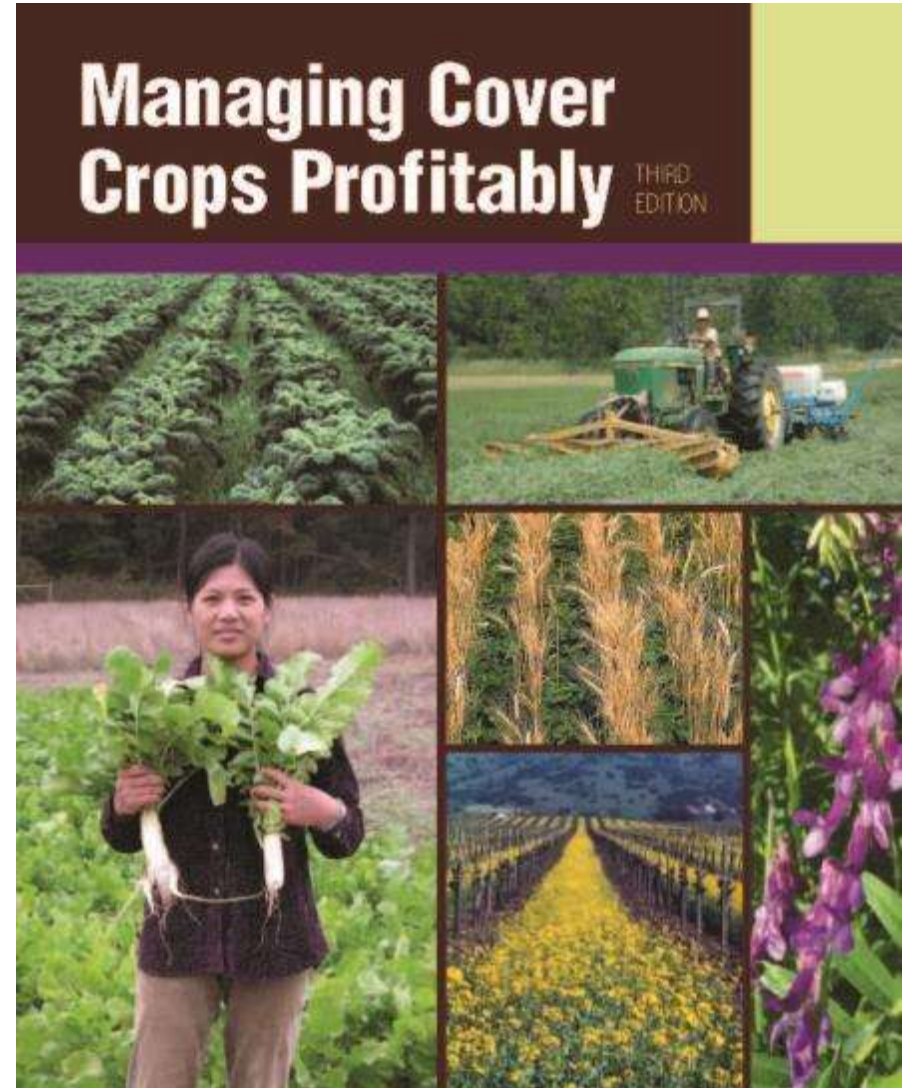
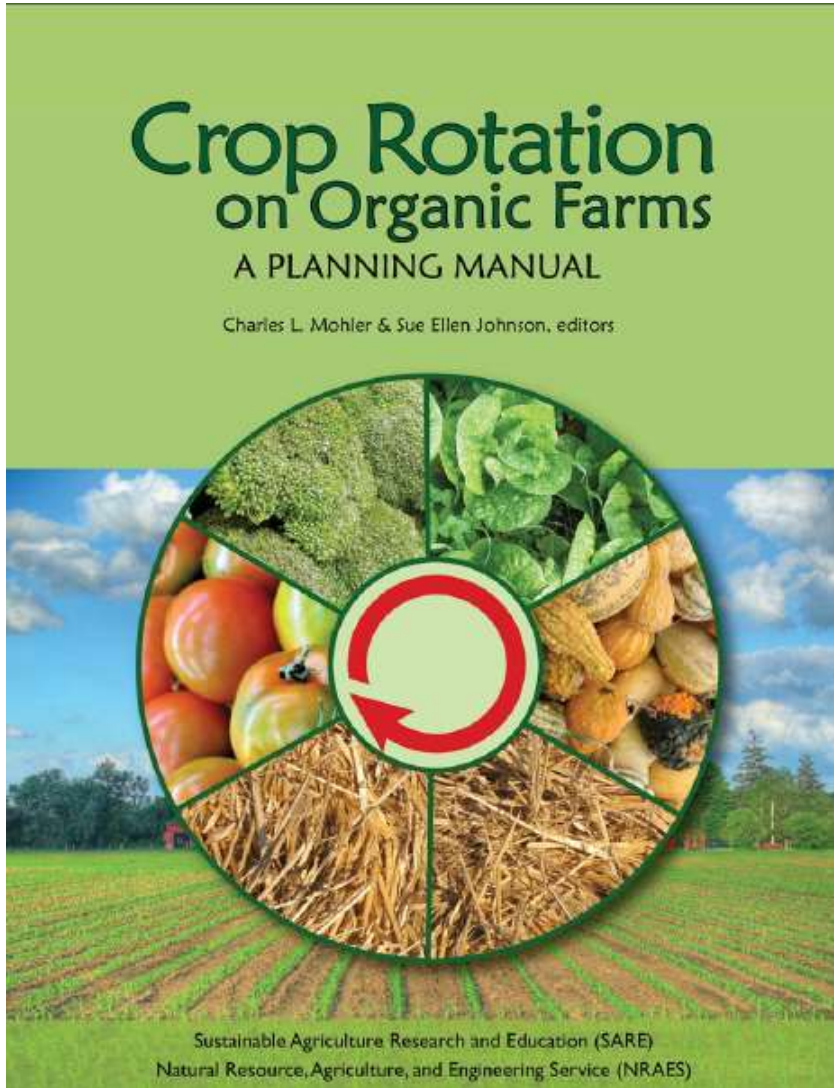
*Late Spring*

***Tomato + Alfalfa hay***

*Fall*

***Oats + Hairy Vetch***





## ***Technical Assistance and Resources***



# APPENDIX 2 Crop Sequence Problems and Opportunities

Compiled by Charles L. Mohler

Find the preceding crop in the second column and the following crop in the 5<sup>th</sup> row. The row goes across pp. 104–108. Using the row number and column number, locate the detailed note in the notes section, p.s 109–123.

		A	B	C	D	E	F	G	H	I
<b>FAMILY</b>										
—		Lily	Lily	Lily	Lily	Lily	Legume	Legume	Lettuce	Night-shade
<b>FOLLOWING CROP</b>										
<b>FAMILY</b>	<b>PRECEDING CROP</b>	General	Onion	Scallion	Leek	Garlic	Bean, snap	Pea	Lettuce, etc. <sup>1</sup>	Potato
1	—	General	W-							W-
2	Lily	Onion	C	XXXX	D	D				
3	Lily	Scallion	C		XXXX					
4	Lily	Leek	C	D		XXXX	D, S			S
5	Lily	Garlic	C	D		D, S	XXXX			S, S-, N-
6	Legume	Bean, snap					XXXX		D	D
7	Legume	Pea						XXXX	D, C-	
8	Lettuce	Lettuce etc. <sup>1</sup>		W-		W-	D	D	XXXX	D
9	Nightshade	Potato	W-			S	S, C-	D	D	XXXX
10	Nightshade	Tomato					D		D	D, I
11	Nightshade	Eggplant								D, I
12	Nightshade	Pepper								D
13	Carrot	Carrot, parsnip		W		S	S	D		D, S
14	Carrot	Celery, herbs etc. <sup>2</sup>								D
15	Carrot	Celeriac								D







October 8, 2015: Residue from a cover crop chopped down for mulch in the spring decomposed during the season. The rate depends on temperature, moisture, and biology in the soil. In this case, no supplemental mulch was and only minor manual weeding was needed throughout the season.













# **Cereal Rye No Tillage Strategy**







***Cereal Rye  
May 4, 2016***





***Cereal Rye  
May 16, 2016***

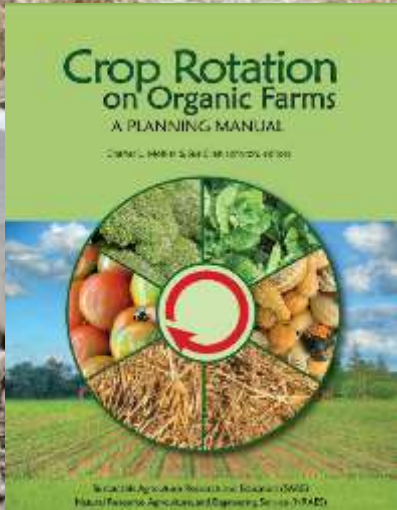












May 22, 2015: Transplanting vegetables into a cut down Cereal Rye cover crop  
- Mature cereal rye creates a high carbon system  
- Resources for C:N and crop rotation: SARE Crop Rotation on Organic Farms











# **Legume Cover Crops No-Tillage Strategy**











12/8/2015: Fall Creek Gardens





5/14/2016: Beneficial insect attracted to the Hairy Vetch legume cover crop





With the help of nitrogen-fixing bacteria, legume cover crops can supply some or all of the Nitrogen needed by succeeding crops.



**Table 1. Nitrogen requirement of vegetable crops based on seasonal nitrogen uptake**

<b>Low Total N Need &lt;120 lb/acre</b>	<b>Medium Total N Need &lt;120-200 lb/acre</b>	<b>High Total N Need &gt;200 lb/acre</b>
<b>Baby greens</b>	<b>Carrot</b>	<b>Broccoli</b>
<b>Beans</b>	<b>Corn, Sweet</b>	<b>Cabbage</b>
<b>Cucumbers</b>	<b>Garlic</b>	<b>Cauliflower</b>
<b>Radish</b>	<b>Lettuce</b>	<b>Celery</b>
<b>Spinach</b>	<b>Melons</b>	<b>Potato</b>
<b>Squashes</b>	<b>Onion</b>	
	<b>Peppers</b>	
	<b>Tomatoes</b>	

— *Gaskell et al. 2006, Soil Fertility Management for Organic Crops*



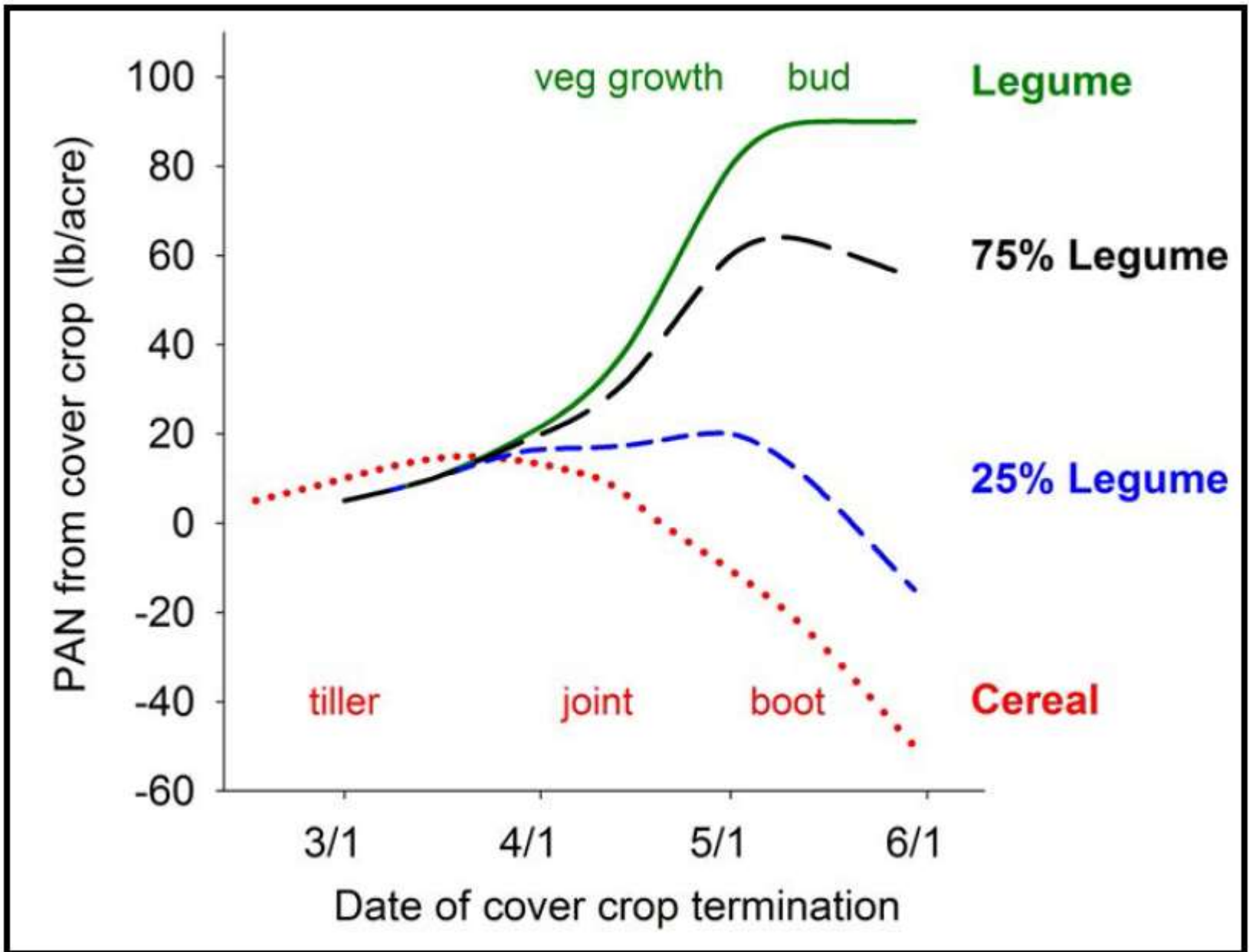


Figure from PNW 636, *Estimating Plant-available Nitrogen Release from Cover Crops* (Sullivan and Andrews, 2012), ©Oregon State University









5/18/2015: A Flowering Hairy Vetch Cover Crop



This figure shows hairy vetch growth stages based on the upper five nodes of the vine. Growth stage depends on the number of buds that have begun to bloom or produce pods.

Consistent control can be achieved by cutting or crimping the hairy vetch at early pod set (7), after flowering and when 1 or 2 seed pods are visible.

Cutting before seed pod set ensures the hairy vetch will not produce seed. Cutting before flower may promote plant regrowth.

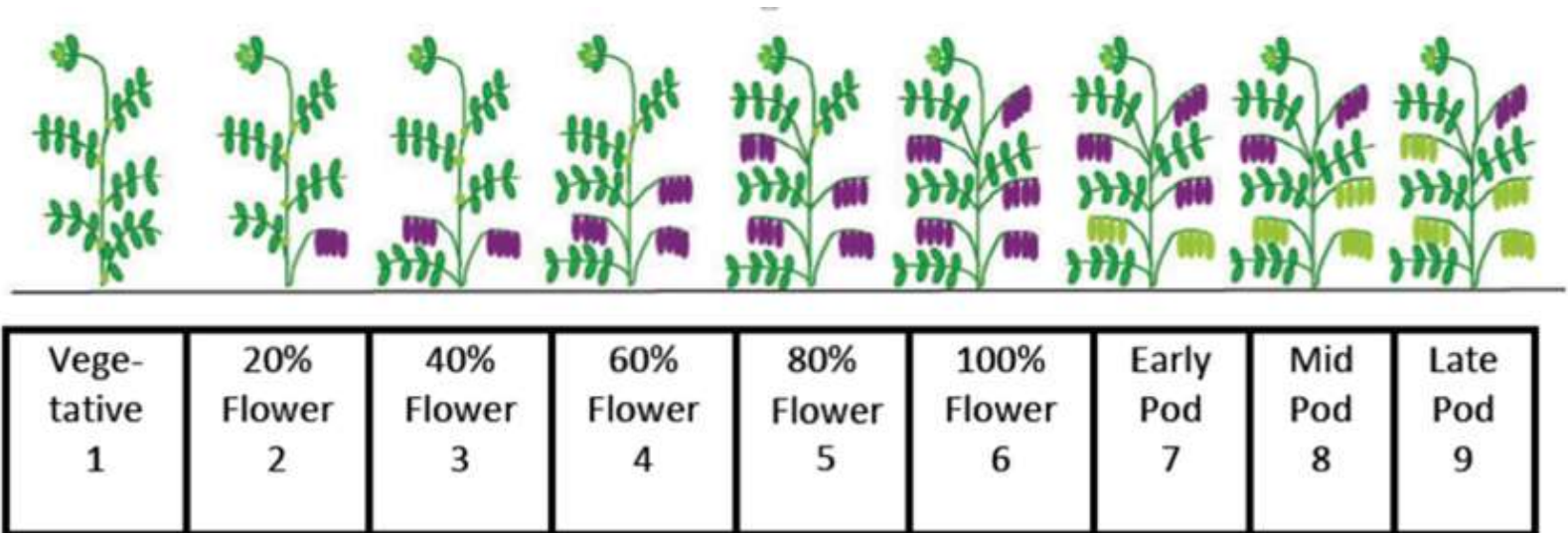


Figure: Curran, W. & Ryan, M., Penn State University and Mirsky, S., USDA-ARS. 2010. Cover Crop Rollers for Northeastern Grain Production. <http://extension.psu.edu/pests/weeds/cover-crop-rollers-for-northeastern-grain-production>



5/5: Hairy Vetch flower progression



5/5/2015: Hairy Vetch flower progression  
Timing can vary with climate and seed variety.









2017/05/08

















Oats and Hairy Vetch residue are easy to place in rows for direct seeding. Cereal Rye and Hairy Vetch is bulkier and more difficult.





May 22, 2015: Cut down Hairy Vetch cover crop & planted peppers  
- Garden shears were used on this bed













Tomatoes growing strong with nitrogen fertilizer and mulch provided by hairy vetch cover crop.



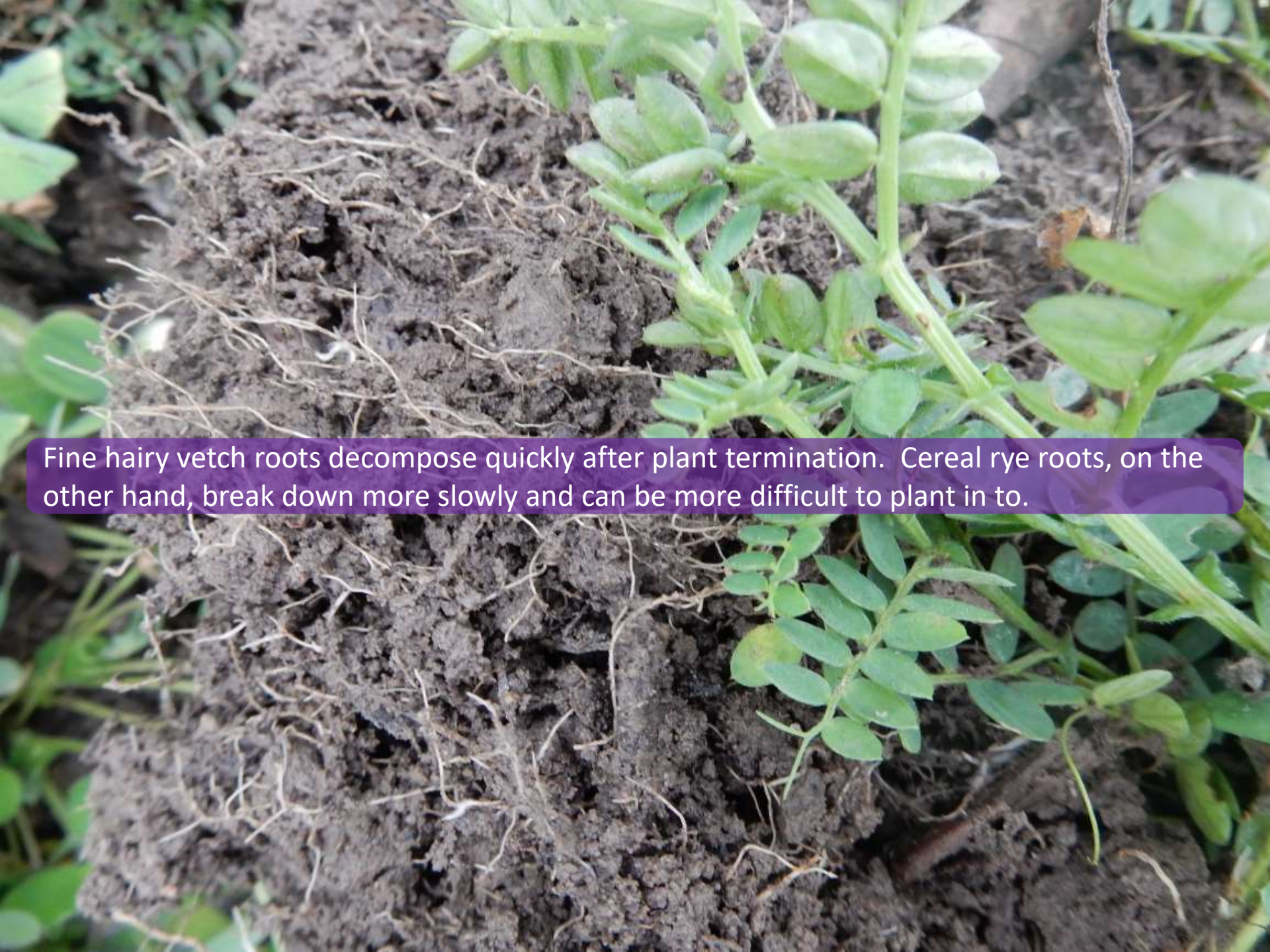
Hairy Vetch & Cereal Rye cover crop mulch

High biomass cover crops are needed for 4" weed suppressing mulch

Layering up supplemental mulch with appropriate C:N ratios can benefit the system





A close-up photograph of dark, moist soil. The soil is crumbly and contains a dense network of fine, light-colored roots. Some roots are thin and hair-like, while others are slightly thicker. The roots are spread throughout the soil, particularly in the upper layers. In the background, there are green, leafy plants, likely vetch, with small, rounded leaves. The overall scene is a detailed view of the root system in the soil.

Fine hairy vetch roots decompose quickly after plant termination. Cereal rye roots, on the other hand, break down more slowly and can be more difficult to plant in to.

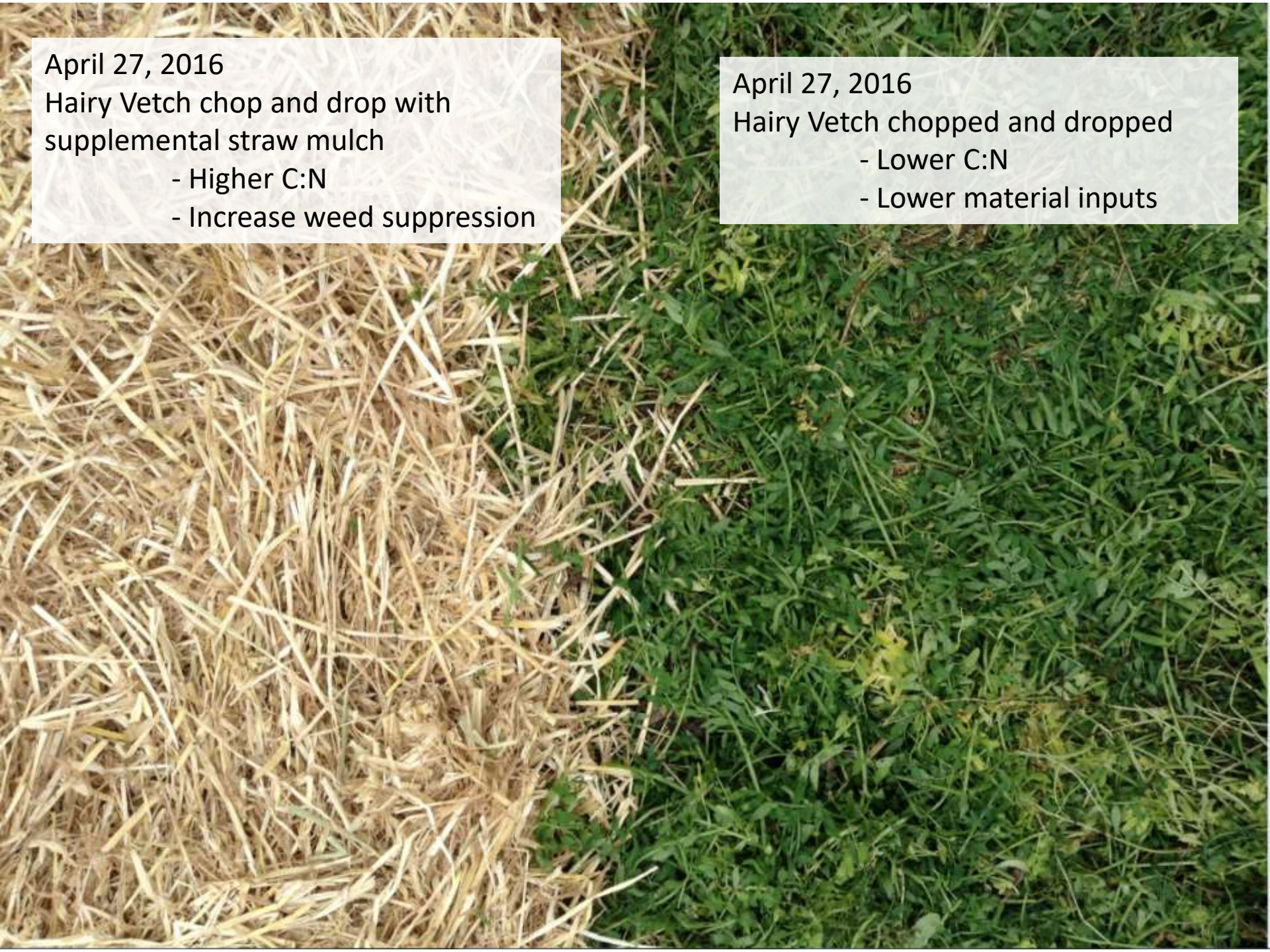


April 27, 2016: Chopped down oats and crimson clover cover crop + two layers of newspaper for extra weed suppression + alfalfa mulch for weed suppression and nutrients



**LASAGNA GARDENING  
ENERGIZED BY COVER CROPS**





April 27, 2016

Hairy Vetch chop and drop with  
supplemental straw mulch

- Higher C:N
- Increase weed suppression

April 27, 2016

Hairy Vetch chopped and dropped

- Lower C:N
- Lower material inputs













2017/05/04



April 27, 2016

Hairy Vetch – early cut before flower



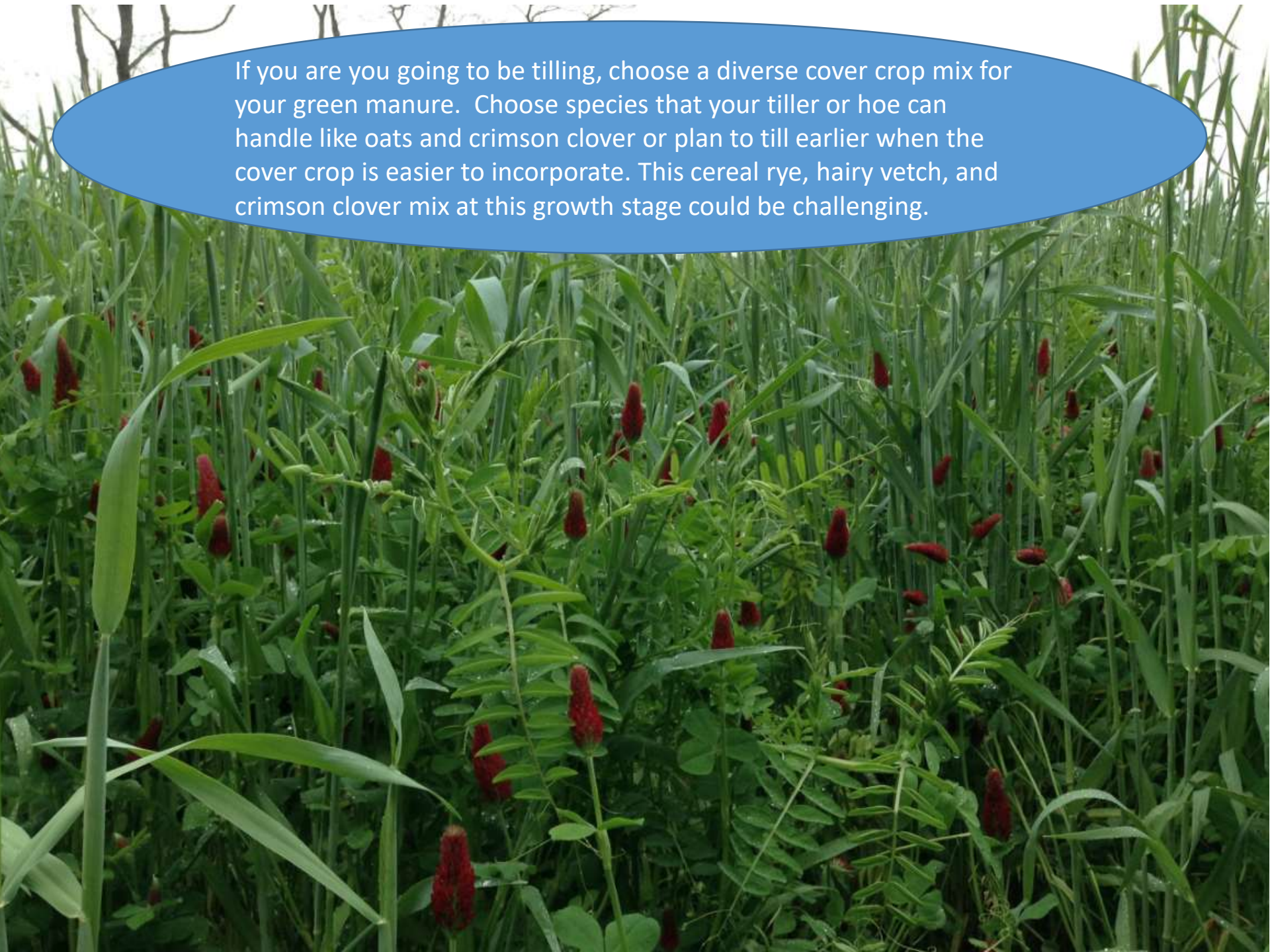


April 22, 2016: Cereal Rye, Hairy Vetch, and Crimson Clover mowed and failed tillage attempt. Cereal Rye roots were too bulky for this grower's push behind tiller.





If you are you going to be tilling, choose a diverse cover crop mix for your green manure. Choose species that your tiller or hoe can handle like oats and crimson clover or plan to till earlier when the cover crop is easier to incorporate. This cereal rye, hairy vetch, and crimson clover mix at this growth stage could be challenging.





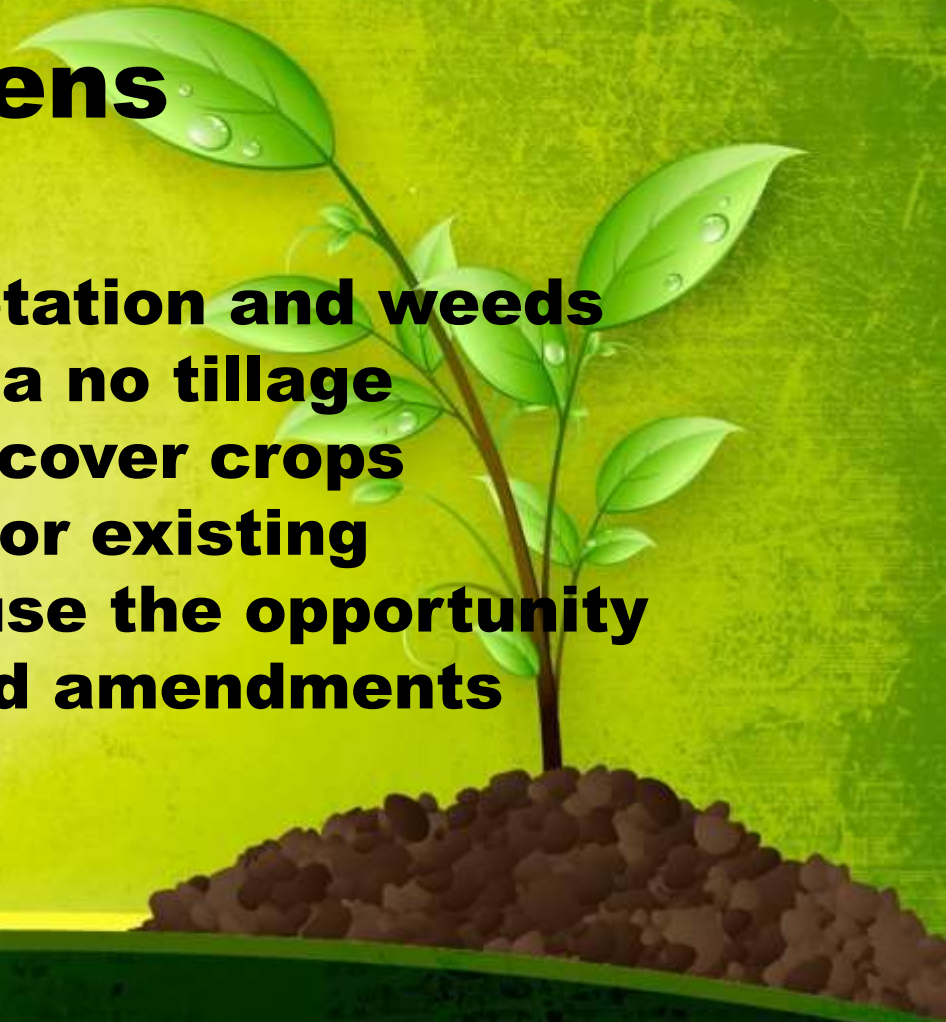
May 5, 2016: Cereal Rye, Hairy Vetch, and Crimson Clover crimp attempt. A biodiverse cover crop is mix is beneficial but can present challenges. The crimson clover generally blooms before the vetch and rye, creating timing issues for organic termination without tillage. Legumes and grasses crimped or cut early can regrow.





# Breaking in Gardens

- **Soil Test**
- **Eliminate unwanted vegetation and weeds**
- **If nutrients are good, try a no tillage approach with tarps and cover crops**
- **If nutrients are deficient or existing vegetation needs tilled, use the opportunity to incorporate the needed amendments with tillage.**







*May 5th*



*June 3*





Buckwheat cover crop after 23 days: Quick weed suppression



**The sky is the limit**



















October 16, 2015: Experimenting with peppers and red clover legume understory.





May 15, 2015: Dutch White Clover legume in the walkways



# **Very useful webinar**

<http://articles.extension.org/pages/71822/rotational-no-till-and-mulching-systems-for-organic-vegetable-farms-webinar>