Growing Your Own Nitrogen through Cover Crops

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UNIVERSITY OF MINNESOTA
Driven to Discover℠

Cover crops are HOT news!

FEATURED

Legume cover crops play role in nitrogen enhancement

By DICK HAGEN Jun 6, 2016

Best Summer Cover Crops

For weed suppression and a major boost to soil fertility, sow these four fast-growing summer cover crops in any patch possible, even during your prime gardening season.

Cover Crops, a Farming Revolution With Deep Roots in the Past

By STEPHANIE STROM FEB. 6, 2016

Dan DeSutter, in a field of dried-up daikon radish, sunflower, turnip and hairy vetch, has been experimenting with cover crops for 17 years. David Kasnic for The New York Times

CROPS > GRAPES

Sonoma County grower switches cover crop regime

Veteran Sonoma County grape grower Duff Bevill of Healdsburg, Calif., is changing his cover crop regime to generate more nitrogen for his wine grape vines.

Plant cover crops in fall to protect, improve soil

By Will Hehemann
UAPB School of Agriculture, Fisheries and Human Sciences
October 21, 2016

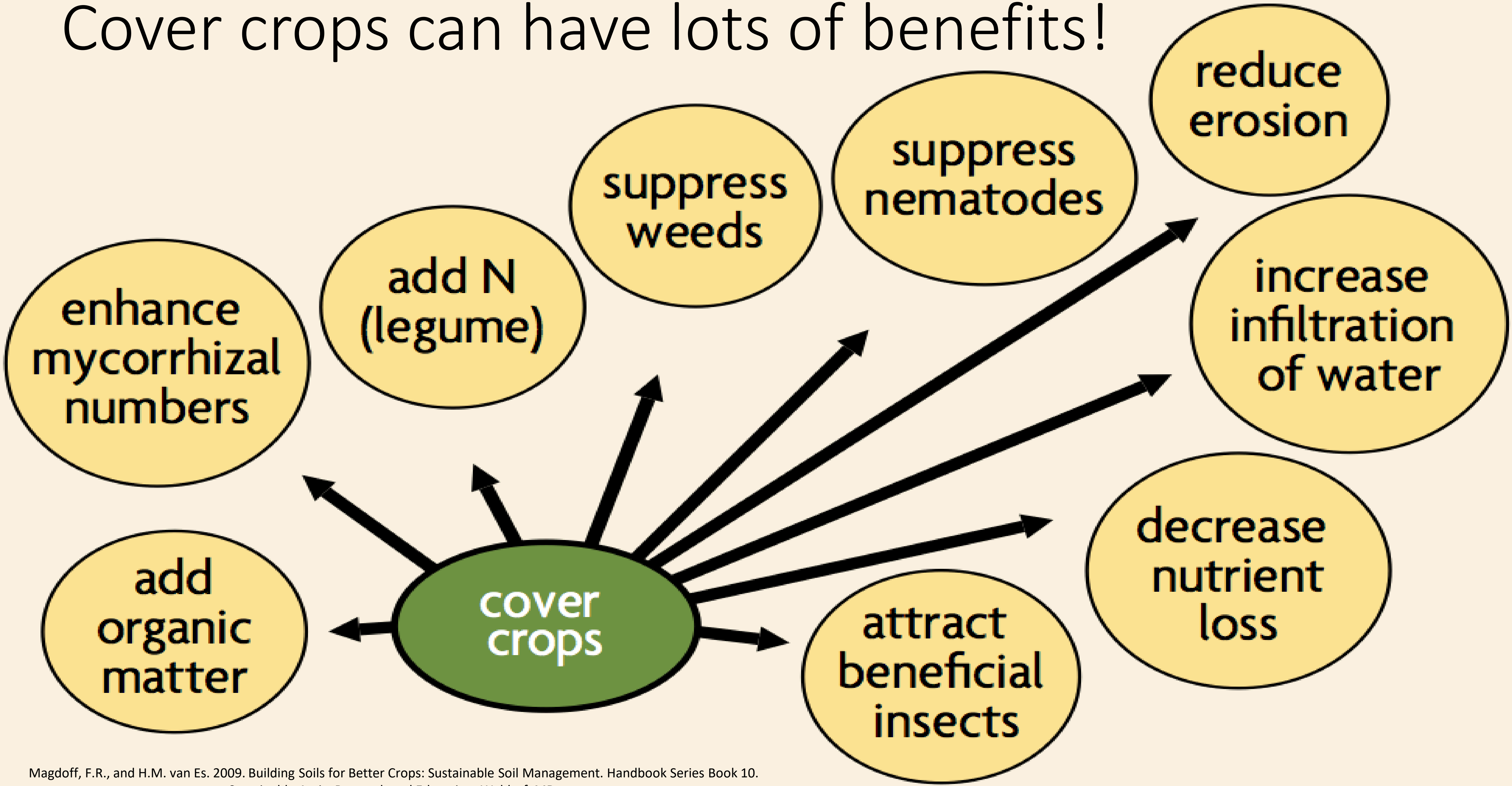
Cover crop: non-cash crop plants integrated into cash crop rotations

Spatial or temporal integration

Range of interconnected benefits

Our lab optimizes legume management to provide non-legume plants with nitrogen they need for growth, and improve soil quality and functioning, especially in organic systems.

Cover crops can have lots of benefits!



Magdoff, F.R., and H.M. van Es. 2009. Building Soils for Better Crops: Sustainable Soil Management. Handbook Series Book 10. Sustainable Agric. Research and Education, Waldorf, MD.

Free fertilizer!

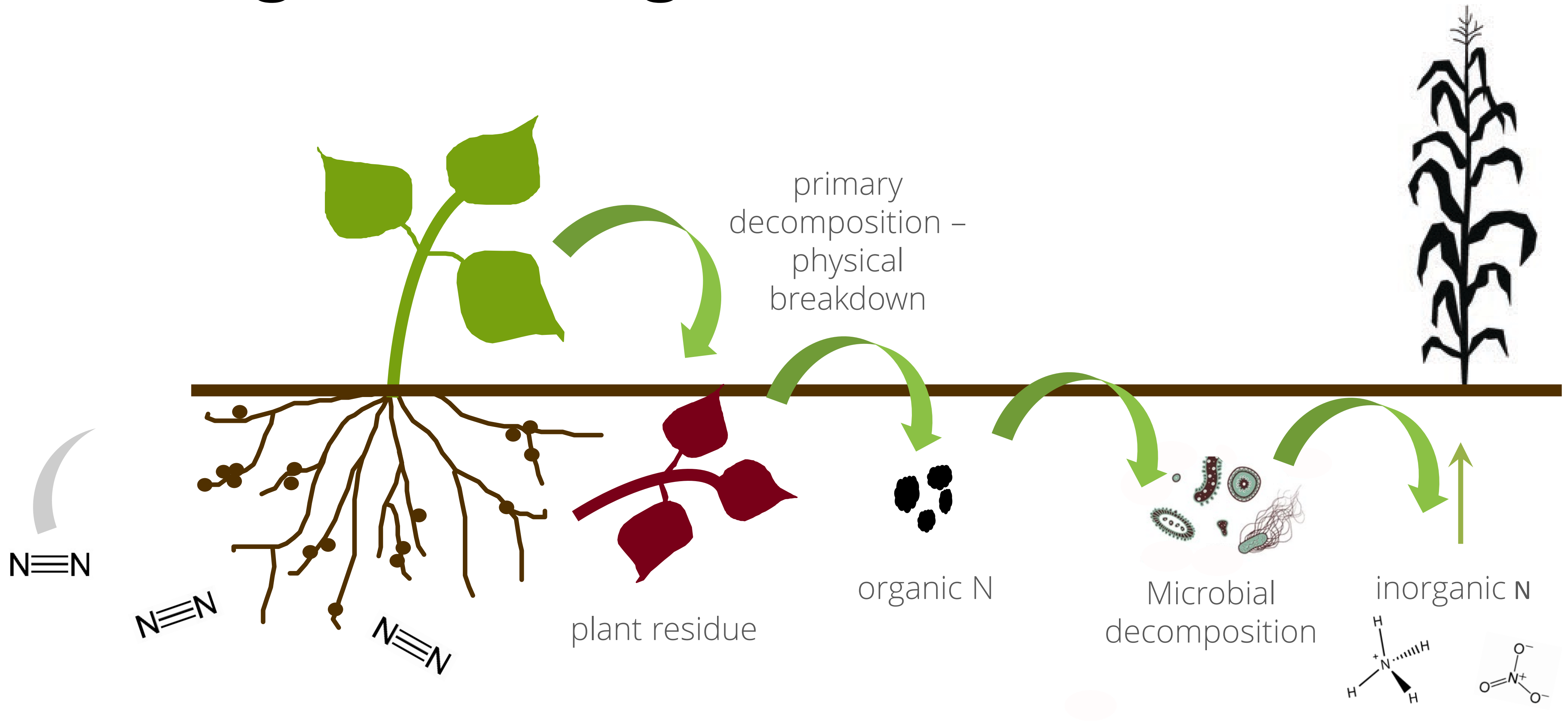
Table 9.5. Green manure nitrogen credits.

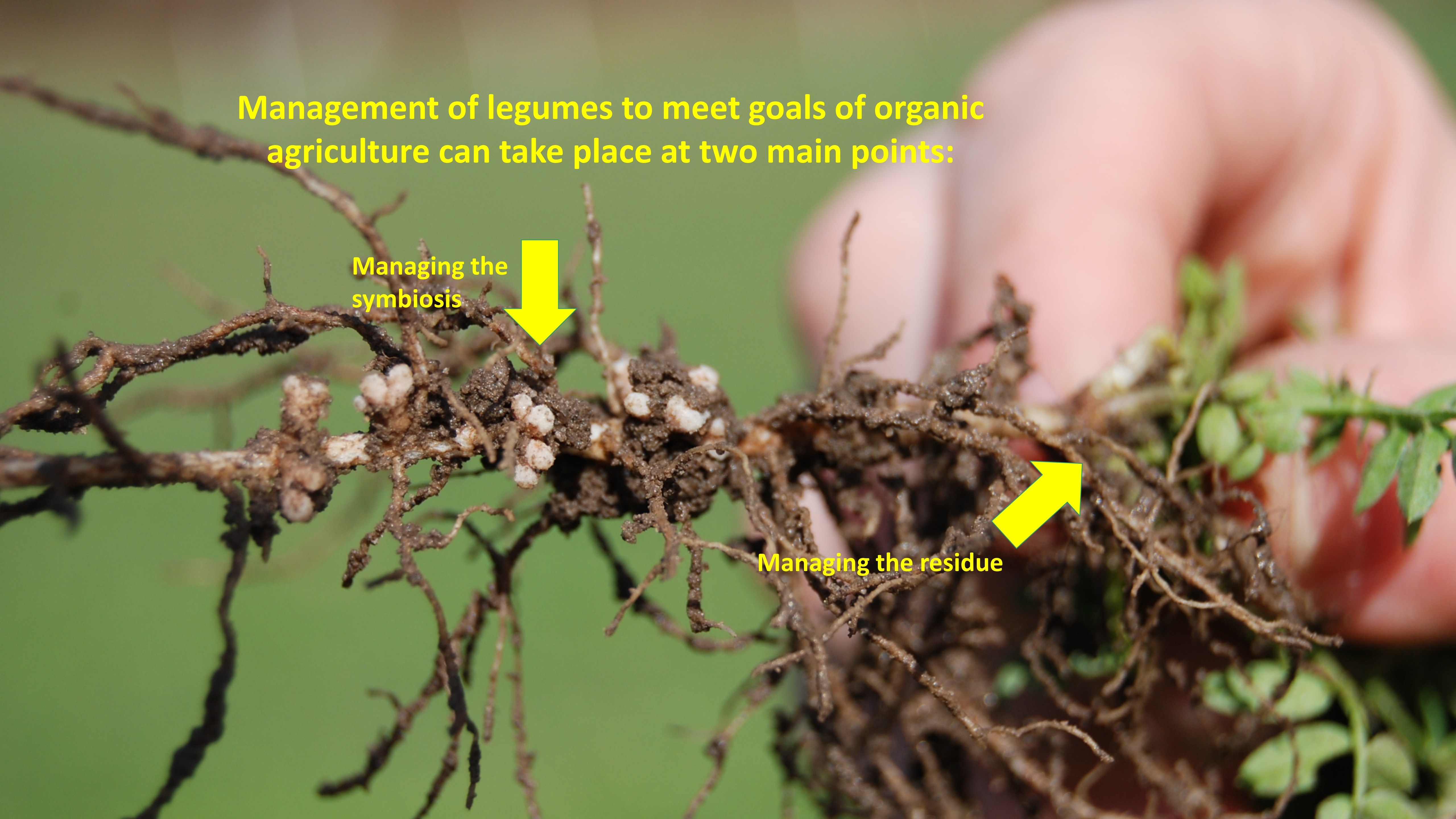
Crop	< 6″ growth	> 6″ growth
	——— lb N/a to credit ———	
Alfalfa	40	60–100 [a]
Clover, red	40	50–80 [a]
Clover, sweet	40	80–120 [a]
Vetch	40	40–90 [a,b]

[a] Use the upper end of the range for spring seeded green manures that are plowed under the following spring. Use the lower end of the range for fall seedings.

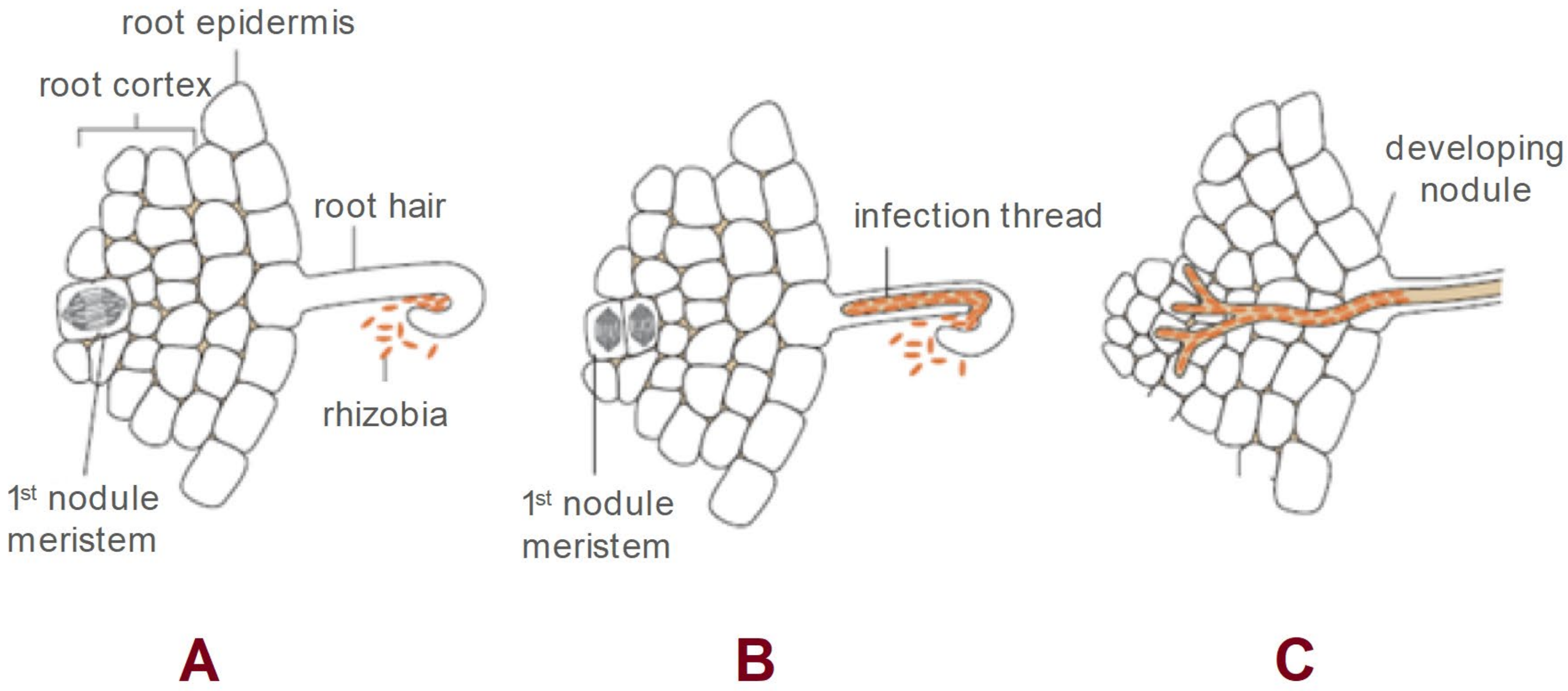
[b] If top growth is more than 12 inches before tillage credit 110–160 lb N/a.

Biological Nitrogen Fixation




Management of legumes to meet goals of organic agriculture can take place at two main points:
Managing the symbiosis
Managing the residue

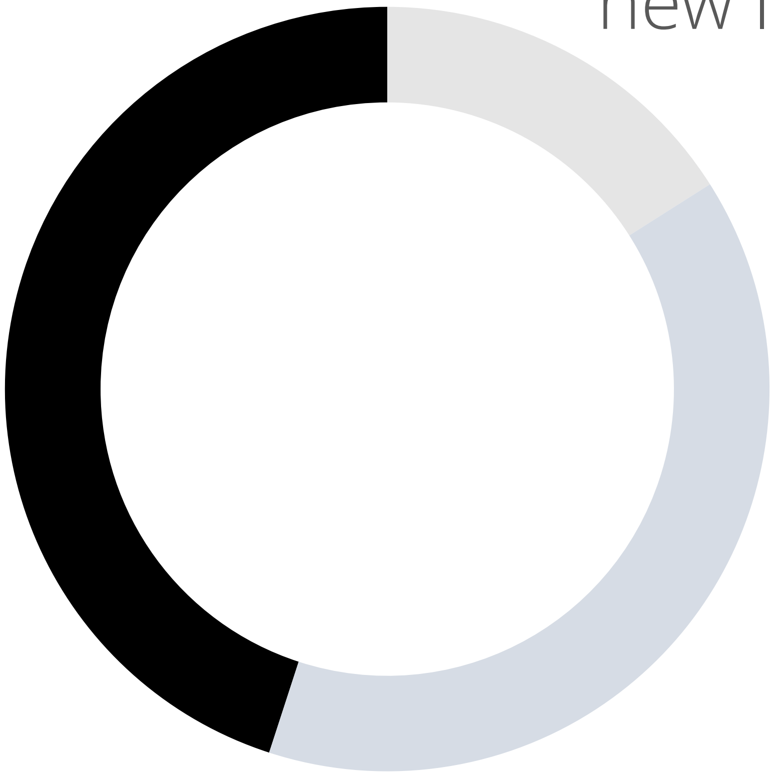
Rhizobia infection



Lévai & Veres (2013)

Who inoculates?

16%
only when introducing a new legume



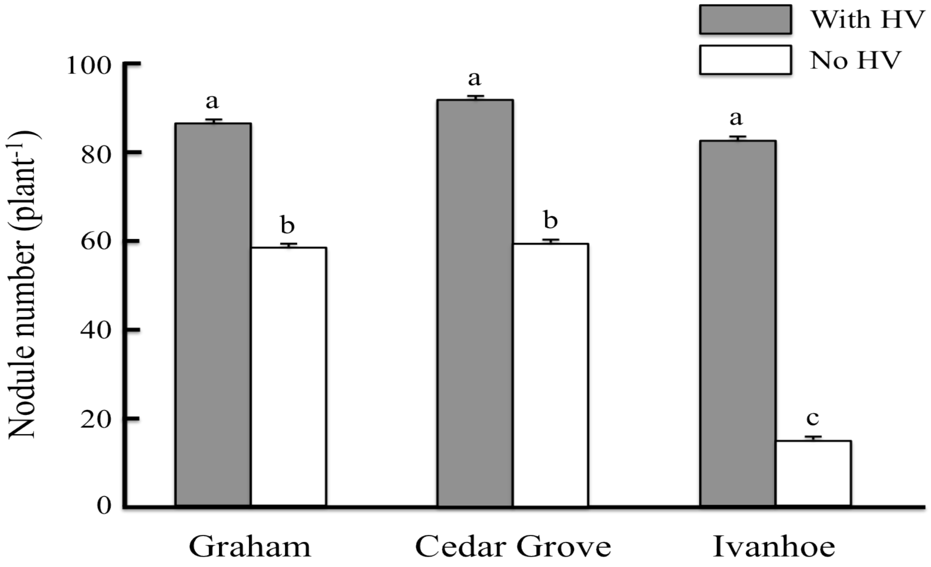
45%
always inoculate

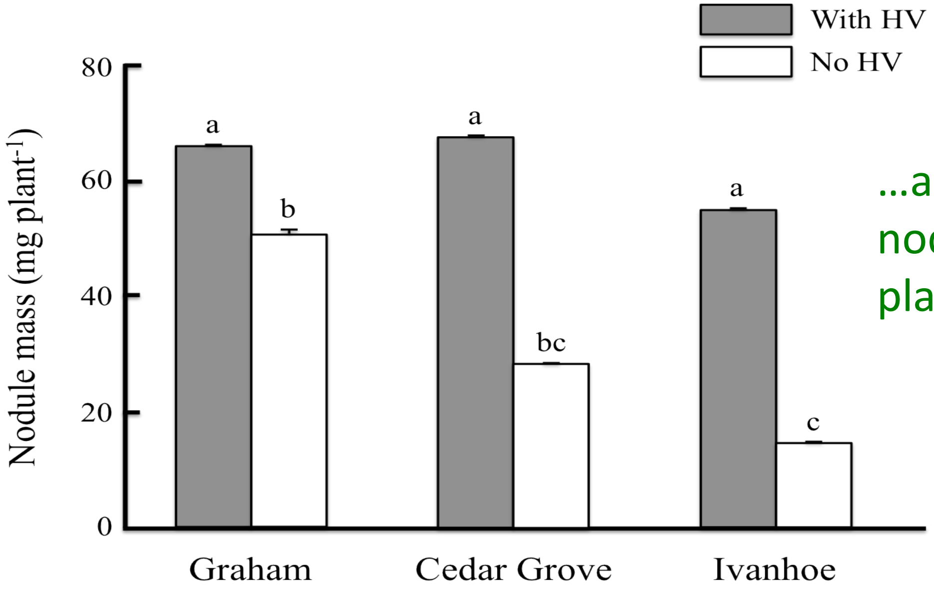
39%
don't inoculate

O'Connell *et al.* (2014)

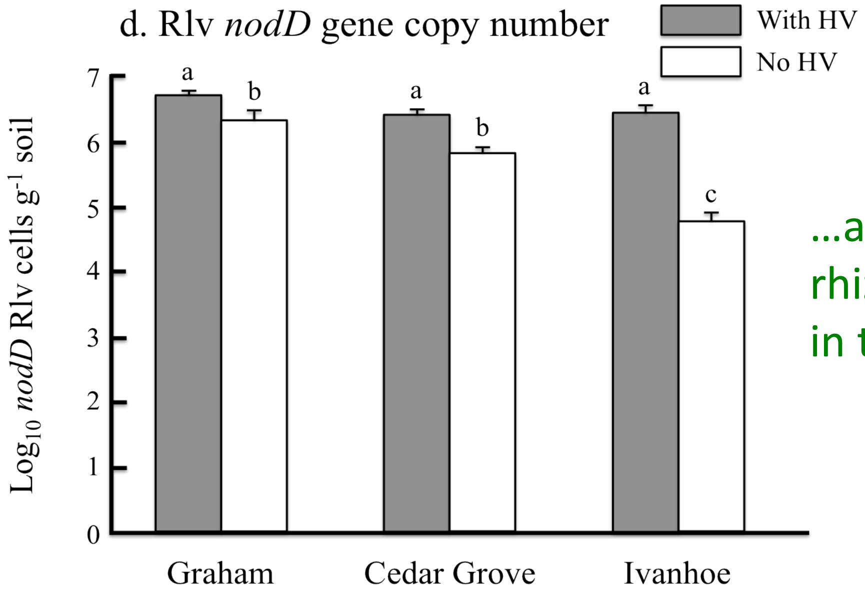
Having legumes in rotation with cash crops modifies and improves rhizobia population size

History of Hairy vetch (HV) in the rotation increased nodule number per plant

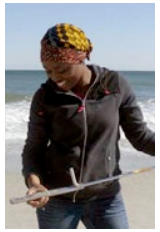




…as well as nodule mass per plant…



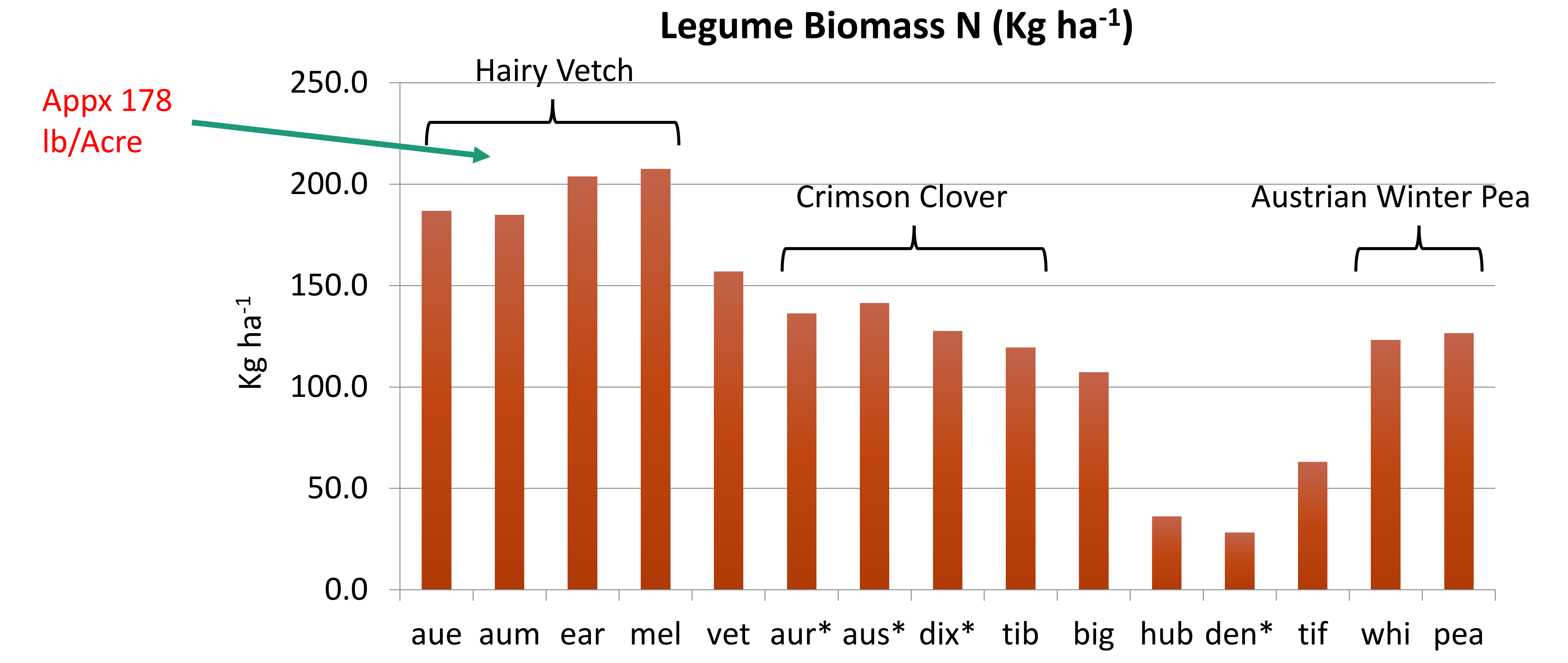
…and number of rhizobia present in the soil



Nape

Mothapo et al., *Biology and Fertility of Soils, 2013*

Total legume N contributed can be high in Southern regions of US

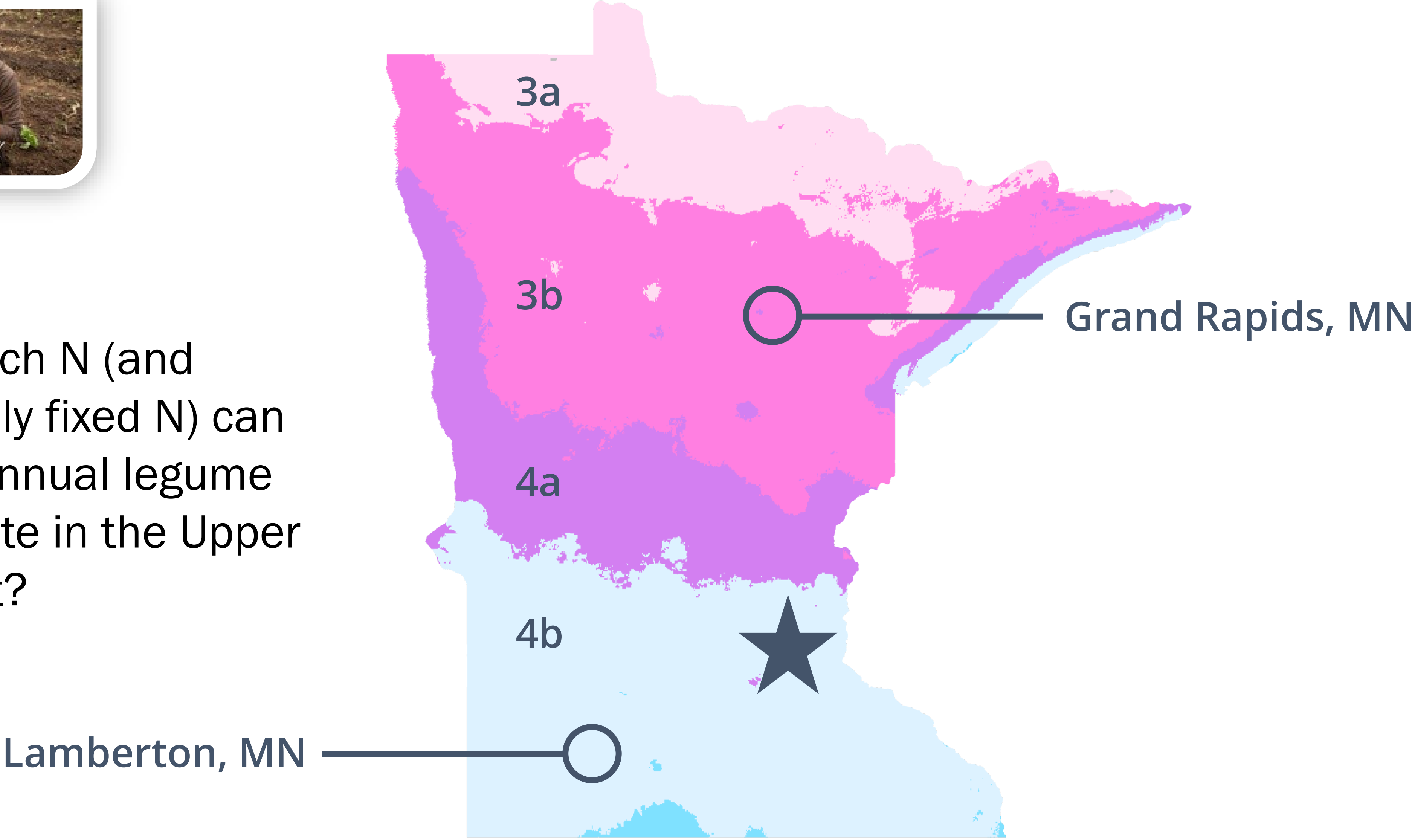


* Designates 1 year of data only

Parr, Grossman, et al., *Agronomy Journal*, 2011

Sharon

How much N (and especially fixed N) can winter annual legume contribute in the Upper Midwest?



Cover crop legume treatments

Hairy vetch 1
(Vicia villosa R.)

Hairy vetch 2
(Vicia villosa R.)

Red clover
(*Trifolium pretense)*

Mix (*Vicia villosa* R. 2 + *Secale cereale* L.)

Cereal rye *(Secale cereale* L.)

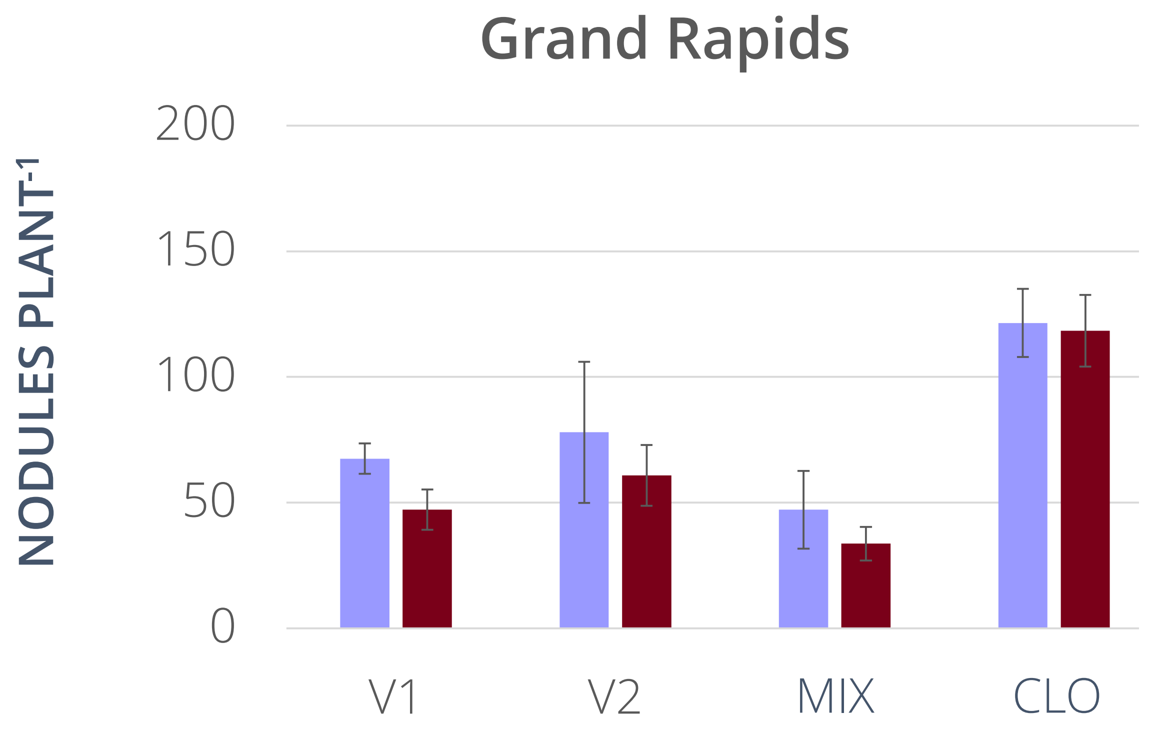
Bare ground control

With inoculant

Without inoculant

Does inoculation increase nodulation?

KEY
V1 = vetch
V2 = vetch
MIX = Vetch +Rye
Clo = Red Clover
Inoculated
Uninoculated



- Nodule mass
- Total shoot biomass
- Total shoot N
- %Ndfa

All treatments are not significant at α = 0.05.
*Error bars represent standard error.

Perrone et al., 2018, In preparation

Shoot biomass and plant N

Doesn't quite give us enough time to get what we need! Small grains may provide a longer fall growth period and thus increase N contribution

In MN, overwintered legumes contribute between 26 – 79 lbs/acre N

	2015-2016				2016-2017			
	Grand Rapids		Lamberton		Grand Rapids		Lamberton	
Trt	Biomass	N	Biomass	N	Biomass	N	Biomass	N
	Mg ha^{-1}	kg ha^{-1}	Mg ha^{-1}	kg ha^{-1}	Mg ha^{-1}	kg ha^{-1}	Mg ha^{-1}	kg ha^{-1}
MIX	2.5 ab	39 b	3.1 ab	79 a	1.9 a	29 a	3.7 a	81
V1	1.5 b	52 ab	2.0 bc	74 a	ND*	ND	1.8 b	85
V2	1.8 ab	71 a	1.9 c	73 a	0.3 b	10 ab	2.2 b	82
CLO	0.9 c	30 b	0.6 d	23 b	0.1 b	3 b	2.0 b	72
RYE	3.0 a	35 b	3.7 a	53 a	1.9 a	29 a	3.7 a	52

*ND, Not Determined

Perrone et al., 2018, In preparation

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Nitrogen Fixed

	2015-2016				2016-2017			
Trt	**Grand Rapids**		**Lamberton**		**Grand Rapids**		**Lamberton**	
	%Ndfa	kg ha^{-1}	%Ndfa	kg ha^{-1}	%Ndfa	kg ha^{-1}	%Ndfa	kg ha^{-1}
MIX	99 a	9 c	74 a	30 bc	82	1	100 a	30 b
V1	84 ab	43 a	66 ab	51 a	ND*	ND	65 b	54 a
V2	38 bc	36 ab	45 b	33 ab	103	1	60 b	48 ab
CLO	36 c	11 b	60 ab	13 c	53	10	53 b	37 ab

*ND, Not Determined

Perrone et al., 2018, In preparation

Management

When growing a cover crop 3 things need to happen:

1. Planting
2. Termination
3. Incorporation

Management - planting

But I don't have time to squeeze them in!

- **Difficult after corn**
  interseeding, underseeding

Management – planting

New technologies from maize systems may provide the opportunity to interseed cover crops into standing crops, like corn

Cereal rye aerially interseeded at corn maturity
(Wilson et al., 2013)

Annual ryegrass and mixtures with legumes drill-interseeded at V2-V6
(Curran et al., 2018)

Interseeding with different levels of soil disturbance at V7
(Noland et al., 2018)

Slide credit: Hannah Rusch

Small grains may provide new cover crop opportunities

1. Warm Season annuals

Berseem clover, crimson clover

2. Perennial clovers

Medium red clover

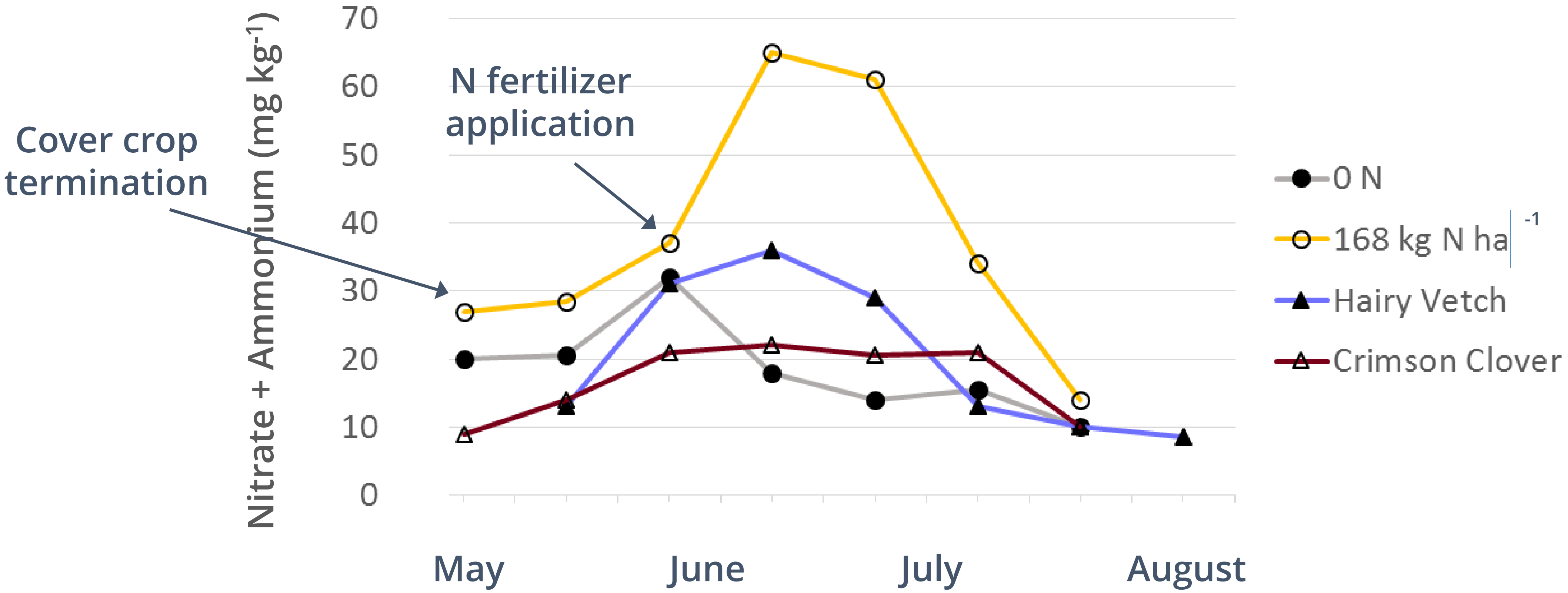
3. Cool season annuals

Field pea, hairy vetch

Management - termination

- Termination goal: 50% of plants flowering
- Flowering = max nitrogen
- What if I let the cover crop go to seed?
    1. Weedy next year
    2. Nitrogen tied up in seed, not biomass

N from legume is released slowly over season



Parr, Grossman *et al*. Communications in Soil Science and Plant Analysis (2014)

Challenges: nutrient immobilization

Very mature crimson clover mulch

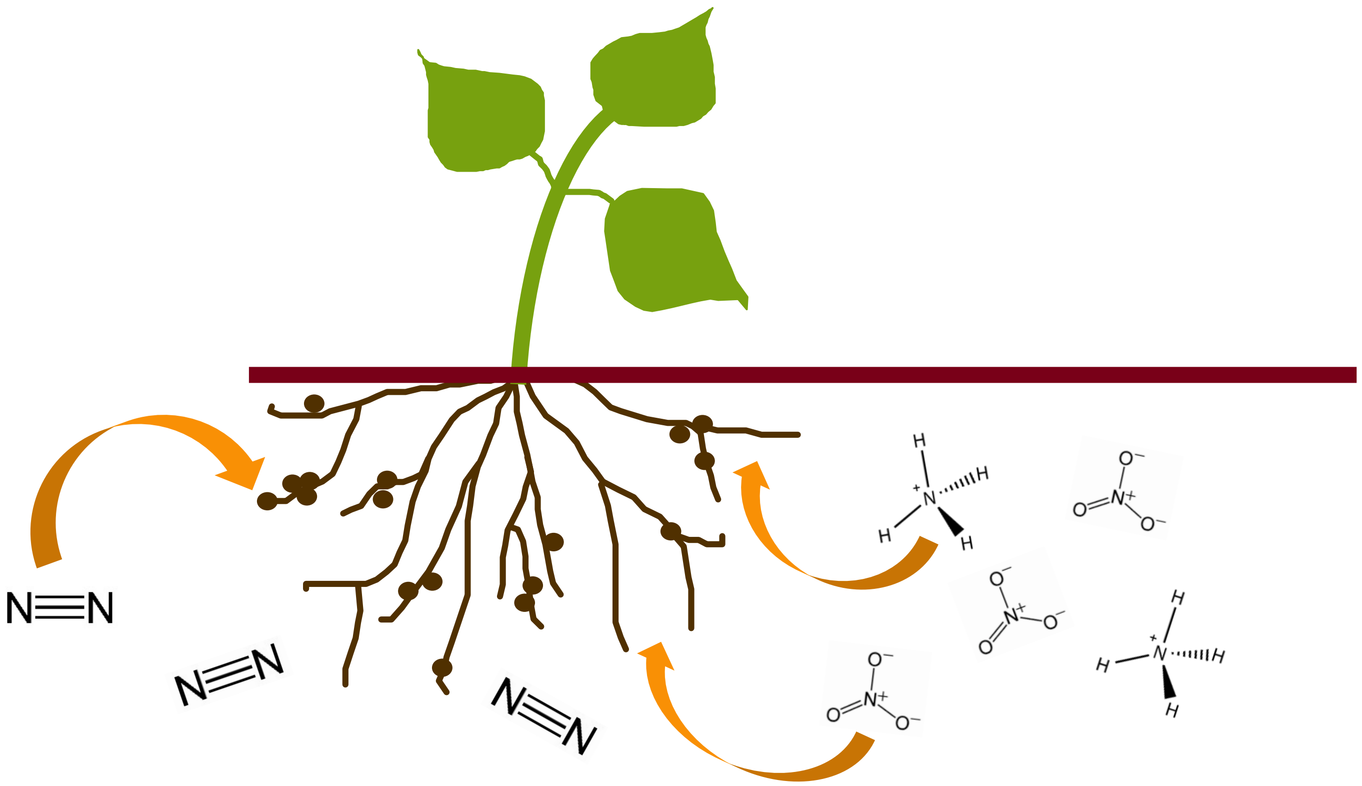
Hairy vetch mulch

Management – incorporation

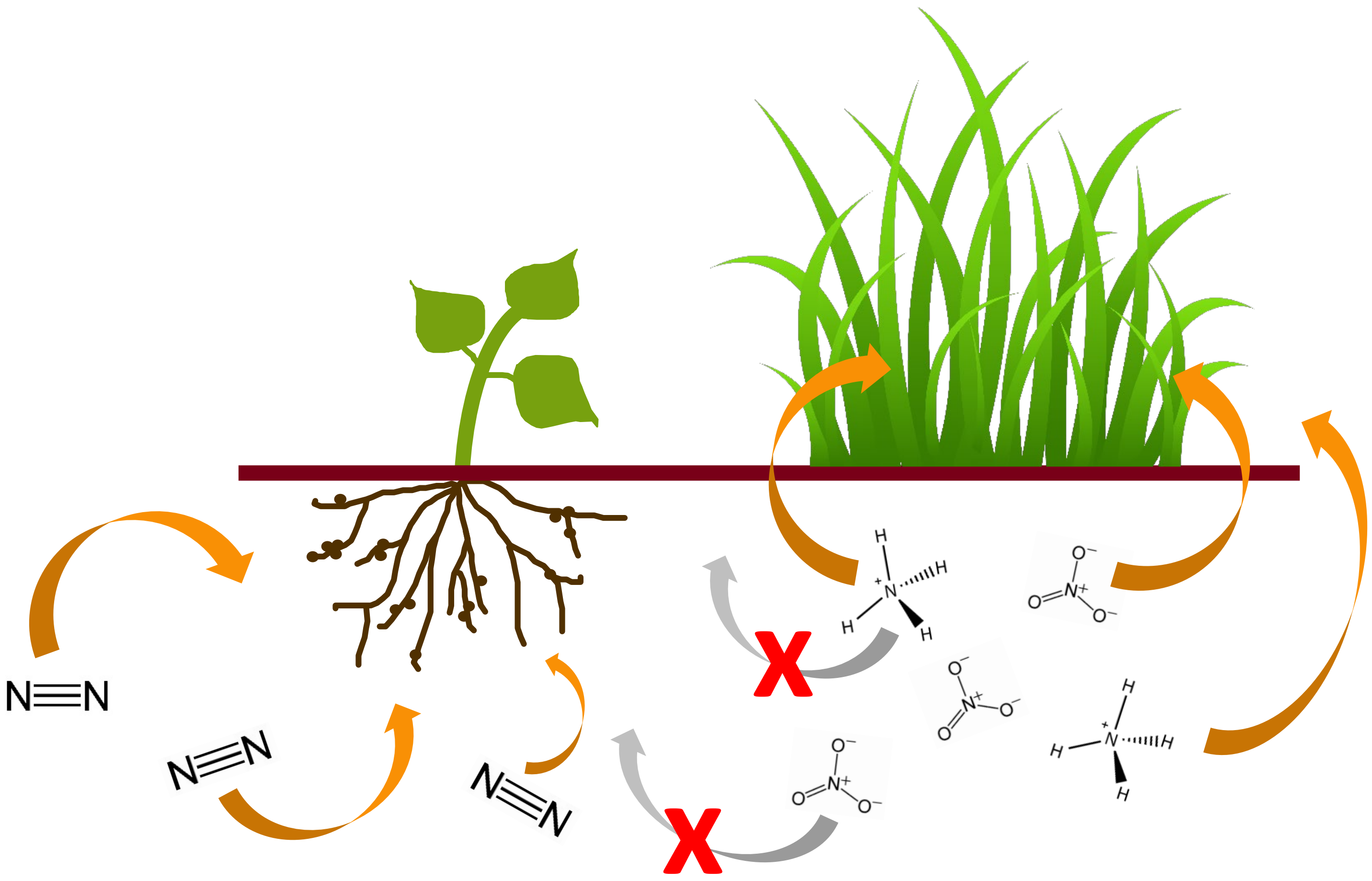
Residue on surface?

Residue incorporated?

Management - Legumes & grasses in biculture



Management - Legumes & grasses in biculture



How much nitrogen did we add with a cover crop?

- Let’s say we grew medium red clover (in the rotation described by Graham Adsit yesterday – so beautiful!)
- We got a strong stand; how to we determine how much nitrogen we got from the crop?

What information do you think we need to know?

1.
2.
3.

Estimating N credits from cover crops

What we need to know:

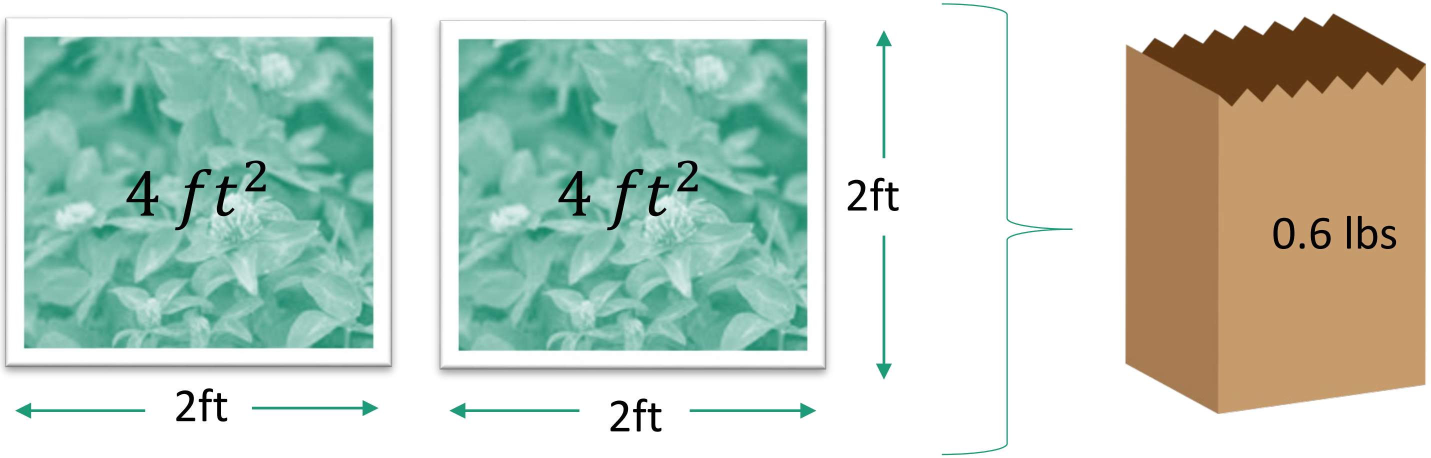
1. How much plant material is in a given area
2. How much nitrogen is in that material
3. How quickly will the material decompose and become available

1. How much plant material is in a given area?

Sample your biomass!

- Use a ruler or yardstick to measure out a known area in your cover cropped area
- Clip the plants within the square *at several places in your field*
- Dry the samples in the oven (or truck dash) until they are crunchy dry

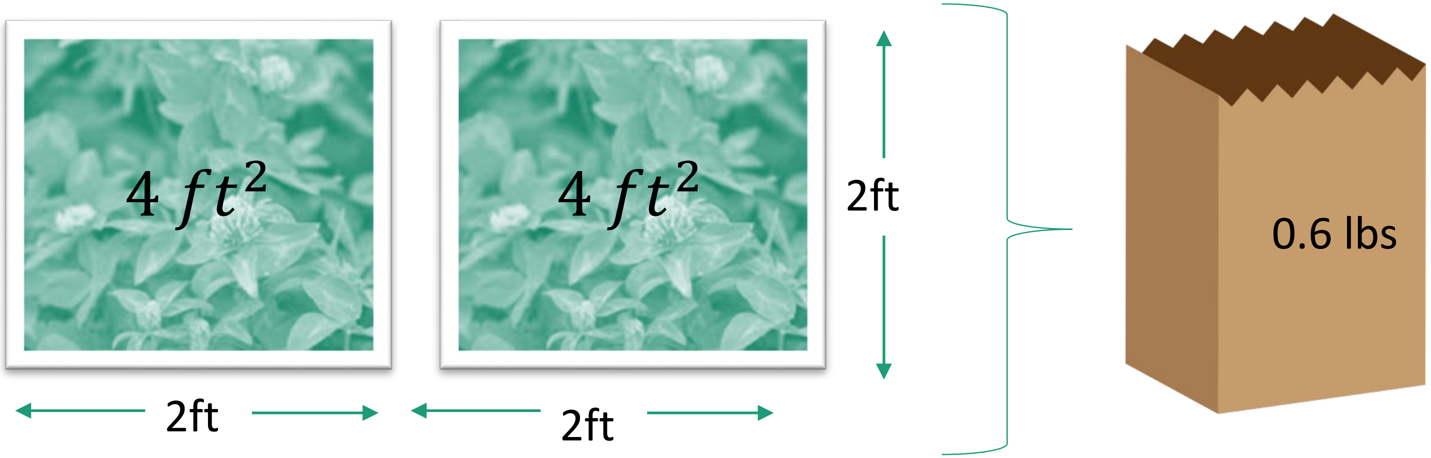
1. How much plant material is in a given area?



CONVERT TO BIOMASS per ACRE

$$\frac{dry\ sample\ weight\ (lb)}{area\ sampled\ (ft^2)} * \frac{43{,}560\ ft^2}{acre} = \frac{lbs\ biomass}{acre}$$

1. How much plant material is in a given area?

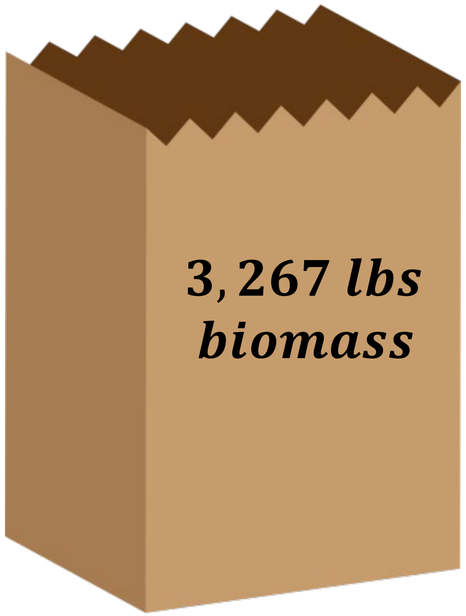


HOW MUCH BIOMASS PER ACRE DO I HAVE?

$$\frac{dry\ sample\ weight\ (lb)}{area\ sampled\ (ft^2)} * \frac{43{,}560 ft^2}{acre} = \frac{lbs\ biomass}{acre}$$

$$\frac{\mathbf{0.6\ lbs}}{\mathbf{8\ ft^2}} * \frac{\mathbf{43,560\ ft^2}}{\mathbf{acre}} = \frac{\mathbf{3,267\ lbs\ biomass}}{\mathbf{acre}}$$

2. How much nitrogen is in that material?



Cover Crop	Examples	% N
Legumes	Hairy vetch Clovers Pea Sunn hemp	4% at flowering 3% as seeds are maturing
Non-legume grasses	Rye Oat Sorghum sudangrass	3% at flowering 2% as seeds are maturing
Non-legume broadleaves	Buckwheat Tillage radish Canola	Similar or a little less than grasses

3,267 lb biomass /acre x 0.04 =

130 lbs N from cover crop!

3. How quickly will the material decompose and become available?

MICROBES HAVE TO EAT THE MATERIAL
FOR IT TO BE AVAILABLE FOR PLANTS

Leave the cover crop on the surface

40% will be available in year 1

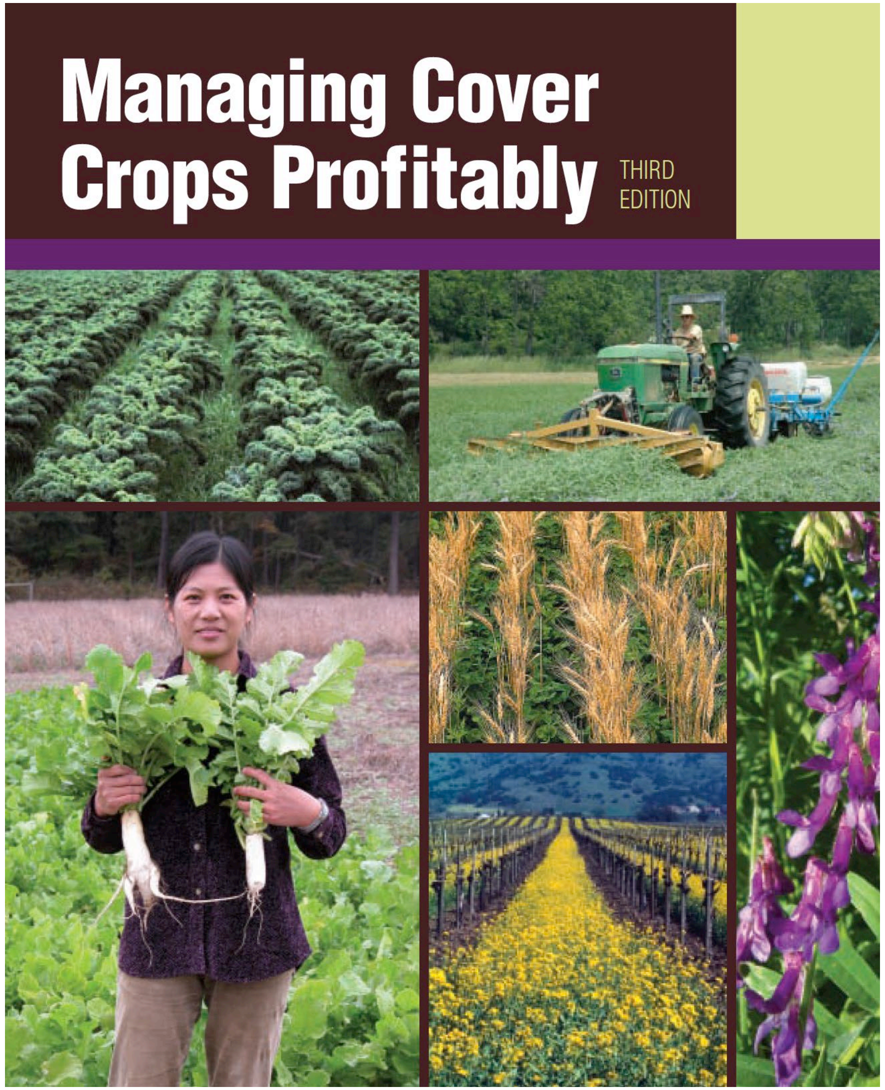
Incorporate it belowground

50% will be available in year 1

3. How quickly will the material decompose and become available?

MICROBES HAVE TO EAT THE MATERIAL
FOR IT TO BE AVAILABLE FOR PLANTS

Leave the cover crop on the surface	Incorporate it belowground
↓	↓
40% will be available in year 1	50% will be available in year 1
130 lb N x 0.4 = 52 lb N/ac	130 lb N x 0.5 = 65 lb N/ac



What to grow, why to grow it
and how to grow it!

SARE publication; FREE!

Thank you!

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