



# COVERCROP

VEGETABLE PRODUCTION TRAINING

**Session 4**

**Estimating Nitrogen Credits**

**UofA** DIVISION OF AGRICULTURE  
RESEARCH & EXTENSION  
*University of Arkansas System*

# Outline

- Factors effecting nitrogen content of cover crop
- Factors effecting cover crop nitrogen availability to cash crop
- Major steps to estimating nitrogen credits
  - Biomass sampling of area of known sq. ft.
  - Assessment of biomass nitrogen content
  - Estimate of nitrogen release and availability to cash crop



**N<sub>2</sub>**

# How Legume Cover Crops Supply Nitrogen to Cash Crops

Summer cowpea cover crop

Fall broccoli cash crop

Nitrogen Uptake

Biological Nitrogen Fixation

Plant matter added to the soil

Mineralization

Soil microbes mineralize organic nitrogen held in plant matter into plant available forms

# Legume Cover Crop Require Inoculants

- Ensure good seed coverage
- Can be added to the seed dry, some recommend a sticking agent
- Contain live organisms so avoid temperature extremes

Legume	Recommended Inoculant Group(s) <sup>3</sup>
Cowpeas, Lespedeza	Cowpeas or Lespedeza
Crimson clover, Berseem clover	Crimson or Berseem
Field peas, Hairy vetch , Lentil	Pea or Vetch
Red clover White clover	Red clover or White clover
Subterranean clover	Subterranean clover or Clover or Rose clover
Sunn hemp	Cowpea EL (based on Abdul-Baki et al., 2001) <sup>4</sup>
Velvetbean	Cowpea EL (based on Piper and Morse, 1928) <sup>5</sup>



# How much nitrogen can cover crops fix?

Legume	Total Nitrogen Content of the Cover Crop Biomass <sup>1</sup> (Total lbs. /acre)
Austrian pea	90-150
Crimson Clover	70-130
Vetch	90-200
Cowpea	50-150
Soybean	50-150

For reference:  
Tomato nitrogen requirements range from 90-200 lbs. of Nitrogen.  
(Total season)<sup>10</sup>



# Factors Affecting Nitrogen Content of Cover Crop

- **Cover crop mixes**
  - Mixes with higher proportions of legumes will have higher N content
- **Inoculation**
  - Legumes must have active rhizobia and root nodules to fix Nitrogen.
  - May require an inoculant
- **Different legumes species fix different amounts of N and have different biomass potentials.**
  - Consider seed costs and potential lbs. N/ acre fixed.
- **Cover crop stand**
  - Amount of N is dependent on the amount of biomass produced
- **Available soil N**
  - High soil N will inhibit legume reliance on biological nitrogen fixation
- **Cover crop age**
  - Established legumes fix more N than young seedlings.
  - Peak nitrogen content in green *aboveground* tissue generally occurs at or just before bloom.



# Estimating Nitrogen Credits from Cover Crops

## Assess biomass

- Known dry weight per known area
  - Estimate Total Nitrogen
    - From established ranges
    - Send material to be tested at lab
  - Estimate Available Nitrogen
    - Estimate how much of the total nitrogen will be available to the cash crop
      - **50 % is a good rule of thumb**<sup>13</sup>
- ❖ This method does not include nitrogen in the plant roots in the estimation, the amount of below ground N is variable but release tends to be very quick after termination <sup>6, 7</sup>



# Example Estimating Nitrogen Credits from Cover Crops

## Example:

**Biomass (lb.)/Acre = (Total weight of dried samples (lb.)/ # square feet sampled) X (43,560 sq. ft./Acre)**

*Then multiply by percent nitrogen in the plant tissue*

- *General Estimates: Annual legumes 3.5-4.0% N in their aboveground parts prior to FLOWERING and 3.0-3.5% percent at flowering.*<sup>1</sup>

**Example:** 37 grams = 37/454 g per lb. = 0.081 lb

(0.081 lbs./ 2.25 sq. ft. sampling square = 0.036) x (43,560/1) = 1,577 lbs. of biomass per acre x 3% N = **47.33 lbs. of Total Nitrogen**





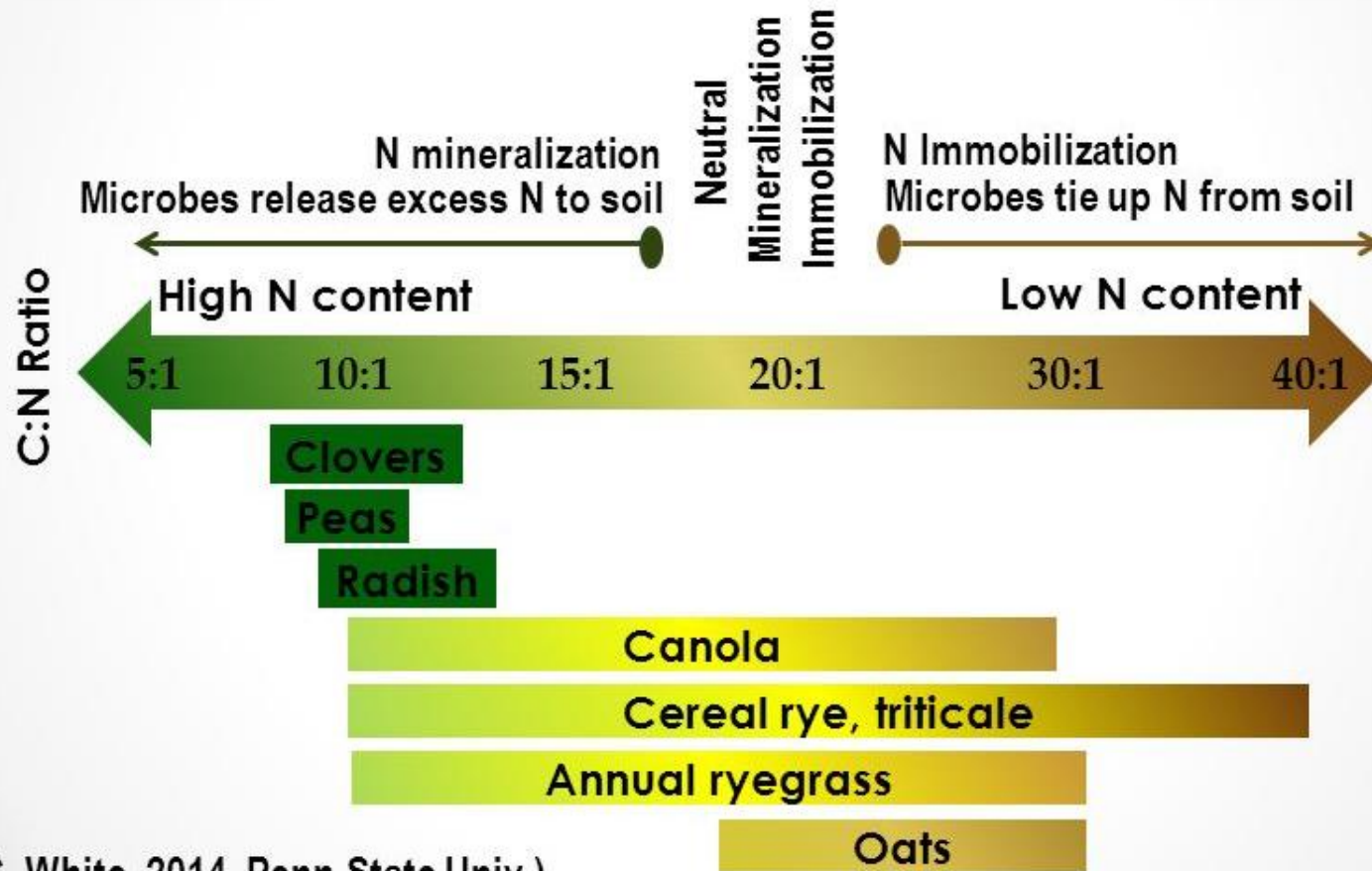
# Factors Affecting Nitrogen Return to Cash Crop

- Crop biomass incorporated or on soil surface
  - Some sources estimate up to 25% less Nitrogen from the cover crop will be returned to the cash crop if the residue is left on the soil surface rather than incorporated; other estimates suggest no difference between surface application and soil incorporation for the Southeast. <sup>1</sup>
  - Nitrogen can be lost from cover crop residues due to microbial activity. <sup>1</sup>
- Soil temperature <sup>8</sup>
  - Influences soil biological activity
- Soil moisture <sup>8</sup>
  - Influences soil biological activity
- C:N ratio of biomass<sup>2</sup>
  - Immobilization (tie up) >30:1
  - Mobilization (release) <15:1
- Time
  - General rule of thumb has suggested much of the plant available Nitrogen (50-75%) supplied by the cover crop is released 4-6 weeks after incorporation or termination
    - *So if the nitrogen credit was estimated to be 60lbs; 30-45 lbs. of that will have become available in the first 4-6 weeks after termination*

Affect rates of mineralization



# C:N Ratio of Cover Crops Residues and N Mineralization / Immobilization

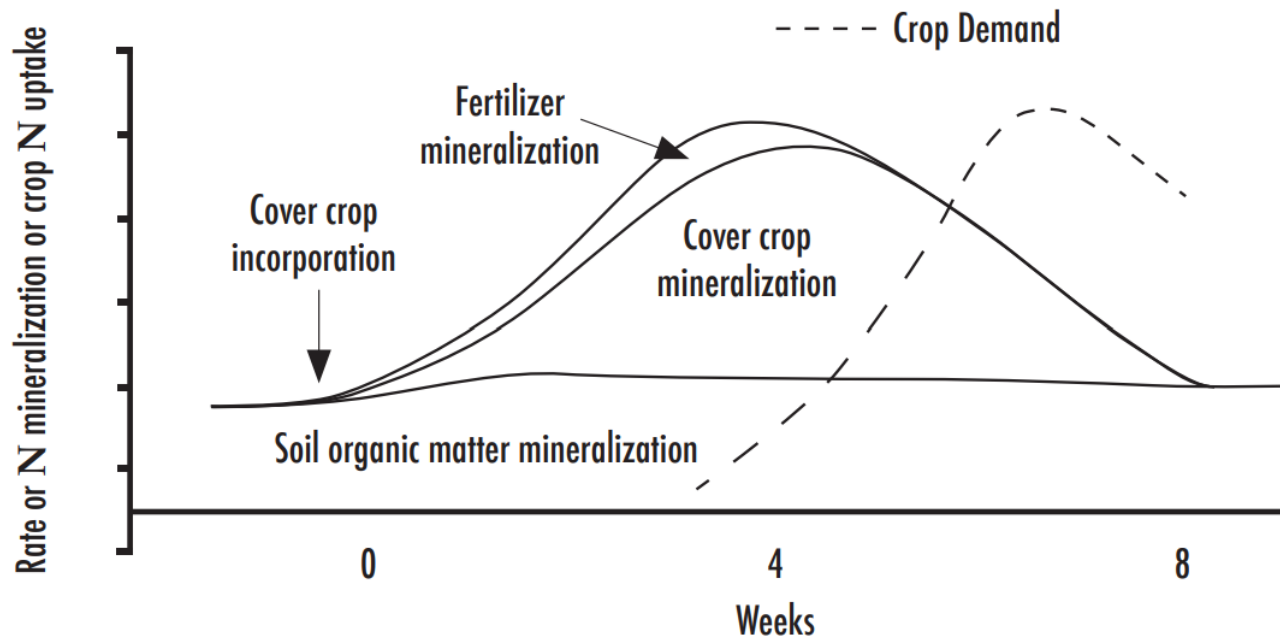


(C. White, 2014. Penn State Univ.)



# Timing of Cover Crop Nitrogen Release and Cash Crop Demand

Figure 1. Timing of nitrogen mineralization from soil organic matter, cover crop residue, and organic fertilizer in relation to crop nitrogen uptake.



Source:  
Gaskell and  
Smith, 2007



# Nutrient Inputs from Legume Cover Crops and Cover Crop Mixes

Estimates of Lbs./ Acre of **Plant Available**<sup>1</sup> N, Total P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O and C:N Ratios of Summer Cover Crop Mixes

	N	P	K	C:N
Buckwheat	21.0	5.2	54.0	28:1
Buckwheat + Millet	15.8	8.3	53.1	36:1
Buckwheat + Sudan	18.2	5.1	45.1	38:1
Cowpea	51.1	6.6	59.3	17:1
Cowpea + Millet	28.3	6.2	58.1	35:1
Cowpea + Sudan	31.3	6.1	34.7	32:1

<sup>1</sup>Based off an estimate that 50% of the total Nitrogen would be available to the cash crop

*\*Based off results from of two site locations in Arkansas in 2016*

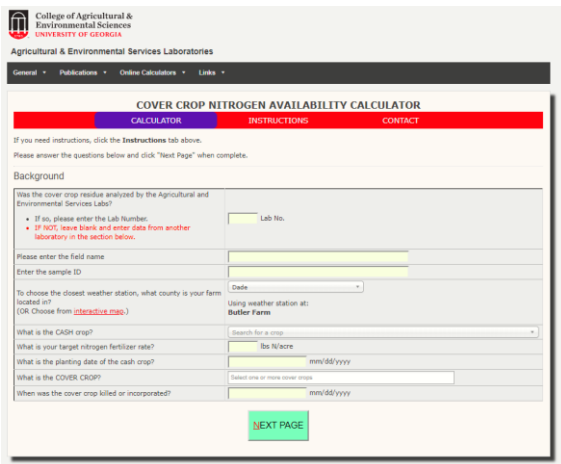


# Calculators: Cover Crop Nitrogen Credits

- Combine estimated nitrogen contents of the cover crop with temperature or weather data to estimate nitrogen release patterns.
  - Georgia:

<http://aesl.ces.uga.edu/mineralization/>

*\*\*\*Relies on local weather stations in Georgia*



The screenshot shows the 'COVER CROP NITROGEN AVAILABILITY CALCULATOR' web form. The form is titled 'COVER CROP NITROGEN AVAILABILITY CALCULATOR' and has three tabs: 'CALCULATOR', 'INSTRUCTIONS', and 'CONTACT'. Below the tabs, there is a navigation bar with 'General', 'Publications', 'Online Calculators', and 'Links'. The main content area contains the following fields and instructions:

- Background:** A section with a light blue background containing instructions: "Was the cover crop residue analyzed by the Agricultural and Environmental Services Labs?" and "If so, please enter the Lab Number: If not, leave blank and enter data from another laboratory in the section below." There is a "Lab No." input field.
- Please enter the field name:** An input field for the field name.
- Enter the sample ID:** An input field for the sample ID.
- To choose the closest weather station, what county is your farm located in? (OR Choose from [interactive map](#)):** A dropdown menu for the county.
- Using weather station at: Butler Farm:** A dropdown menu for the weather station.
- What is the CAGR crop?** A dropdown menu for the cover crop type.
- What is your target nitrogen fertilizer rate?** An input field for the fertilizer rate in lbs N/acre.
- What is the planting date of the cash crop?** An input field for the planting date in mm/dd/yyyy.
- What is the COVER CROP?** An input field for the cover crop type.
- When was the cover crop killed or incorporated?** An input field for the date in mm/dd/yyyy.

A green "NEXT PAGE" button is located at the bottom of the form.



# Costs of Cover Crop Nitrogen

*Estimates of Cover Crop Seeding Costs per Acre*

	Broadcast Seeding Rate, lbs/acre	Seed Cost, \$/50lbs	Seed Cost, \$/lb	Seed Cost, \$/acre
Fall/Winter: Single Species				
Black Oats	100	25.00	0.50	50.00
Cereal rye	100	22.00	0.44	44.00
Winter Wheat	90	25.00	0.50	45.00
Austrian Pea	50	40.00	0.80	40.00
Crimson Clover	12	60.00	1.20	14.40
Mustard	10	120.00	2.40	24.00
Sodbuster Radish	10	80.00	1.60	16.00
Hairy Vetch	20	110.00	2.20	44.00
Spring/Summer: Single Species				
Sorghum Sudan	40	80.00	1.60	64.00
Pearl Millet	30	80.00	1.60	48.00
Japanese Millet	30	40.00	0.80	24.00
Cowpea	80	40.00	0.80	64.00
Soybean	90	40.00	0.80	72.00
Velvet Bean	40	175.00	3.50	140.00
Lablab	40	250.00	5.00	200.00
Buckwheat	60	50.00	1.00	60.00
Sunflower	15	45.00	0.90	13.50
Chinese Red Pea	20	50.00	1.00	20.00

**Estimated Cost Range**

per Total unit of nitrogen

\$0.44-0.27 per lb. of N

\$0.20-0.11 per lb. of N

\$0.48-0.22 per lb. of N

\$1.28-0.42 per lb. of N

\$1.44-0.48 per lb. of N

*\*These are only rough estimates. Seeding rates and local conditions will influence the potential nitrogen credit obtained by various legumes and seed prices vary by region and year. Estimates obtained based off of two years of data,*



# Take Home Message

- Legume cover crops can supply large quantities of nitrogen to subsequent cash crops
- We can make estimates of how much of that nitrogen will become plant available
  - These are generally only well educated estimates due to the reliance on biological processes to release the nitrogen into plant available forms that are impacted by temperature and moisture



# Authors and Acknowledgements

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# Resources and Sources

- <sup>1</sup> Clark, A., editor. 2012. *Managing Cover Crops Profitably, 3rd Edition*. Sustainable Agriculture Research and Education. Handbook Series Book 9. <https://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Printable-Version>
- <sup>2</sup> Virginia NRCS Cover Crop Planning Manual 1.0
- <sup>3</sup> Buying and Sourcing Cover Crop Seed for Organic Farming Systems <https://articles.extension.org/pages/18654/buying-and-sourcing-cover-crop-seed-for-organic-farming-systems>
- <sup>4</sup> Abdul-Baki, A. A., H. H. Bryan, G. M. Zinati, W. Klassen, M. Codallo, and N. Heckert. 2001. Biomass yield and flower production in sunn hemp: Effect of cutting the main stem. *Journal of Vegetable Crop Production* 71:83–104.
- <sup>5</sup> Piper, C. V., and W. J. Morse. 1928. The velvet bean. Farmers' bulletin No. 1276. U. S. Department of Agriculture, Washington, DC.
- <sup>6</sup> Sievers and Cook. 2018. Aboveground and Root Decomposition of Cereal Rye and Hairy Vetch Cover Crops. *Soil Fertility and Plant Nutrition*. 82 (1):147-155. <https://dl.sciencesocieties.org/publications/sssaj/abstracts/82/1/147?access=0&view=pdf>
- <sup>7</sup> Jani, A., Grossman, J., Smyth, T., and S. Hu. 2015. Winter legume cover-crop root decomposition and N release dynamics under disking and roller-crimping termination approaches. *Renewable Agriculture and Food Systems*. 31(3): 214-229 <https://www.cambridge.org/core/journals/renewable-agriculture-and-food-systems/article/winter-legume-covercrop-root-decomposition-and-n-release-dynamics-under-disking-and-rollercrimping-termination-approaches/65E7DFBA13888A5BF32DCA1A1840EBF4>
- <sup>8</sup> Soil fertility management for organic crops <https://anrcatalog.ucanr.edu/pdf/7249.pdf>
- <sup>9</sup> Gaskell, M., and R. Smith. 2007. Nitrogen Sources for Organic Vegetable Crops. *HortTechnology* 17(4): 431-441
- <sup>10</sup> Southeastern vegetable crop handbook <https://content.ces.ncsu.edu/southeastern-us-vegetable-crop-handbook>
- <sup>11</sup> FSA2156. Understanding Cover Crops. <https://www.uaex.edu/publications/pdf/FSA-2156.pdf>
- <sup>12</sup> <https://cropwatch.unl.edu/2016/nitrogen-fixation-oversold-legume-cover-crops>
- <sup>13</sup> <https://www.southernsare.org/Regional-News/Bulletins/Cover-Crops-Research-Across-the-Southern-Region/Nitrogen-Release-from-Cover-Crops>

