Organic Nitrogen Management in Annual Cropping Systems

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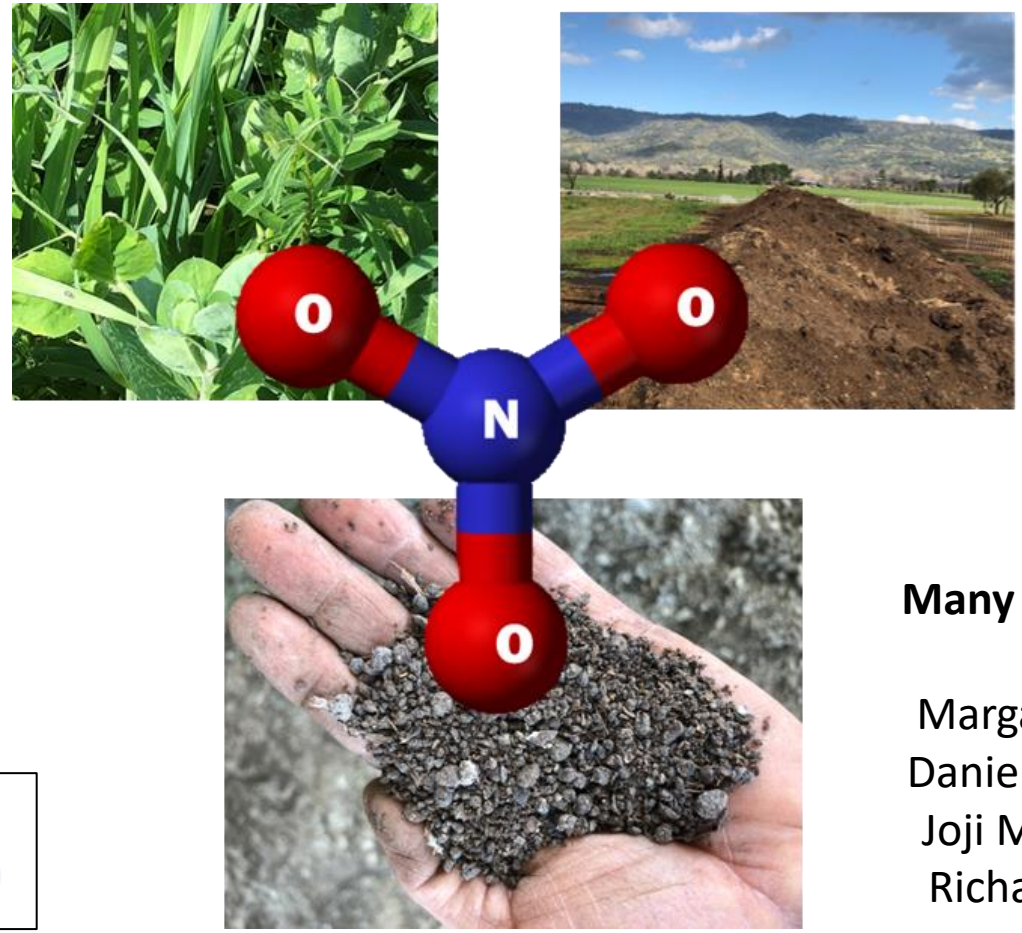
Organic Agriculture Workshop, Sutter-Yuba Counties
Nov 7, 2023



Many thanks to:

Margaret Lloyd
Daniel Geisseler
Joji Muramoto
Richard Smith

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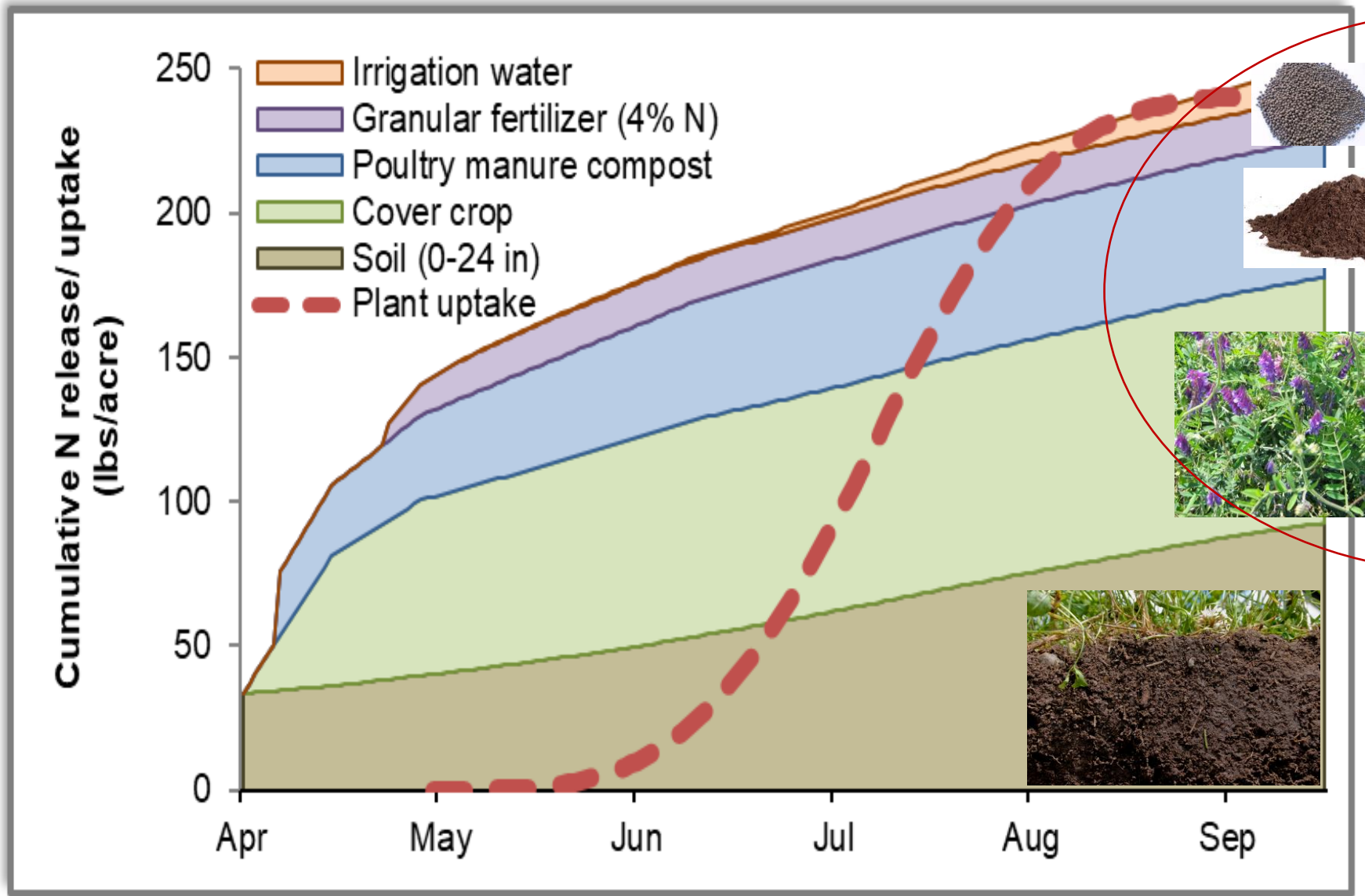
UPCOMING 4-DAY VIRTUAL WORKSHOP!

Registration & details:
http://tinyurl.com/NitrogenWorkshop

Live Spanish translation will be available

The organic N budget



Irrigation water

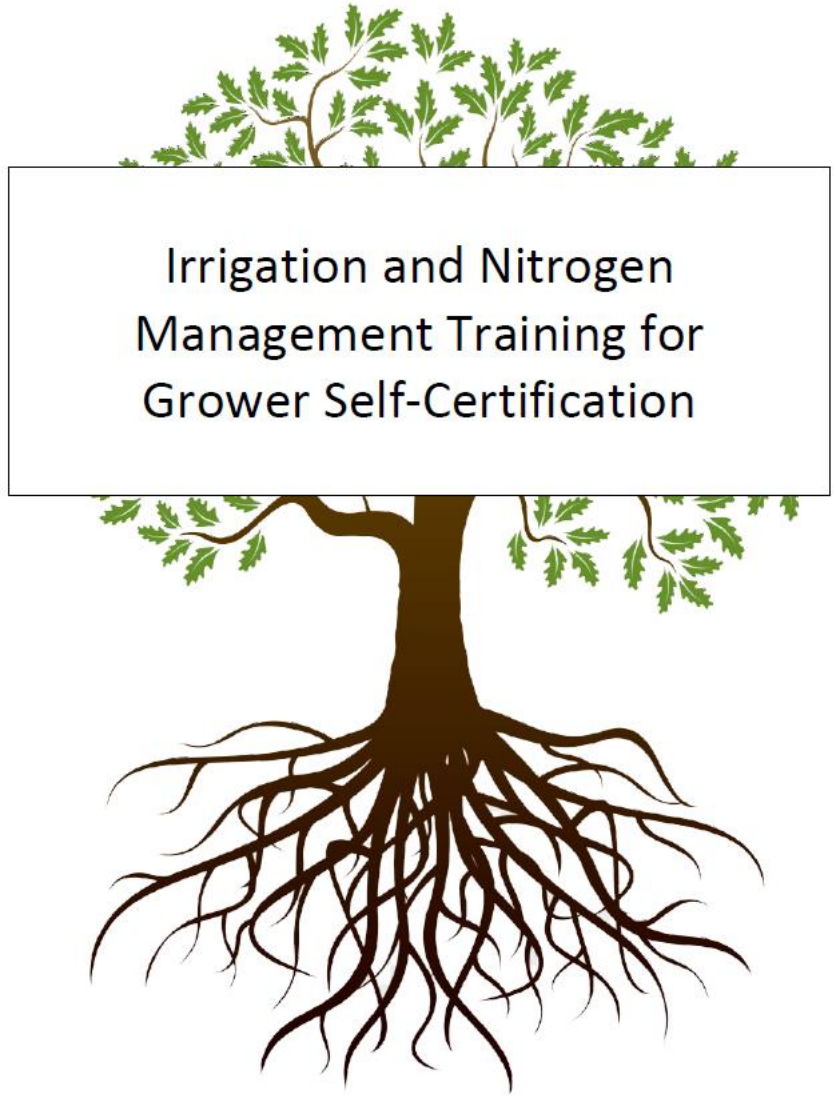
Fertilizers

Compost

Cover crop

Soil organic **matter**

Estimating organic N availability for INMP



Organic Amendments

In the nitrogen management section of the INMP Worksheet, Box 11 asks growers to report nitrogen from organic amendments. Box 11 has two columns one for pre-season planning (A) and one for actuals recorded at the end of the season (B).

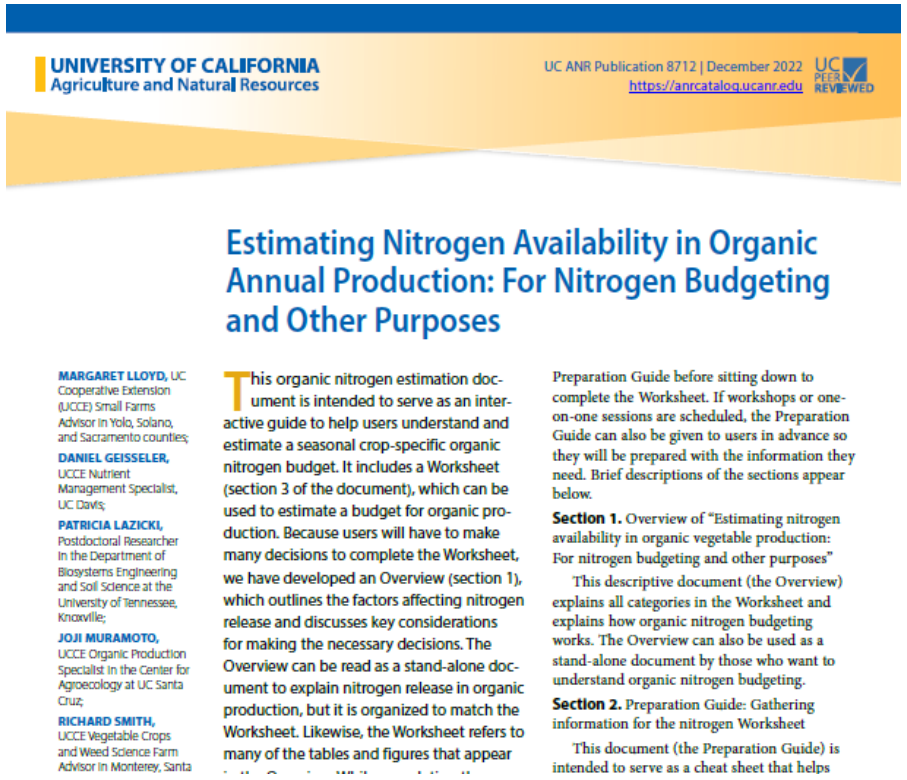
Nitrogen Sources	Recommended / Planned N (A)	Actual N (B)
11. Organic Amendments* (lbs./ac estimate)		

Organic amendments include natural sources of carbon and nutrients that do not have a guaranteed nutrient content. Below are examples of common organic amendments:

- Plant and Animal Based Compost
- Animal Manure (i.e., cow, swine, chicken)
- Animal Based Fertilizers (i.e., bloodmeal, feathermeal, guano, pelleted chicken manure)
- Plant Based Fertilizers (i.e., soybean, cottonseed, and alfalfa meals)
- Cover Crop and Crop Residues

https://www.cdfa.ca.gov/is/ffldrs/frep/pdfs/training/inmtp_workbook.pdf

Free, online publication assists with N budgeting in organic systems



UNIVERSITY OF CALIFORNIA
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UC ANR Publication 8712 | December 2022
https://anrcatalog.ucanr.edu

UC PEER REVIEWED

Estimating Nitrogen Availability in Organic Annual Production: For Nitrogen Budgeting and Other Purposes

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JOJI MURAMOTO, UCCE Organic Production Specialist in the Center for Agroecology at UC Santa Cruz;

RICHARD SMITH, UCCE Vegetable Crops and Weed Science Farm Advisor in Monterey, Santa

This organic nitrogen estimation document is intended to serve as an interactive guide to help users understand and estimate a seasonal crop-specific organic nitrogen budget. It includes a Worksheet (section 3 of the document), which can be used to estimate a budget for organic production. Because users will have to make many decisions to complete the Worksheet, we have developed an Overview (section 1), which outlines the factors affecting nitrogen release and discusses key considerations for making the necessary decisions. The Overview can be read as a stand-alone document to explain nitrogen release in organic production, but it is organized to match the Worksheet. Likewise, the Worksheet refers to many of the tables and figures that appear

Preparation Guide before sitting down to complete the Worksheet. If workshops or one-on-one sessions are scheduled, the Preparation Guide can also be given to users in advance so they will be prepared with the information they need. Brief descriptions of the sections appear below.

Section 1. Overview of "Estimating nitrogen availability in organic vegetable production: For nitrogen budgeting and other purposes"

This descriptive document (the Overview) explains all categories in the Worksheet and explains how organic nitrogen budgeting works. The Overview can also be used as a stand-alone document by those who want to understand organic nitrogen budgeting.

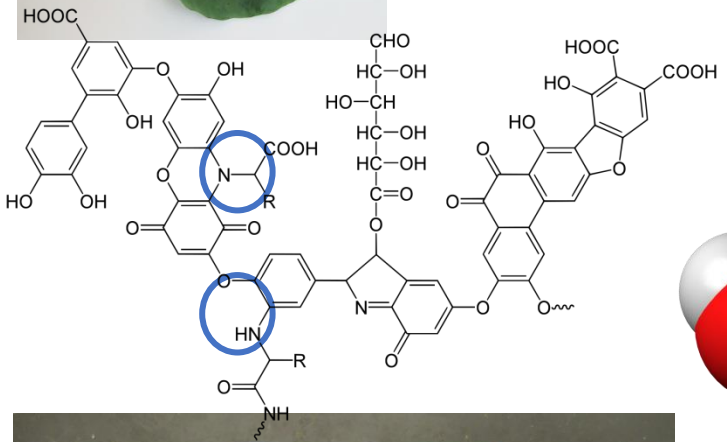
Section 2. Preparation Guide: Gathering information for the nitrogen Worksheet

This document (the Preparation Guide) is intended to serve as a cheat sheet that helps

https://anrcatalog.ucanr.edu/Details.aspx?itemNo=8712

Review: nitrogen transformations

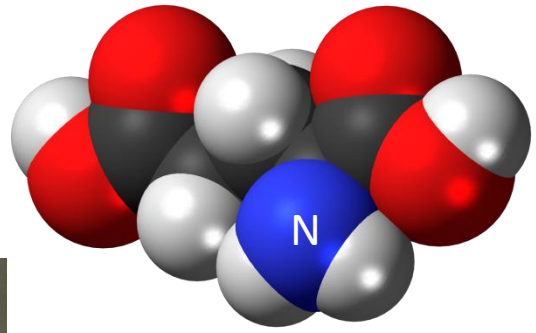
Complex organic forms → Simpler organic forms → Ammonium → (Nitrite) → Nitrate NO_3^-



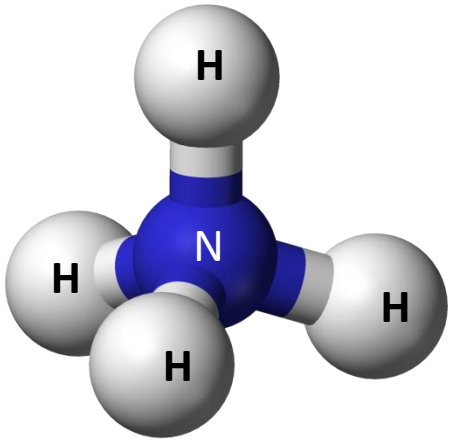
"Breakdown"

"Mineralization"

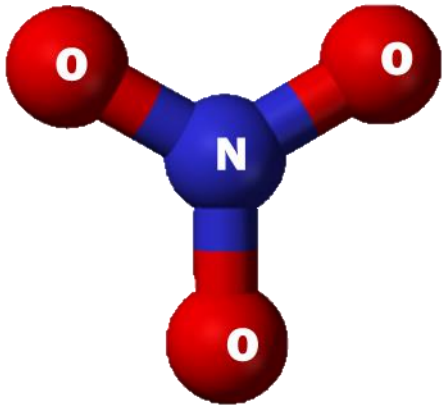
"Nitrification"



NH_4^+



NO_3^-



All these processes are done by enzymes, happen faster at higher moisture, temperature

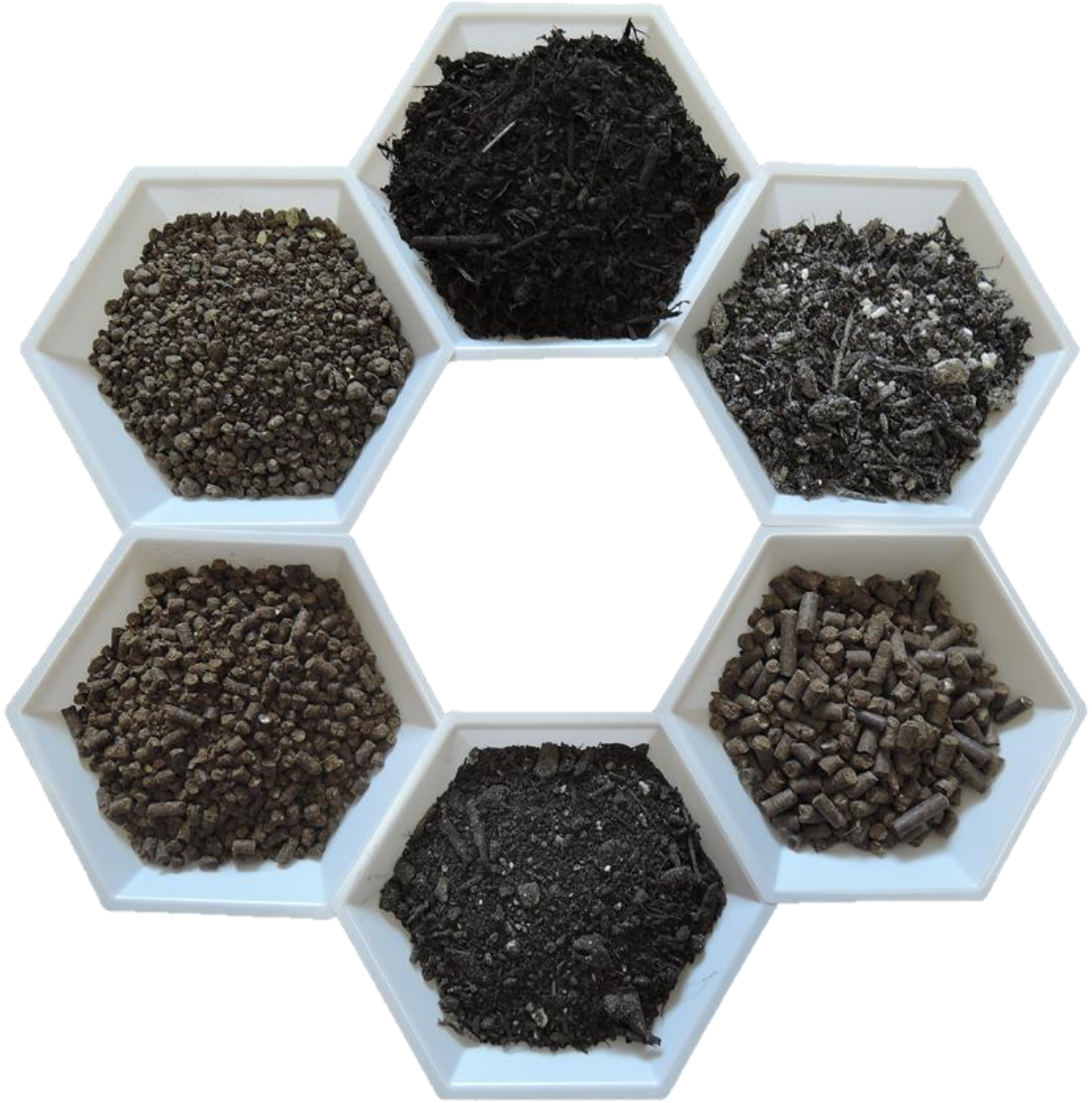
"Organic" nitrogen

"Mineral" nitrogen –form plants normally use

All molecule images in the public domain, courtesy of Wikipedia

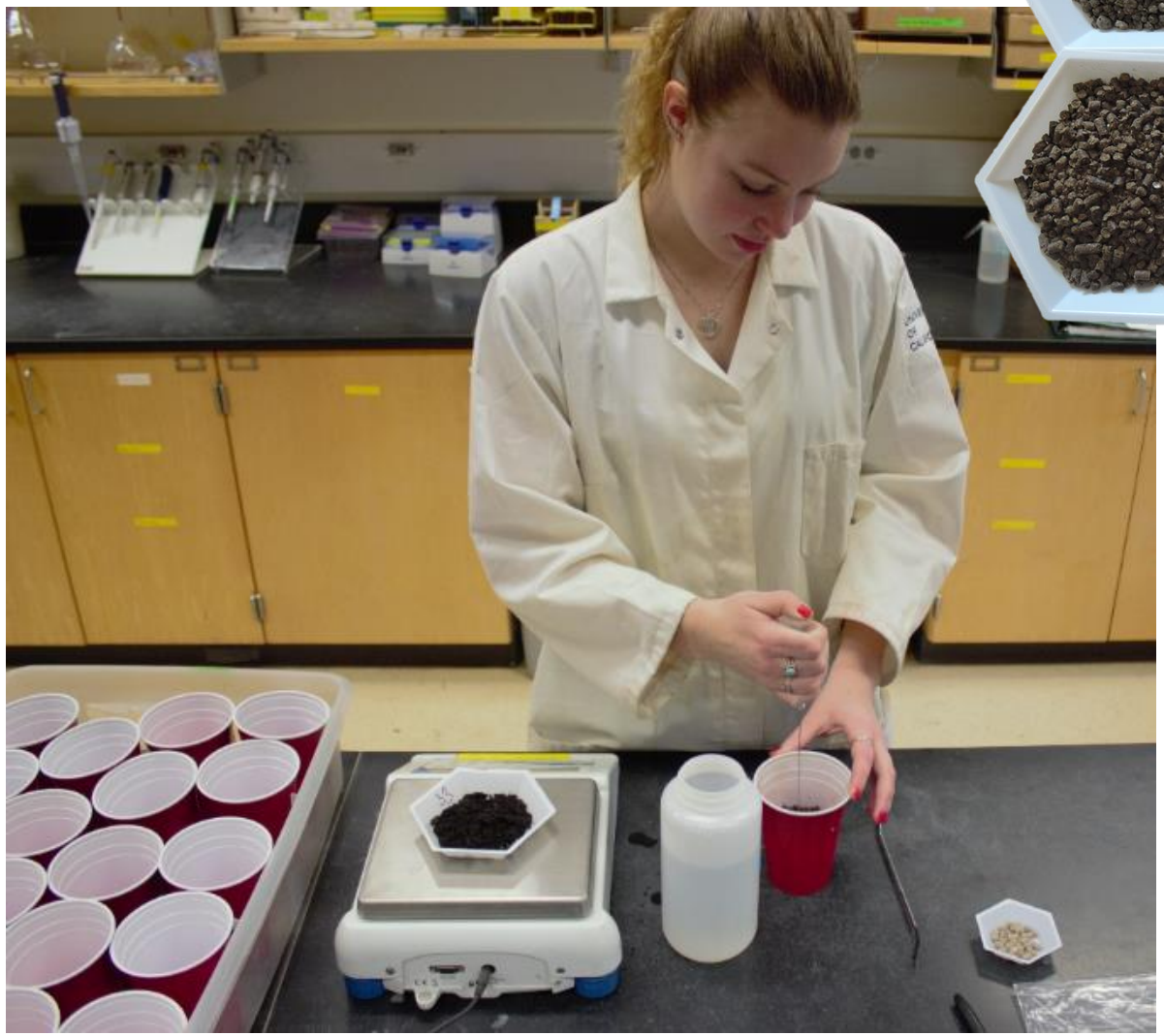
Organic amendments

- Granular fertilizers
- Liquid fertilizers
- Composts



How much N becomes available?

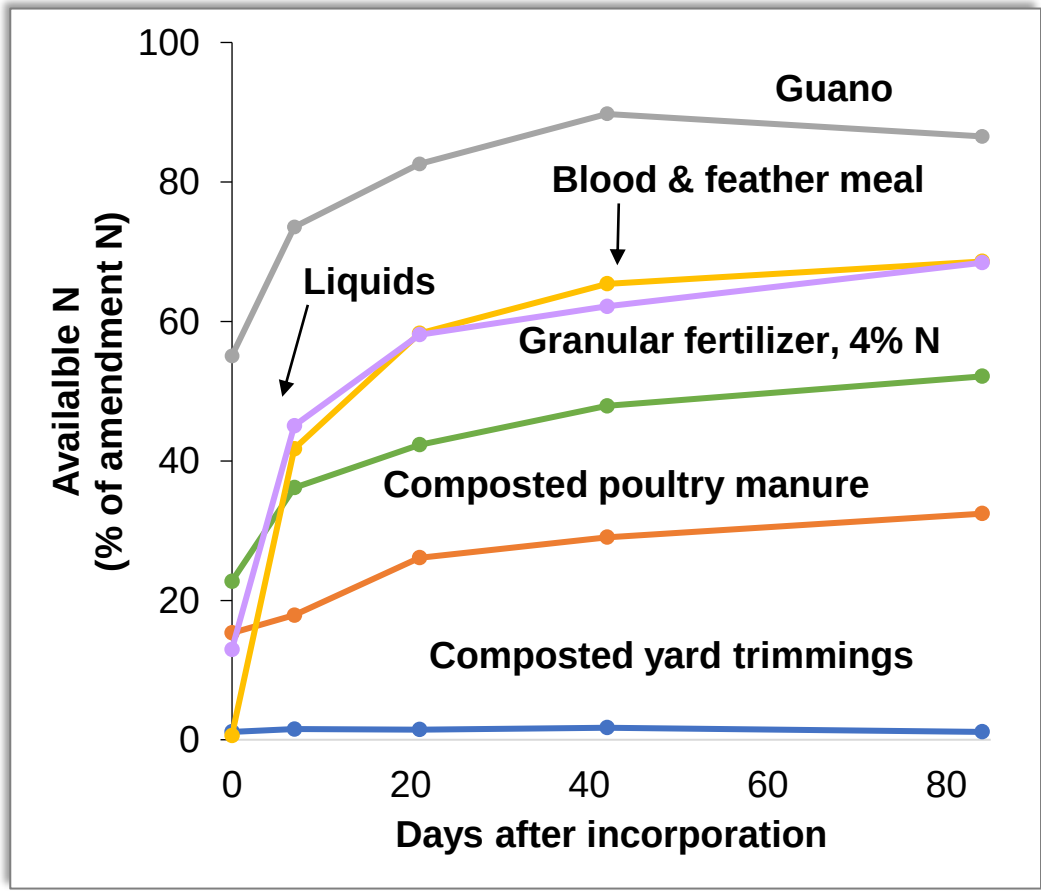
- Incubation experiment
- Optimum moisture, 75°F
- Sample at 0, 1, 3, 6, 12 weeks
- Additional at 40°, 60°F



Work funded by a USDA-AMS grant to Daniel Geisseler and Margaret Lloyd

Organic amendment availability

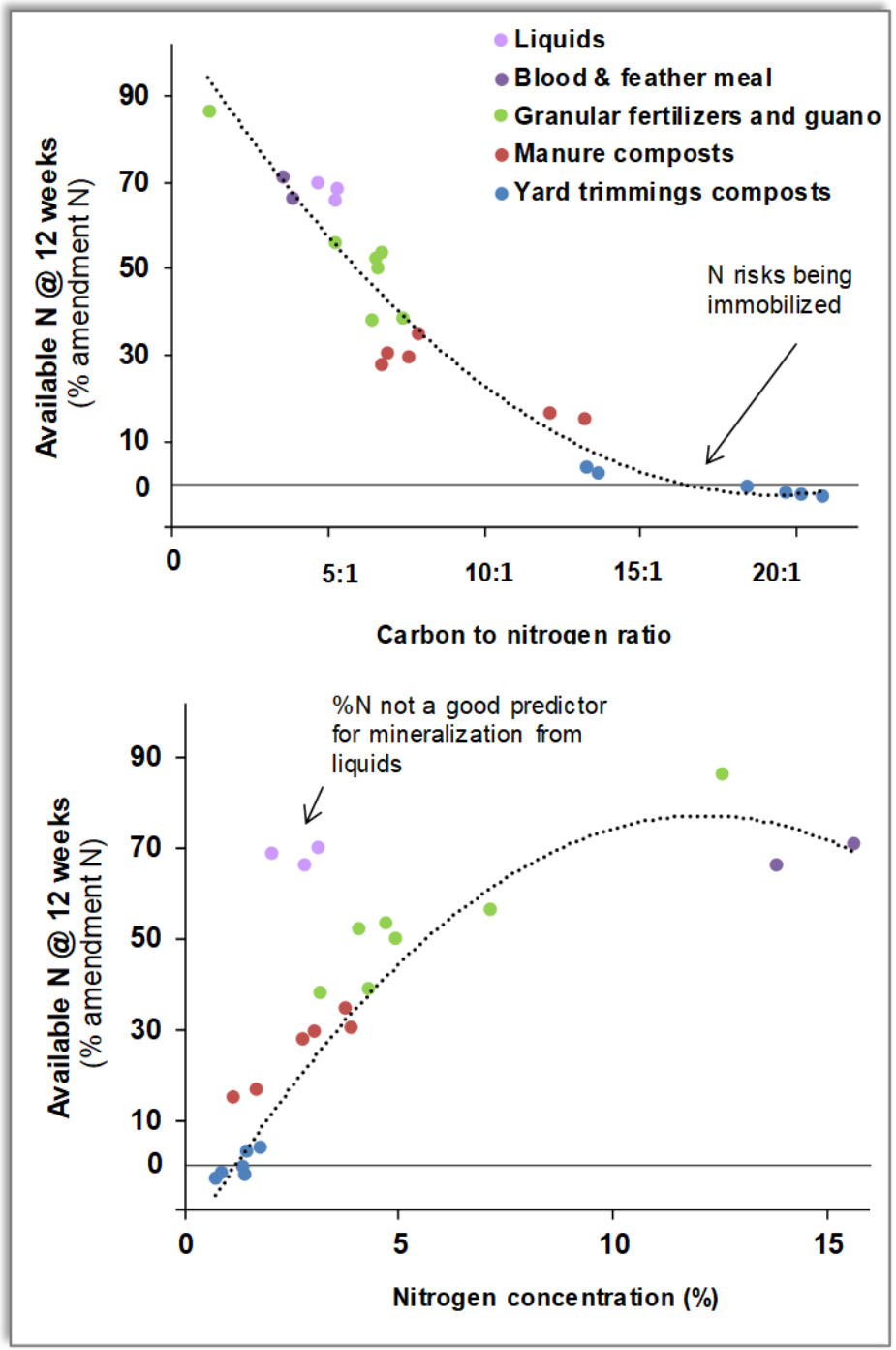
Material	Typical %N	Typical C:N ratio	N available after 12 weeks	Releases in:
Yard trimmings composts	0.5 - 2	13 - 20	-3% - 4%	Years
Poultry manure composts	2 - 5	6 - 8	30 - 35%	Weeks-months
Granular fertilizers (except guano)	2 - 7	5 - 7	38 - 60%	Days-weeks
Blood & feather meal	13 - 15	3 - 4	65 - 70%	Days
Liquid fertilizers	2 - 4*	4 - 6	50-100%	Days
Guano	12 - 13	3 - 4	80-90%	Days



"Nitrogen mineralization from organic amendments is variable but predictable"
Lazicki et al., 2020
https://acsess.onlinelibrary.wiley.com/doi/full/10.1002/jeq2.20030

Quality predicts availability

- C to N ratio
- Percent N
  - Moisture content matters



Factors affecting N mineralization

- **Chemistry**– Get an estimate of N release based on %N or C:N ratio
- **Temperature**– Reduce slightly (~10-15%) for more complex materials applied in cold weather
- **Placement*–** Reduce by ~30-75% for surface placement (more if high initial NH_4, dry conditions)

*"Fine-tuning fertilizer applications in organic cool-season leafy green crops can increase soil quality and yields"
Smith et al., 2022
https://calag.ucanr.edu/archive/?type=pdf&article=ca.2022a0010

Using the N Mineralization Calculator

http://geisseler.ucdavis.edu/Amendment_Calculator.html

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Nutrient Management

Nitrogen Mineralization from Organic Amendments

The calculations in this tool are based on an analysis of 113 datasets from the scientific literature. Nitrogen mineralization rates are adjusted based on soil temperature data from local CIMIS weather stations. Soil moisture is assumed to be optimal near field capacity. **When amendments are incorporated into dry soil, N mineralization would be slower than calculated. The tool should not be used when amendments are left on the soil surface.**
Information on lines marked with an * needs to be provided. If no information on amendment and soil properties are entered, the tool will use average values. In this case, however, the calculations will be less accurate for a specific situation.

Based on Geisseler et al., 2021 (freely available): https://acsess.onlinelibrary.wiley.com/doi/10.1002/jeq2.20295

Amendment
- Type
- Rate
- Temperature
- Placement

Amount and quality of N in the amendment

Gives an estimate of N available to deal with immobilization from high C:N materials

Amendment Application

Region*: Sacramento Valley - Yolo

Type of amendment*: Feather meal

Application rate*: tons/ac

Application date*: mm / dd / yyyy

Period of interest: 3 Months

Depth of incorporation*: inches

* Required input.

- Feather meal
- Guano
- Blood Meal
- Poultry Manure
- Poultry Manure Compost
- Pelleted Material
- Vermicompost
- Yard Waste Compost

Amendment Properties

Amendment dry matter: %

Total nitrogen: % in dry matter

Carbon to nitrogen ratio:

Mineral nitrogen: (ammonium and nitrate) % in dry matter

Soil Properties

Soil organic matter: %

Residual soil nitrate: ppm Nitrate-N

Display Results/Changes

http://geisseler.ucdavis.edu/Amendment_Calculator.html

Amendment
- Type
- Rate
- Temperature
- Placement

Amendment Application

Region*: Sacramento Valley - Yolo

Type of amendment*: Pelleted Material

Application rate*: .5 tons/ac

Application date*: 04 / 28 / 2023

Period of interest: 3 Months

Depth of incorporation*: 4 inches

* Required input.

Amount and quality of N in the amendment

Amendment Properties

Amendment dry matter: 90 %

Total nitrogen: 4 % in dry matter

Carbon to nitrogen ratio: 6

Mineral nitrogen: (ammonium and nitrate) 0.61 % in dry matter

Gives an estimate of N available to deal with immobilization from high C:N materials

Soil Properties

Soil organic matter: 3 %

Residual soil nitrate: 15 ppm Nitrate-N

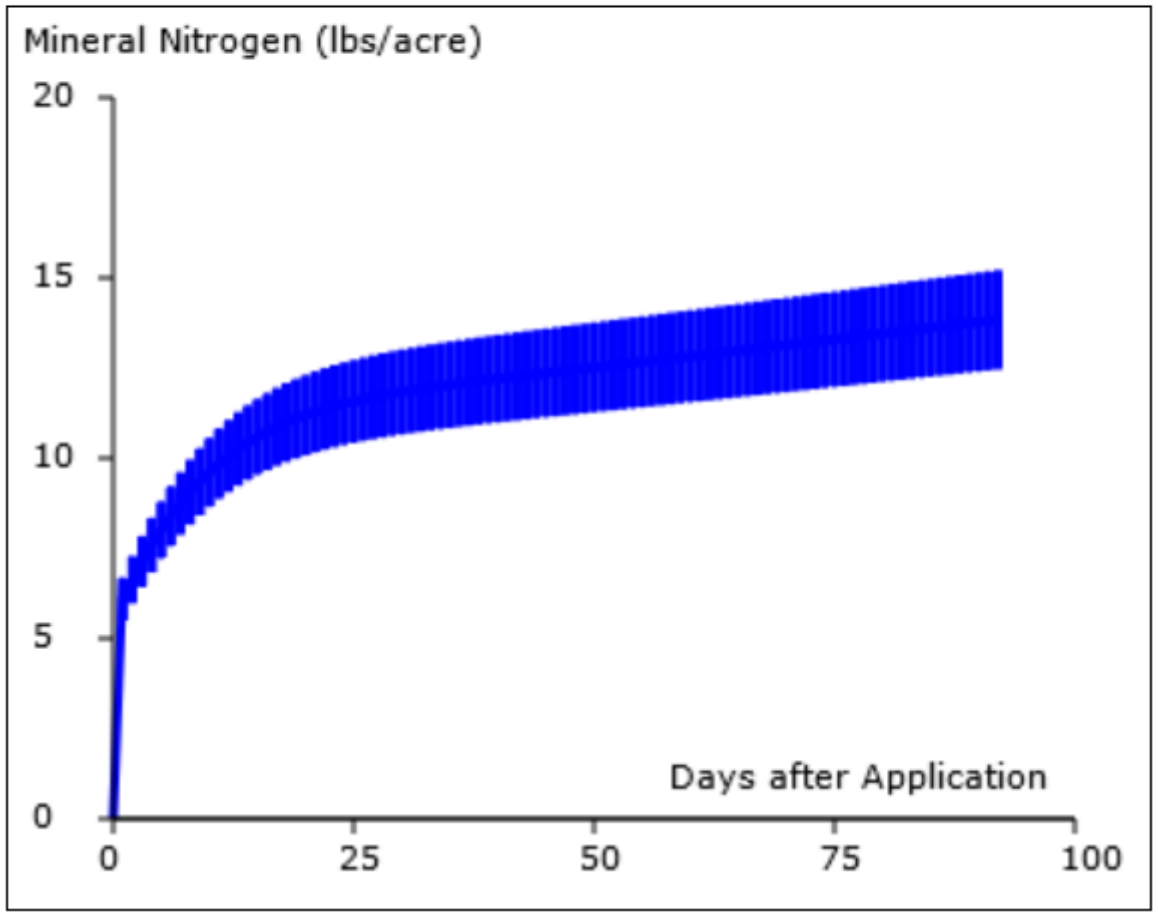
Display Results/Changes

Will fill in default values based on literature averages if no input

http://geisseler.ucdavis.edu/Amendment_Calculator.html

Display Results/Changes

Nitrogen Mineralization



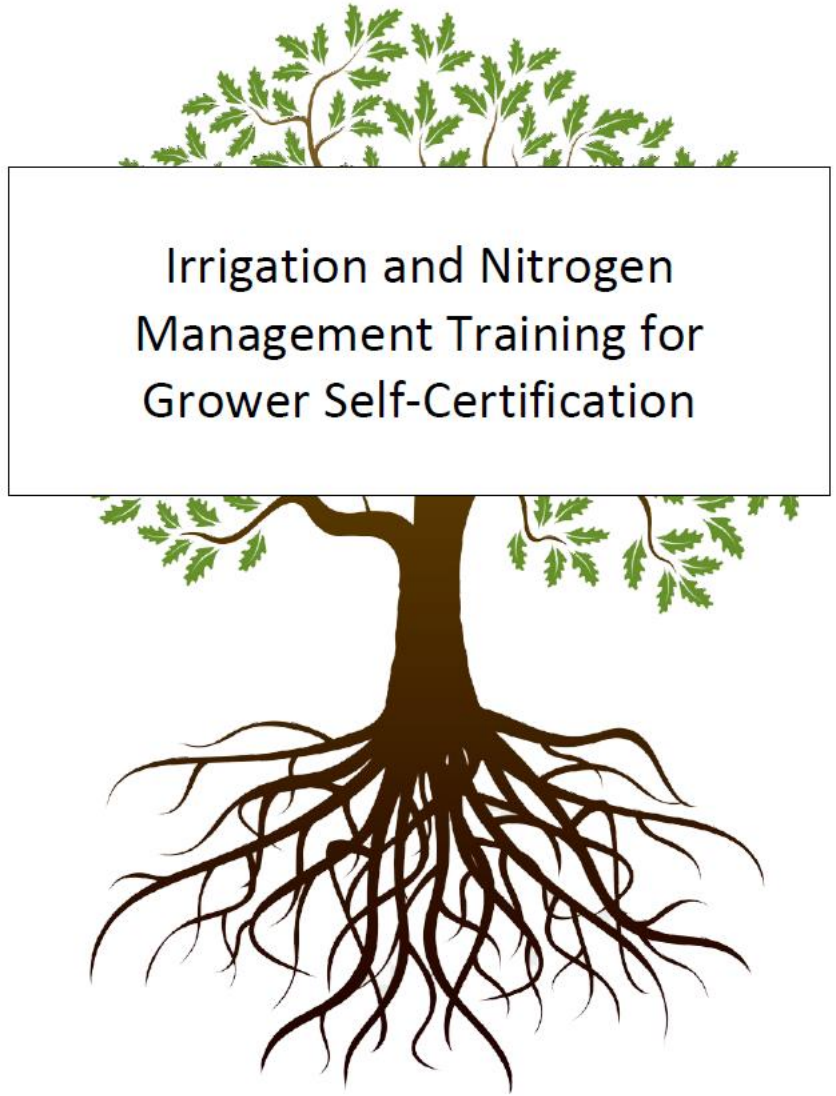
Total N applied:	ⓘ	36 lb/ac
Total mineral N applied:	ⓘ	6 lb/ac
Estimated available N:	ⓘ	12 - 15 lb/ac
Percent available:	ⓘ	35 - 42 %

*****THESE ARE ESTIMATES*****

Monitor with soil and plant testing

http://geisseler.ucdavis.edu/Amendment_Calculator.html

Estimating organic N availability for INMP



Estimating Nitrogen Contribution from Organic Amendments

The University of California Agriculture and Natural Resources Division has an article, worksheet, and calculator for estimating nitrogen availability in organic crop production. The three resources walk growers through estimating the nitrogen contribution from several sources including composts, crop residues, and cover crops.

- Article: https://ucanr.edu/sites/SFA/files/322312.pdf
- Worksheet: https://ucanr.edu/sites/SFA/files/322313.pdf
- Calculator: http://geisseler.ucdavis.edu/Amendment_Calculator.html

Using the Organic Amendment Calculator

The calculator estimates nitrogen availability for the following amendments:

- Feather Meal
- Blood Meal
- Guano
- Poultry Manure
- Poultry Manure Compost
- Pelleted Material
- Vermicompost
- Yard Waste Compost

To use the calculator, growers input the region, type of amendment, application date, application rate, and depth of incorporation. Additional information can be put into the calculator if known including %dry matter, %N, and the C:N ratio.

Organic Amendment Calculator Example

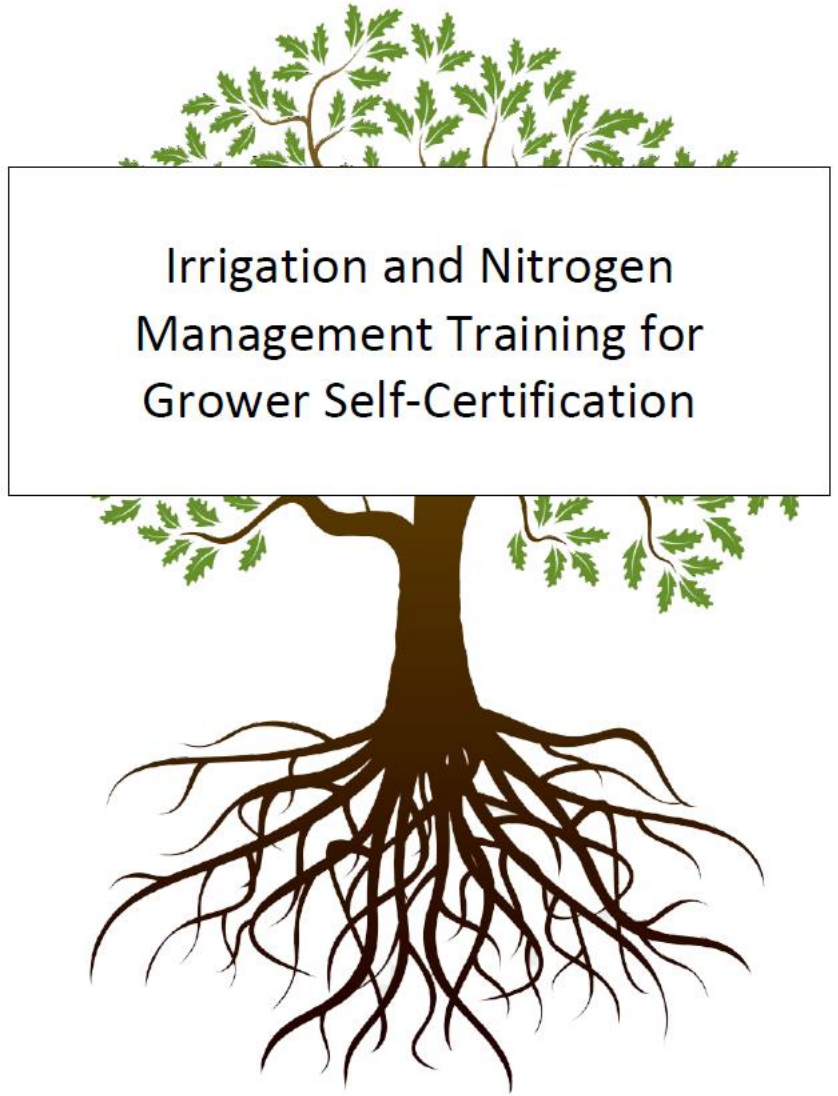
Region*:	San Joaquin Valley - Stanislaus
Type of amendment*:	Poultry Manure Compost
Application rate*:	5 tons/ac
Application date*:	10/09/2021
Period of interest:	6 Months
Depth of incorporation*:	6 inches

* Required input.

Total N applied:	260 lb/ac
Total mineral N applied:	20 lb/ac
Estimated available N:	56 - 65 lb/ac
Percent available:	22 - 25 %

Cover crops/ crop residues

Estimating organic N availability for INMP



Using the Organic Amendment Worksheet

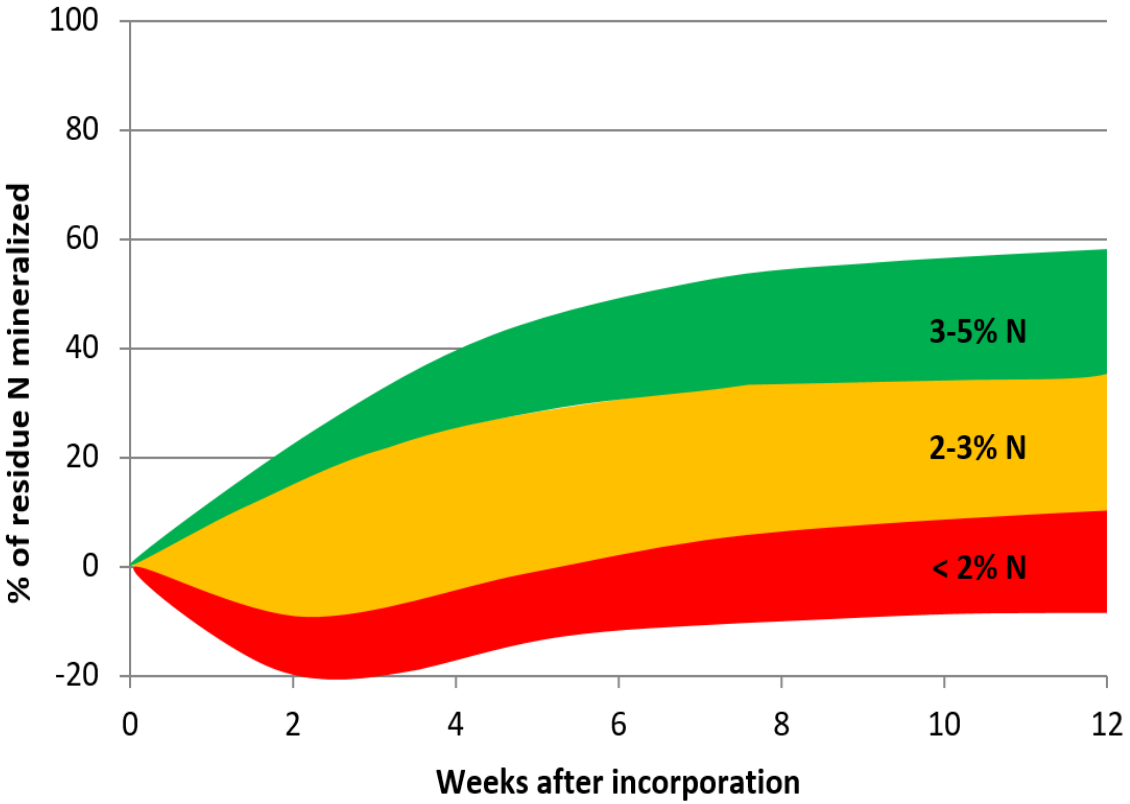
The worksheet walks growers through the calculations for the following organic amendments:

- Cover Crops (Part 2, C1)
  - Inputs required: cover crop's biomass and %N. This information can be found in the UC SAREP Cover Crop Database (https://sarep.ucdavis.edu/covercrop).
- Crop Residues (Part 2, C2)
  - Inputs required: previous crop yield, %N of residue, and expected N in the crop residue

SAREP Database: https://sarep.ucdavis.edu/covercrop

Oregon State University calculator: https://smallfarms.oregonstate.edu/calculator

Higher N content= higher, faster N availability

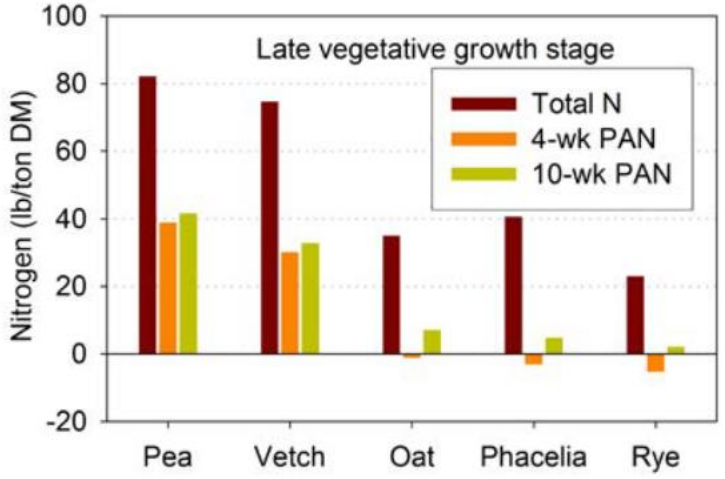


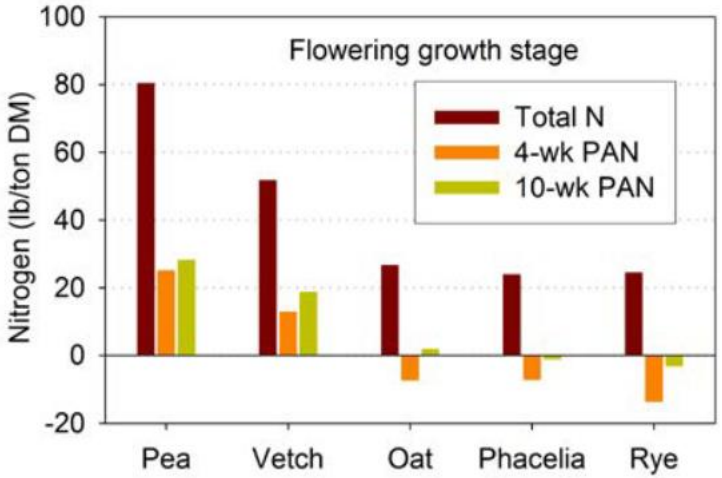
Examples of N release timing from high, medium, and low-N residues.

Cover crop	%N	Biomass	Total N	Available N	% of total N
Common vetch	3	1.5 T	**90**	50	**57%**
Cereal rye (elongation)	2	1.5 T	60	20	33%
Cereal rye (heading)	1	4 T	**80**	-27	**-0.4%**

Cover crop/residue N: factors to consider

- **Species**
  - Legumes> grasses
- **Age at termination**
  - Younger crop=higher N, lower biomass
    - N concentrations steeply decline after flowering (legumes)/boot stage (cereals)
    - Max N usually just before flowering (highest biomass x N concentration
- **Plant part**
  - Aboveground >> belowground biomass (even for legumes)





Estimating Plant-Available Nitrogen Release From Cover Crops
https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/pnw636.pdf

Recently incorporated crop residues: a source of N

Crop	Expected crop residues (lb N/T yield)	(lb N/A)	
Lettuce	5	80-100	3-6% N; (whole plant)
Tomato (fresh-market)	4.5	90	
Tomato (processing)	2	120	
Sweet potato	0.2	5	
Broccoli	25	180-260	3-5% N
Carrot	7	140	
Melon	3	70	
Potato	4.5	115	
Strawberry	4.5	95	
Spinach	3	30-50	5-6% N

These values are mostly based on studies with commercial, conventionally managed vegetables in high production areas, and so the yield values may be high. The amount of N expected to be in the residues can be adjusted for the actual expected yield by multiplying the actual yield by the value for lb- N/ton yield

Using the worksheet (in ANR Pub. 8712)

C2. Available N from cover crops

The amount of nitrogen a cover crop contributes depends on several factors including species, how thick the stand is, and at what stage it is terminated. The C:N ratio is the best predictor of nitrate release rates.

10:1 C:N ratio of cover crop residue

Vetch **Specify cover crop type**

11. 1000 lb/acre — 11. Estimate legume biomass dry weight

Use your own information on biomass dry weight, refer to table 4, or refer to the "Resources" section (UC SAREP cover crop database and Oregon State calculator). When referring to another source that provides a range, consider your own scenario regarding crop density and crop height/maturity to select a number in the range. For example, if a crop is terminated earlier, at 50 percent of maturity, select a biomass weight on the lower end of the range. Denser production and longer production times will likely correspond to numbers at the higher end of the range.

12. 4 % — 12. Percent N in cover crop

Use your own information from a sample sent to a lab, utilize table 4, or refer to the "Resources" section.

13. 40 lb N/acre — 13. Total N from cover crop (refer to table 4)

1000 (11.) lb/acre × 4 (12.) %/100 = 40 (13.) lb N/acre

14. 20 lb N/acre — 14. Total N from cover crop available this season

Refer to figure 5 to estimate percentage of residue nitrogen mineralized using tissue nitrogen content. It's estimated that −10 to 50 percent of cover crop nitrogen is directly available for the next crop. Expect lower availability when material is left on the surface or not incorporated, or when the soil is drier. Use an intermediate availability for legume-cereal mixes. Estimate higher availability when the cover crop is terminated at optimum growth (early flower) and a lower availability for more mature crops. C:N ratio is an excellent predictor of nitrogen availability. A C:N ratio greater than 20:1 will generally not lead to releases of nitrogen. Rather, nitrogen will be used to break down carbon. A ratio of 10:1 will provide intermediate rates of release.

40 (13.) lb N/acre × 50 (−10 to 50%) %/100 = 20 (14.) lb N/acre

C. Available N from crop residue: Cover crops and postharvest residue

If a cover crop or commercial crop is incorporated no more than 6 weeks prior to planting the crop intended for this budget, the nitrogen from these residues should be accounted for. Choose from either the cover crop or crop residue option.

10:1 C:N ratio of previous crop residue at time of incorporation

C1. Available N from previous crop

This section uses crop yield to estimate nitrogen values. If your crop does not appear in table 3, or if you prefer to use residue and percent nitrogen calculations, use the method in section C2 to estimate "available nitrogen from previous crop."

Broccoli **Specify previous crop**

7. 10 ton/acre — 7. Previous crop yield

8. 25 lb N/ton — 8. N in crop residue (table 3)

9. 250 lb N/acre — 9. Estimated N in crop residue

The amount of nitrogen expected to be in the residues can be adjusted for the actual expected yield by multiplying the actual yield by the value for lb N/ton yield.

10 (7.) ton/acre × 25 (8.) lb N/ton = 250 (9.) lb N/acre

10. 125 lb N/acre — 10. Total N from previous crop available this season

Refer to figure 5 to estimate percentage of residue nitrogen mineralized using tissue nitrogen content. Use a lower percentage of nitrogen available when material is left on the surface and not incorporated, or when the soil is drier. C:N ratio is an excellent predictor of nitrogen availability. A C:N ratio greater than 20:1 will generally not release nitrogen, whereas 10:1 will provide intermediate rates of release.

250 (9.) lb N/acre × 50 (−10 to 50%) %/100 = 125 (10.) lb N/acre

https://anrcatalog.ucanr.edu/Details.aspx?itemNo=8712

Thank you!

More information

- "Nitrogen mineralization from organic amendments is variable but predictable"
  Lazicki et al., 2020
  https://acsess.onlinelibrary.wiley.com/doi/full/10.1002/jeq2.20030

- "Nitrogen mineralization from organic fertilizers and composts: Literature survey and model fitting"
  Geisseler et al., 2021
  https://acsess.onlinelibrary.wiley.com/doi/10.1002/jeq2.20295

- "Fine-tuning fertilizer applications in organic cool-season leafy green crops can increase soil quality and yields"
  Smith et al., 2022
  https://calag.ucanr.edu/archive/?type=pdf&article=ca.2022a0010

Questions? Contact me palazicki@ucanr.edu, 530-219-5198