



UC SANTA CRUZ

Center for Agroecology

# Nitrogen Mineralization from Organic Fertilizers and Composts

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Agriculture and Natural Resources

UCCE Small Farm Organic Seminar

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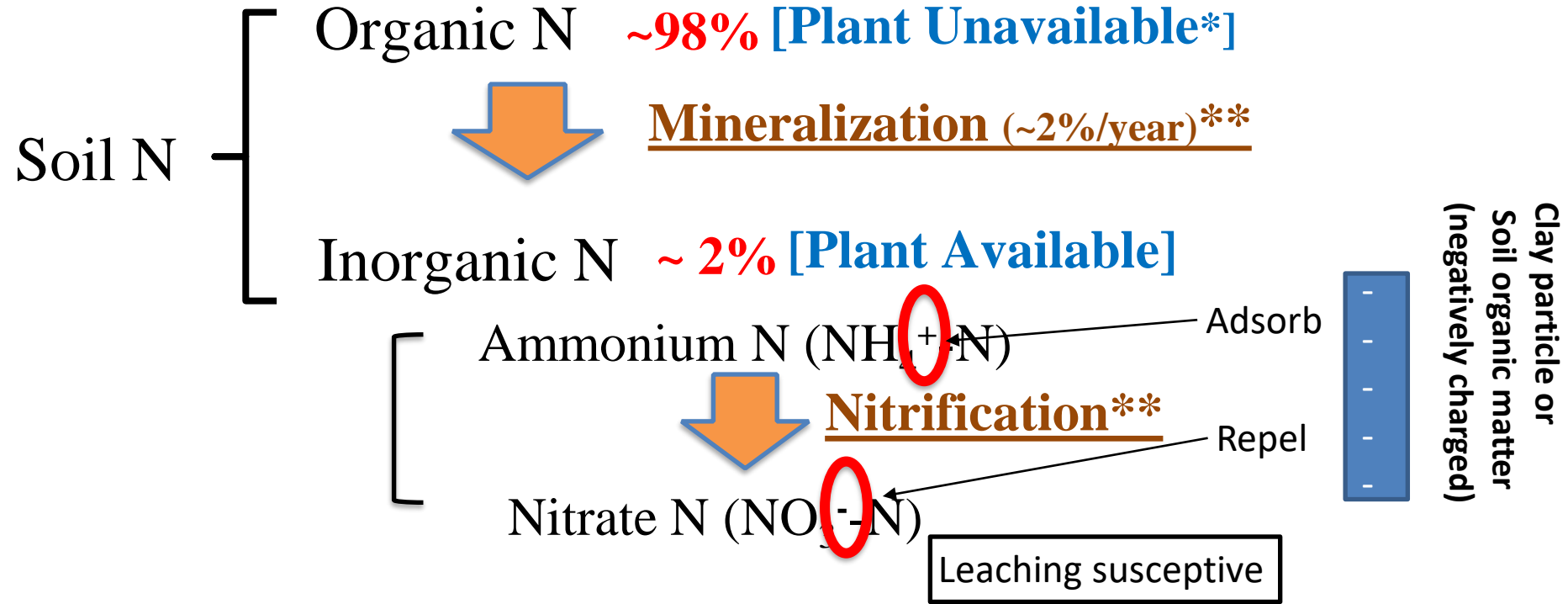
# Outline

1. Why nitrogen (N)?
  - N in plant and N in soil
  - plant available N in soil
2. N mineralization vs. N immobilization
3. N mineralization of organic fertilizers and composts
  - Incubation study
  - Simulation model

# Nitrogen (N) in plants; A key to crop production

- *Primary nutrient affecting plant growth*
  - *photosynthesis*
  - *biomass structure*
  - *metabolism*
  - *energy production*
  - *reproduction*
- *N deficiency*
  - *Yellowish green leaves, smaller plants, lower yield*
- *N excess*
  - *Dark green leaves, large vegetative plants, susceptible to diseases*

# N Forms in Soil and Plant Availability



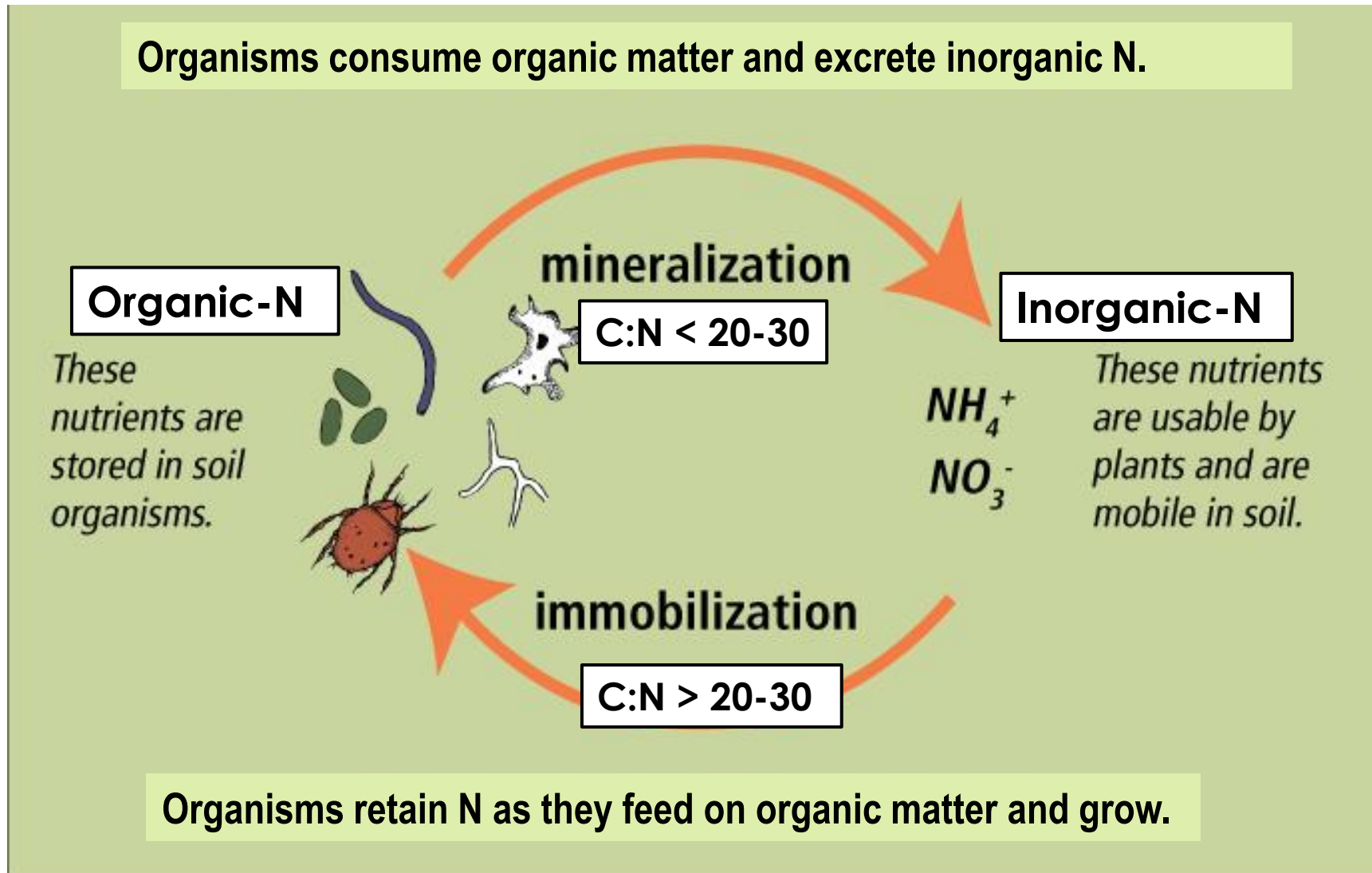
\* Plants can absorb small amounts of organic N and some crop plants can do more than others

\*\* Biological processes affected by *environmental factors* such as *soil temperature. moisture, etc.*

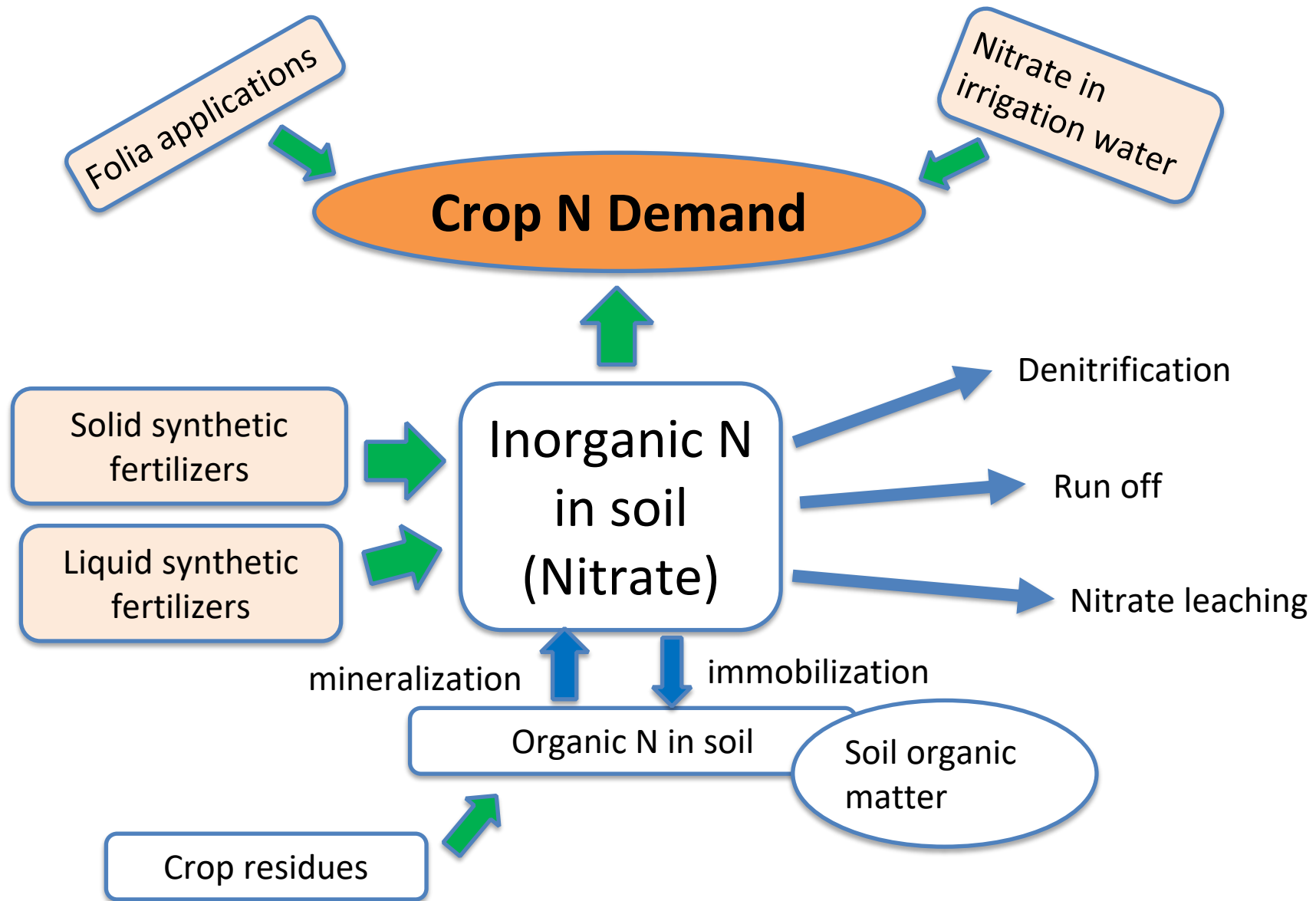
# Nitrogen mineralization & immobilization

- Soil microorganisms decompose residue
- Need N and C as building blocks for their own biomass
- C is also used as energy source
- **N mineralization:** Release excess N in the form of  $\text{NH}_4^+$  into soil solution
- **N immobilization:** Uptake of  $\text{NO}_3^-$  or  $\text{NH}_4^+$  from soil solution and incorporation into microbial tissue

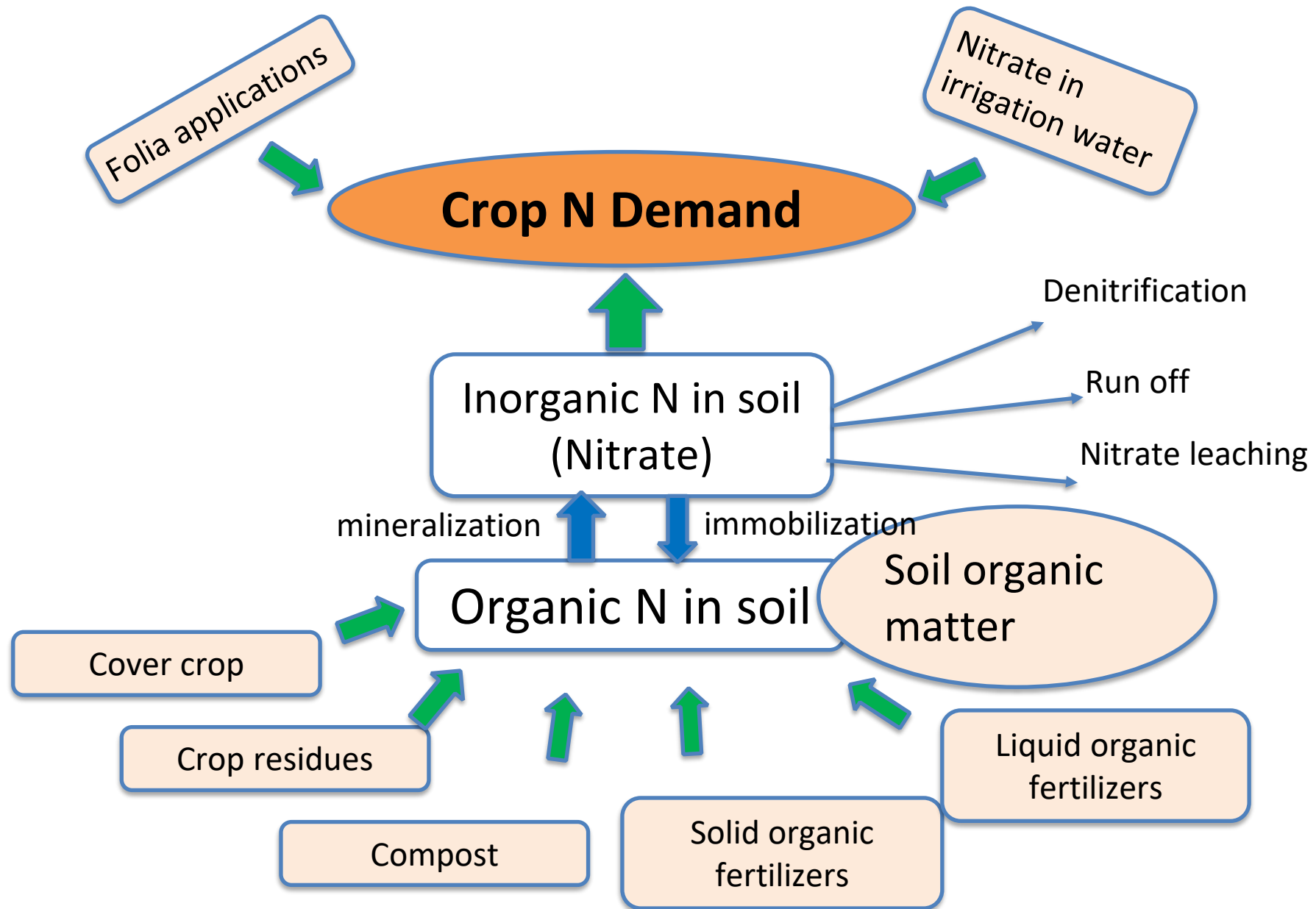
# N mineralization vs. N immobilization



(Adopted from USDA-NRCS, 2017)

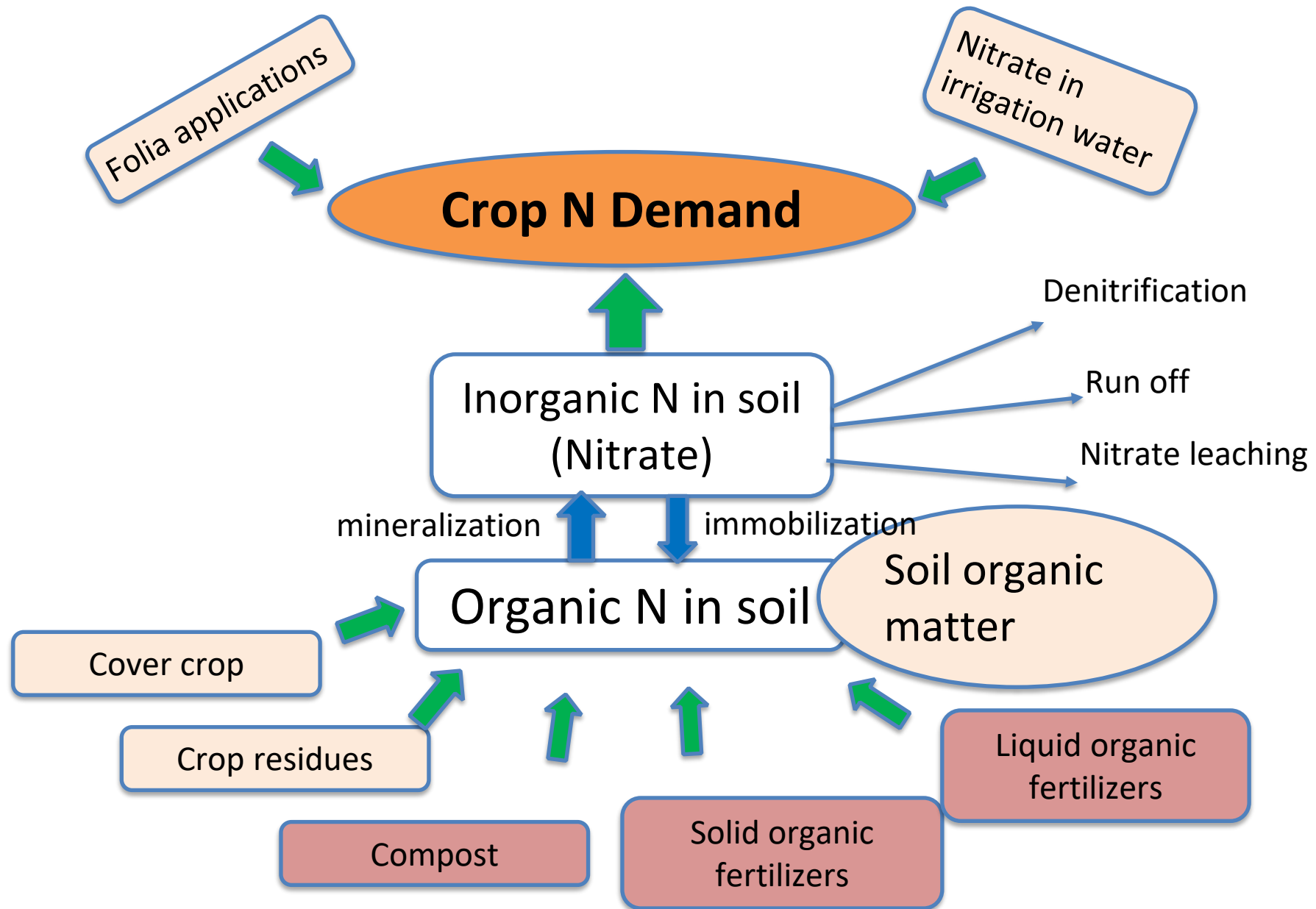


N dynamics in conventional systems



N dynamics in organic systems





N dynamics in organic systems

# Factors affecting decomposition and N mineralization

- Soil temperature
- Soil moisture
- Quality of organic source
  - Nitrogen content
  - C to N ratio
  - Availability of C and N
- Management

# Amendment incubation

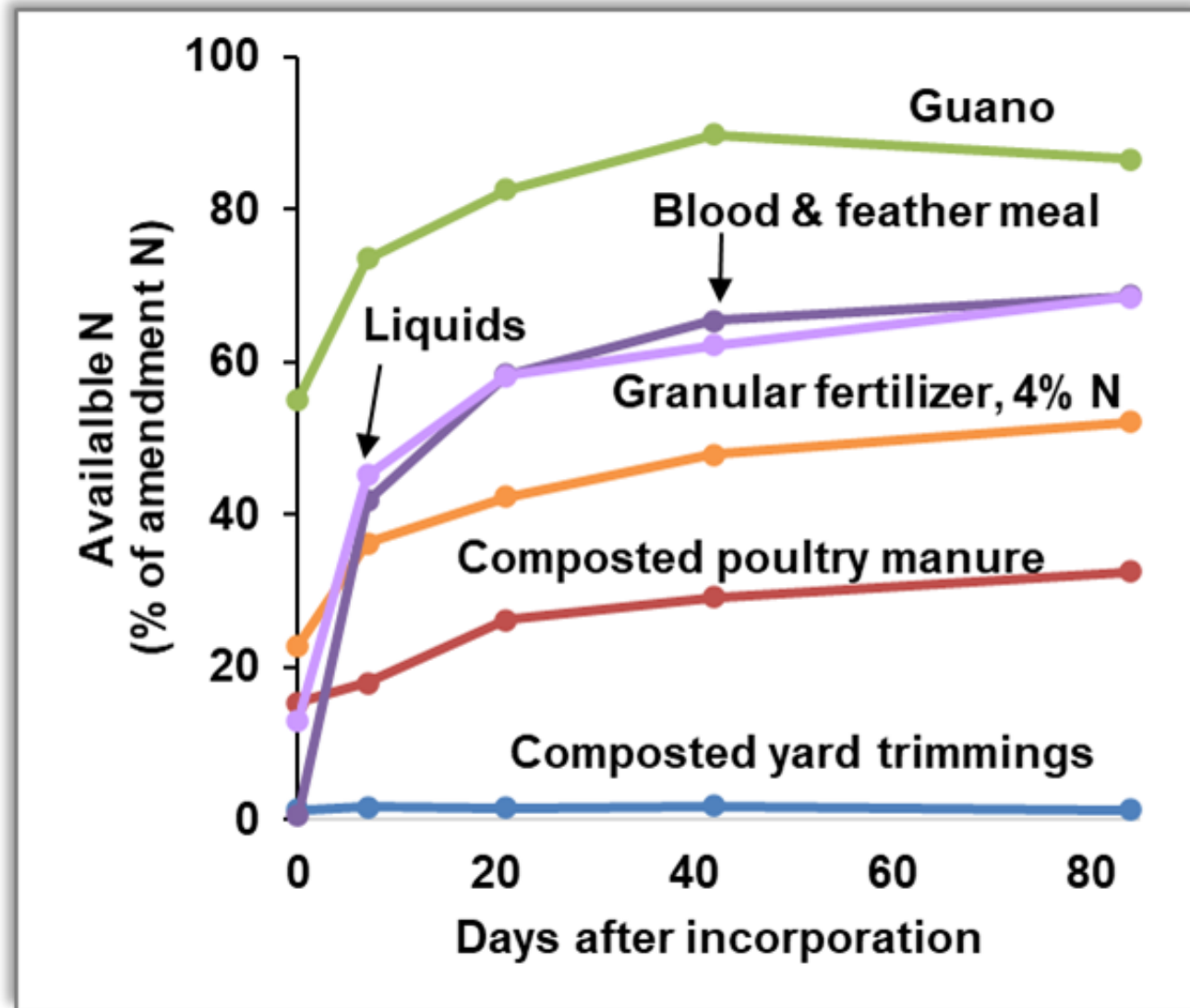


# N Contents and C:N Ratios of Organic Fertilizers

Material	Typical N content (%)	Typical C:N ratio
Municipal yard trimmings composts	0.5 - 2.0	13 - 20
Poultry manure composts	2.0 - 5.0	6 - 8
Granular fertilizers	2.0 - 7.0	5 - 7
Blood & feather meals	13 - 15	3 - 4
Liquid fertilizers	2.0 - 4.0	4 - 6
Guano	12 - 13	3 - 4

Lazicki et al., 2020

# N Release Patterns of Organic Fertilizers



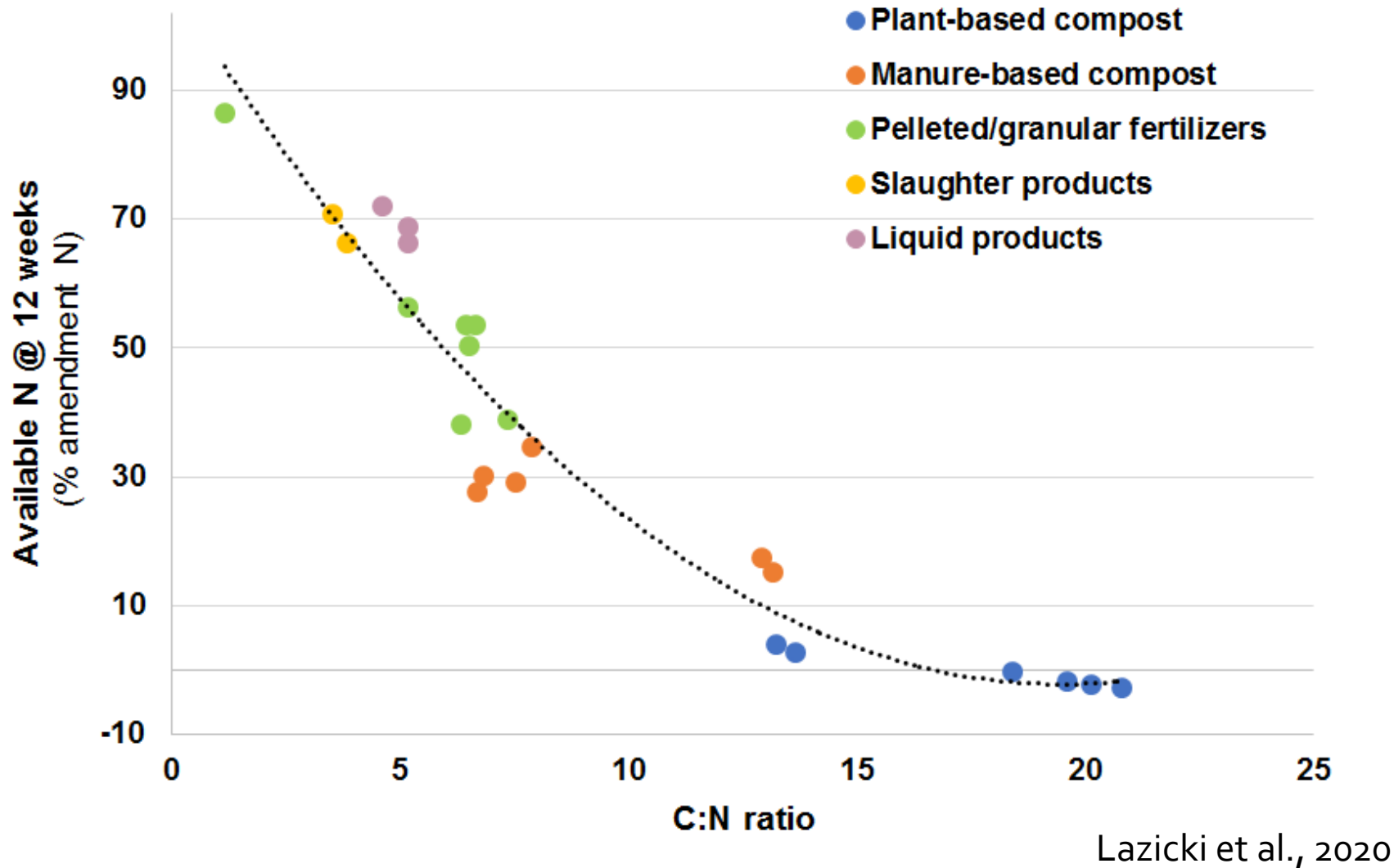
Lazicki et al., 2020

# Total N vs. Plant available N after 12 Weeks

Material	Average total N content (%)	N available after 12 weeks	Plant available N content (%)
Municipal yard trimmings composts	1.25	-3 – 4%	0 – 0.1
Poultry manure composts	3.5	30 – 35%	1.1 – 1.2
Granular fertilizers	4.5	38 – 60%	1.7 – 2.7
Blood & feather meals	14	65 – 70%	9.1 – 9.8
Liquid fertilizers	3.0	50 – 100%	1.5 – 3.0
Guano	12.5	80 – 90%	10 - 11

Based on Lazicki et al., 2020

# Effect of C to N ratio on N release



## AgOrder 4.0

Table MRP-3. Organic Fertilizer Discount Factor

C to N Ratio of Organic Product	Discount Factor Based on Predicted Mineralization Rate (O)
< 1.5	1.00
1.5	0.904
2.0	0.852
2.5	0.802
3.0	0.754
3.5	0.707
4.0	0.661
4.5	0.617
5.0	0.574
5.5	0.533
6.0	0.493
6.5	0.455
7.0	0.418
7.5	0.383
8.0	0.349
8.5	0.317
9.0	0.285
9.5	0.256
10.0	0.228
10.5	0.202
11.0	0.177
11.5	0.153
12.0	0.131
12.5	0.111
13.0	0.091
13.5	0.074
14.0	0.058
14.5	0.043
15.0	0.030

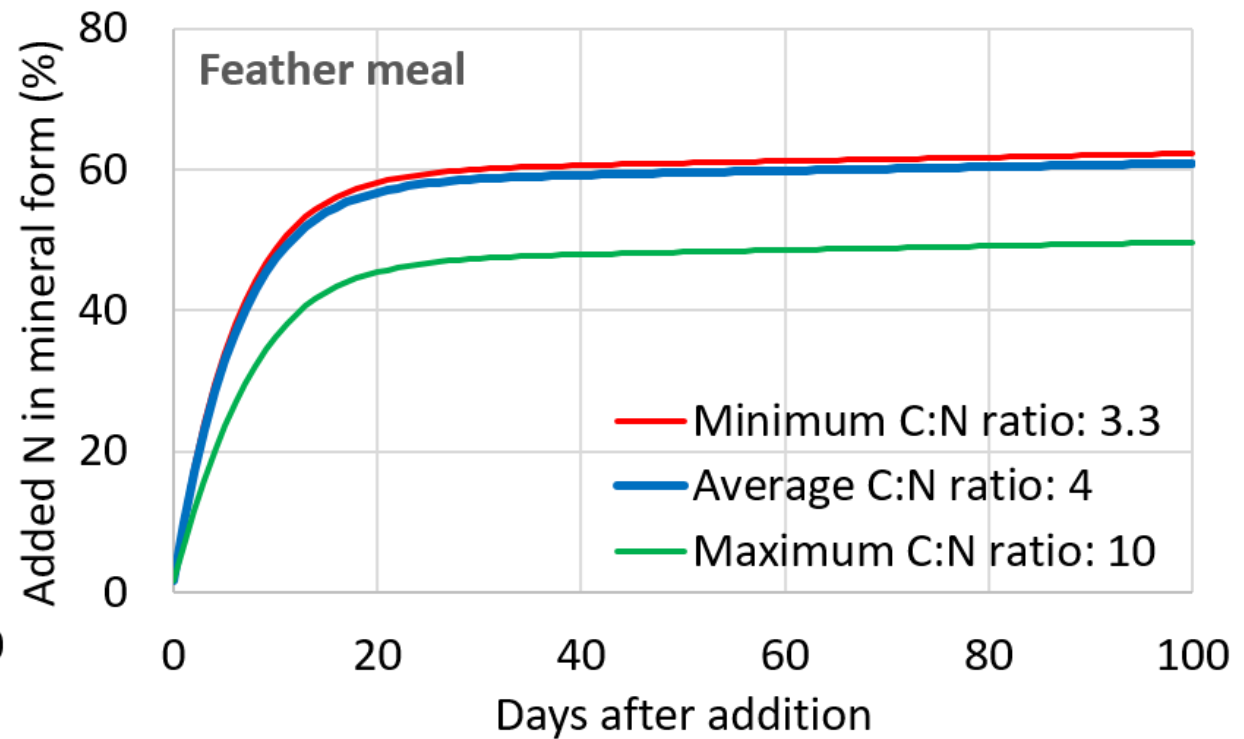
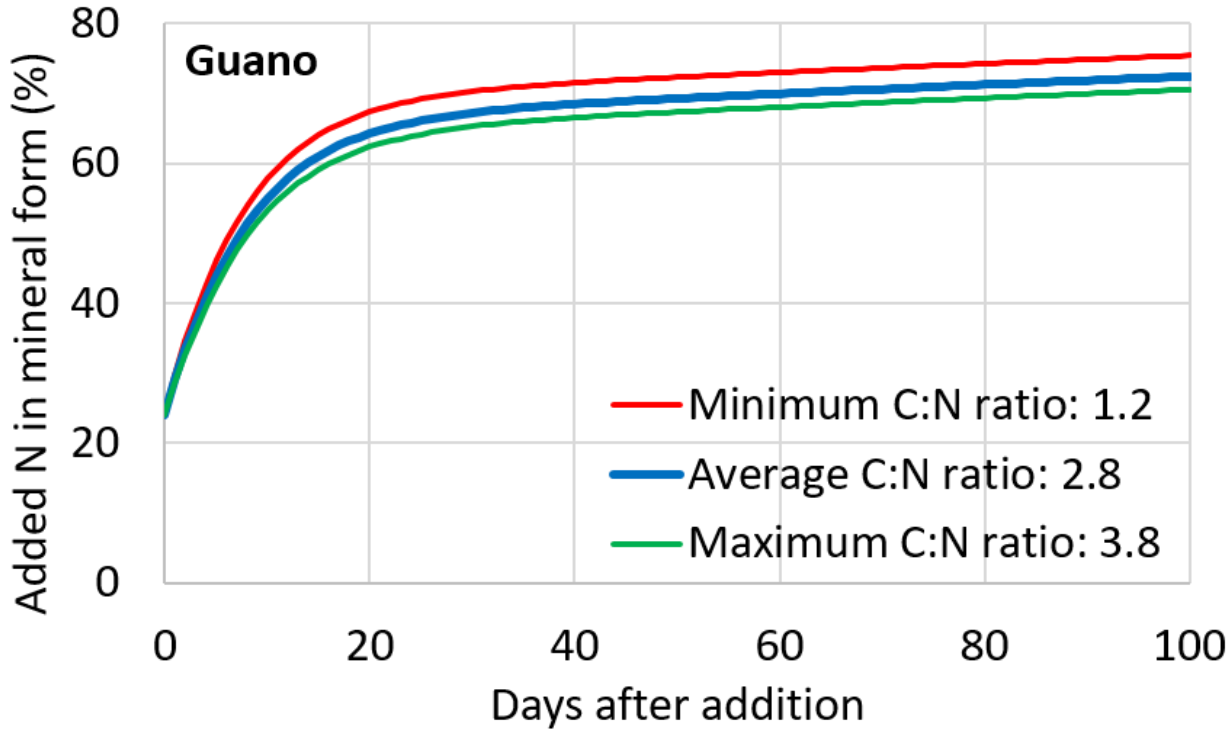
# The dataset

Material	Studies	Datasets	Observations	C to N ratio in dataset		
				Average	Min	Max
Guano	4	8	44	2.8	1.2	3.8
Feather meal	7	14	70	4.0	3.3	10.0
Poultry manure	9	29	195	10.3	6.3	19.5
Poultry manure compost	4	16	77	7.3	5.7	9.4
Vermicompost	8	21	125	11.1	14.9	35.0
Yard waste compost	6	25	126	16.1	9.1	22.3

Geisseler et al., 2021

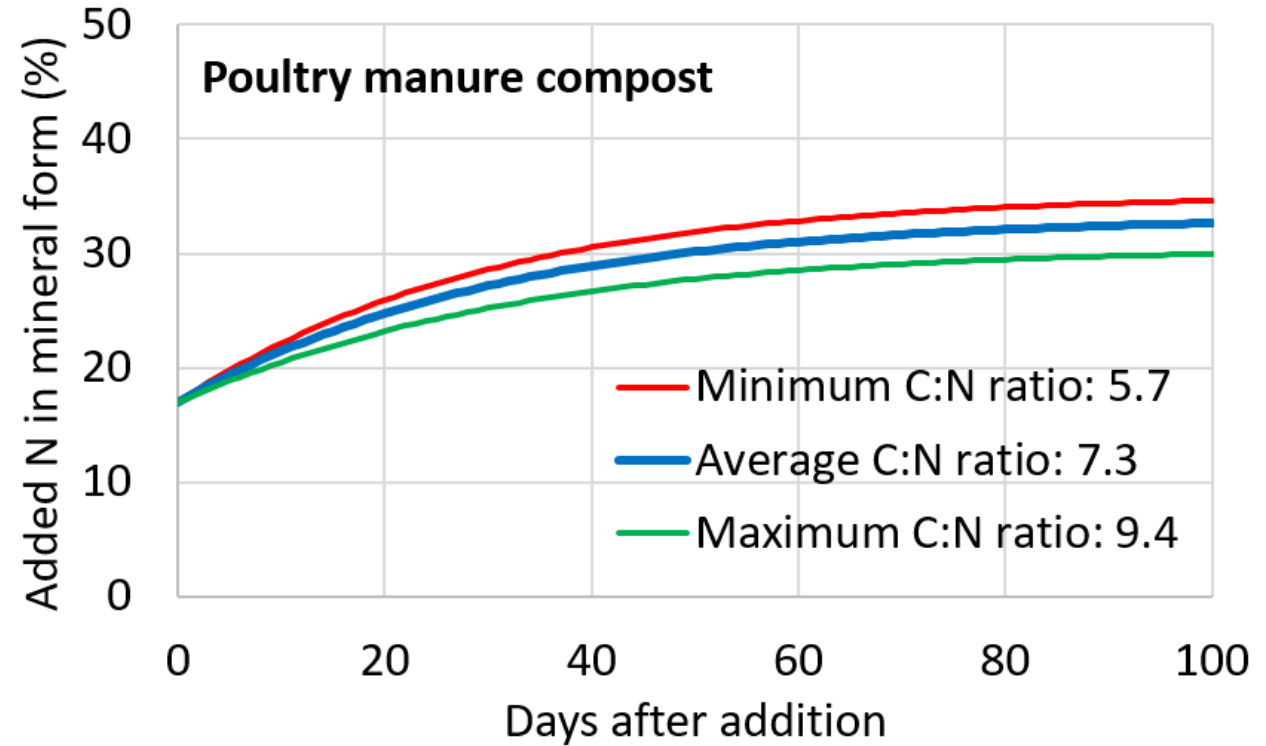
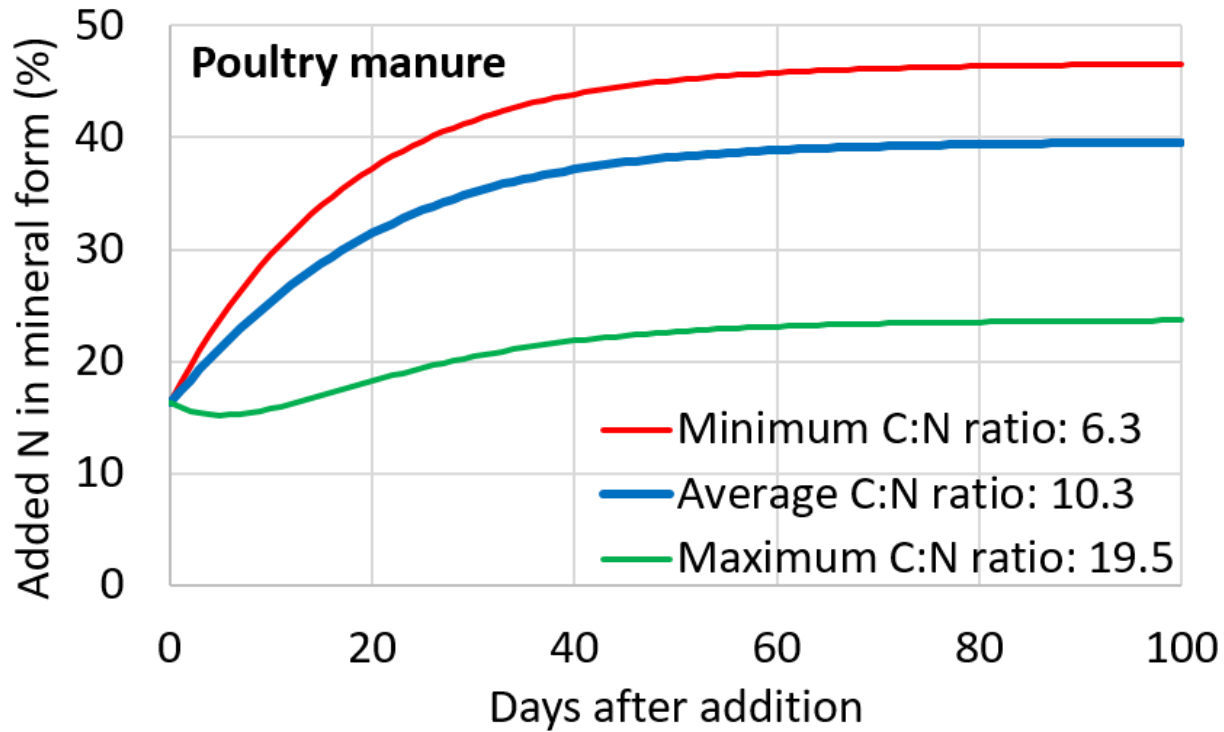


# Guano and feather meal



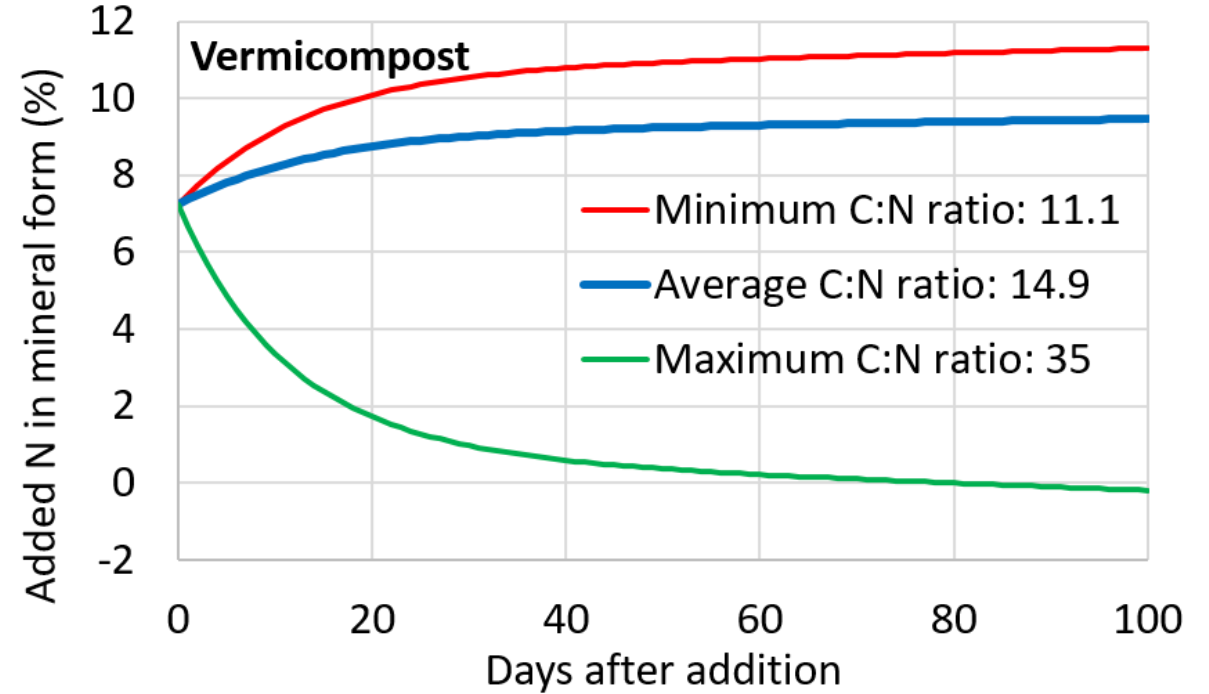
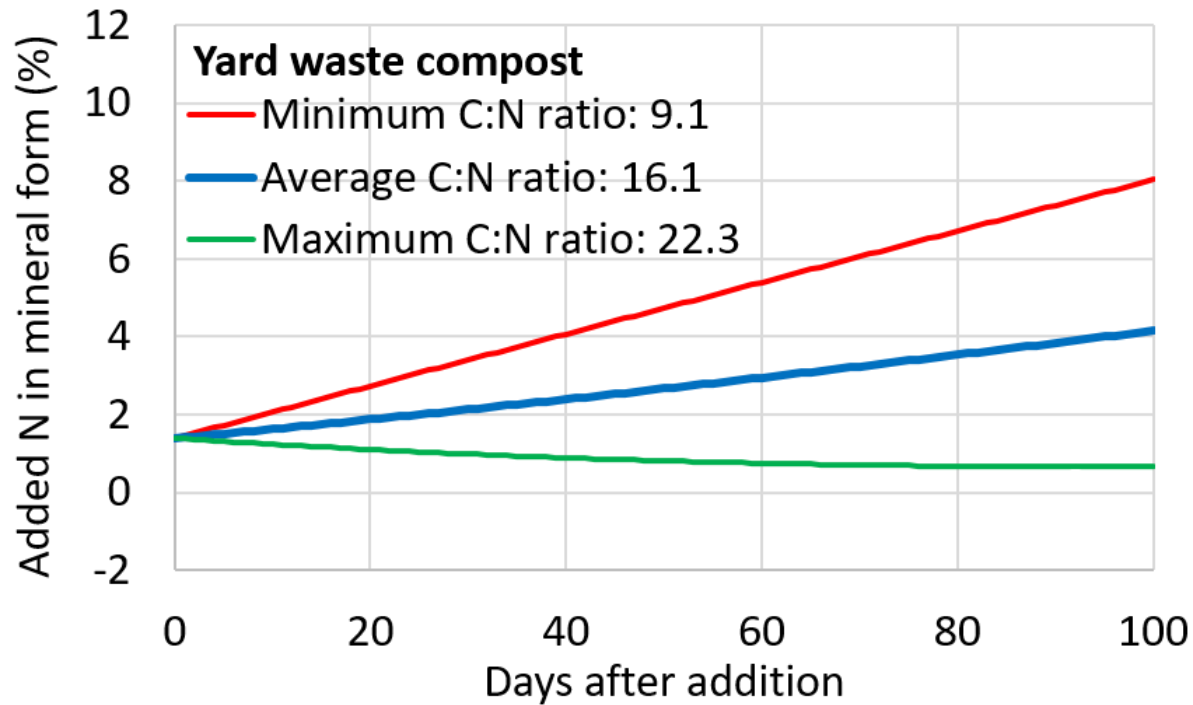
Geisseler et al., 2021

# Poultry manure and poultry manure compost



Geisseler et al., 2021

# Yard waste compost and vermicompost



Geisseler et al., 2021

# The online tool

[http://geisseler.ucdavis.edu/Amendment\\_Calculator.html](http://geisseler.ucdavis.edu/Amendment_Calculator.html)



Geisseler Lab

## 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.

To be  
integrated with  
CropManage!

# Factors affecting decomposition and N mineralization

- ✓ Soil temperature
- ✗ Soil moisture ⇒ Assumes moist soil
- ✓ Quality of organic source
  - Nitrogen content
  - C to N ratio
  - Availability of C and N
- ✗ Management ⇒ Assumes incorporation

# The online tool Input

## Amendment Application

Region\*:

Type of amendment\*:

Application rate\*:  tons/ac

Application date\*:

Period of interest:

Depth of incorporation\*:  inches

\* Required input.

## 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**

# The online tool Input

## Amendment Application

Region\*:

Type of amendment\*:

Application rate\*:  tons/ac

Application date\*:

Period of interest:

Depth of incorporation\*:

\* Required input.

## Amendment Properties

Amendment dry matter:  %

Total nitrogen:

Carbon to nitrogen ratio:

Mineral nitrogen:  
(ammonium and nitrate)

## Soil Properties

Soil organic matter:  %

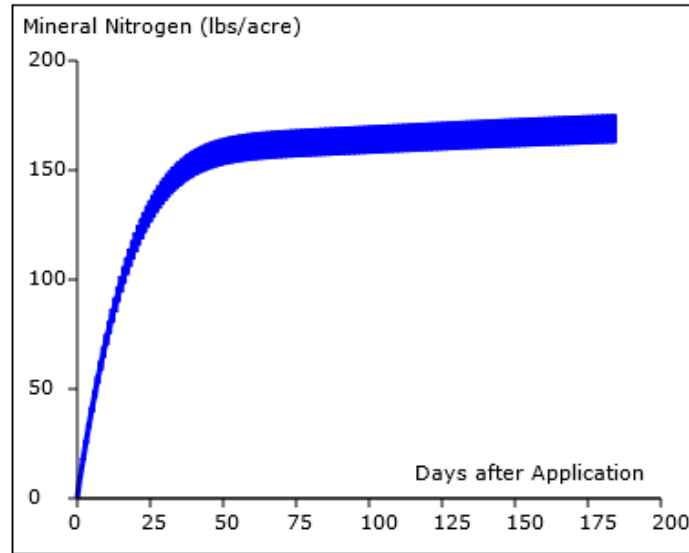
Residual soil nitrate:

**Display Results/Changes**

# The online tool

Output: Feather meal, Sacramento Valley

## Nitrogen Mineralization



The graph and the calculations are based on average values from scientific studies. Weather conditions, soil properties, amendment characteristics and management all can affect N mineralization rates. It is therefore **important to monitor N availability of the field with soil or leaf analyses**. More information about soil and leaf sampling can be found [here](#).

Total N applied:	<input type="text" value="276 lb/ac"/>
Total mineral N applied:	<input type="text" value="1.3 lb/ac"/>
Estimated available N:	<input type="text" value="162 - 176 lb/ac"/>
Percent available:	<input type="text" value="59 - 64 %"/>



# The online tool

## Output: Poultry manure, Sacramento Valley

### Amendment Application

Region\*:

Type of amendment\*:

Application rate\*:  tons/ac

Application date\*:

Period of interest:

Depth of incorporation\*:  inches

\* Required input.

### Amendment Application

Region\*:

Type of amendment\*:

Application rate\*:  tons/ac

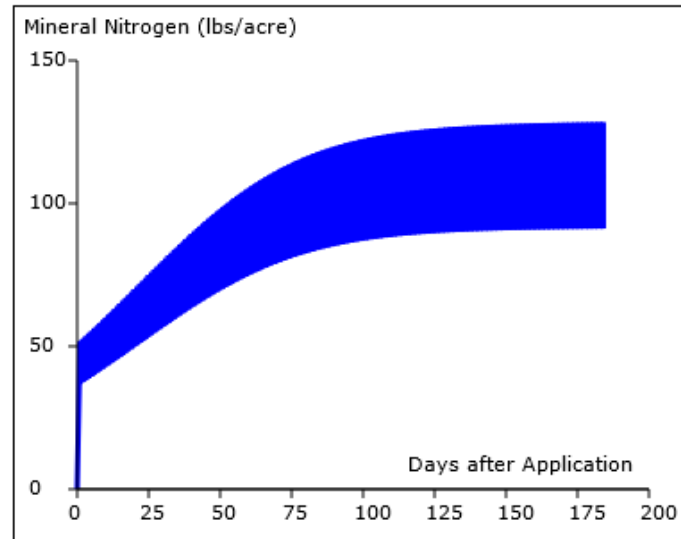
Application date\*:

Period of interest:

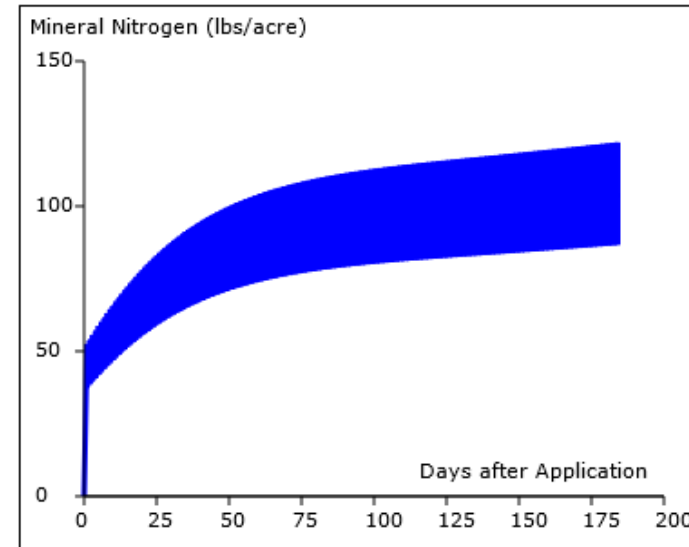
Depth of incorporation\*:  inches

\* Required input.

### Nitrogen Mineralization



### Nitrogen Mineralization



# The online tool

## Output: Poultry manure compost, Tulelake Basin

### Amendment Application

Region\*: Tulelake Basin

Type of amendment\*: Poultry Manure Compost

Application rate\*: 5 tons/ac

Application date\*: 04 / 01 / 2021

Period of interest: 6 Months

Depth of incorporation\*: 8 inches

\* Required input.

### Amendment Application

Region\*: Tulelake Basin

Type of amendment\*: Poultry Manure Compost

Application rate\*: 5 tons/ac

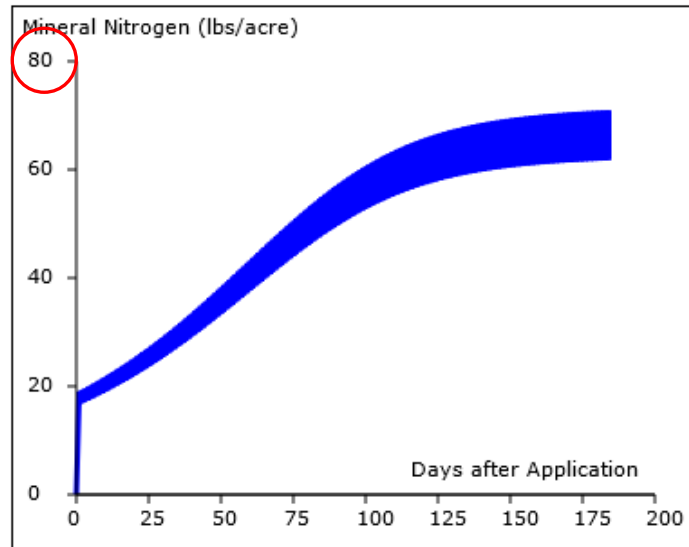
Application date\*: 10 / 01 / 2021

Period of interest: 6 Months

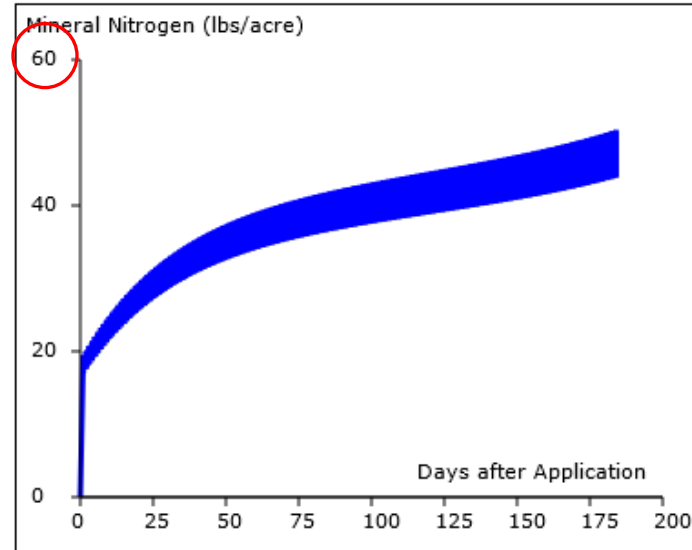
Depth of incorporation\*: 8 inches

\* Required input.

### Nitrogen Mineralization

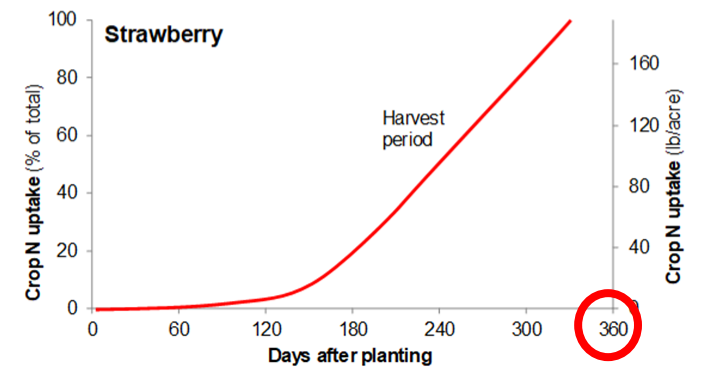
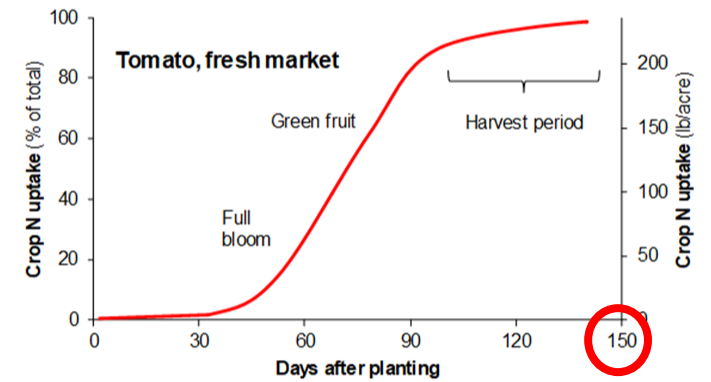
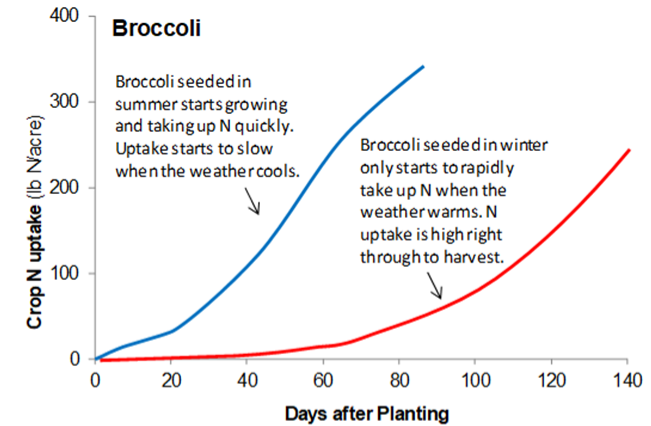


### Nitrogen Mineralization



# Next Steps

- What is N release pattern of cover crops?
- How can we synchronize (= match) N supply from multiple organic fertilizers with the crop N demand?



# Resources

- Estimating Nitrogen Availability in Organic Annual Production: For Nitrogen Budgeting and Other Purposes. UCANR publication 8712, <https://anrcatalog.ucanr.edu/Details.aspx?itemNo=8712>
- Practical Training on Nitrogen Planning and Management in Organic Production of Annual Crops  
Tuesdays, 11/28, 12/5, 12/12/2023 (tentative)  
Email [joji@ucsc.edu](mailto:joji@ucsc.edu), or [mglloyd@ucanr.edu](mailto:mglloyd@ucanr.edu) to receive an updated announcement

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# Question?

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