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Agriculture and Natural Resources

Nitrogen Mineralization from Organic Fertilizers and Composts

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Irrigation and Nutrient Management Meeting

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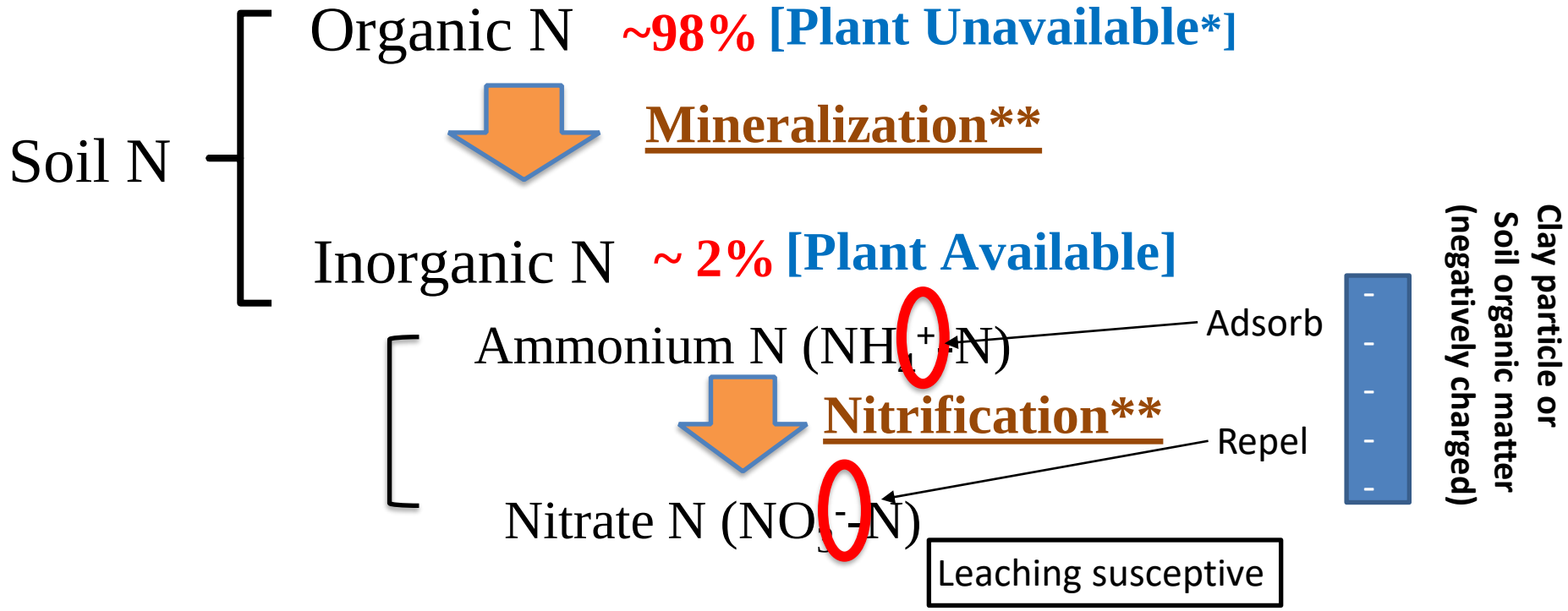
Outline

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, susceptive to diseases*

N Forms in Soil and Plant Availability



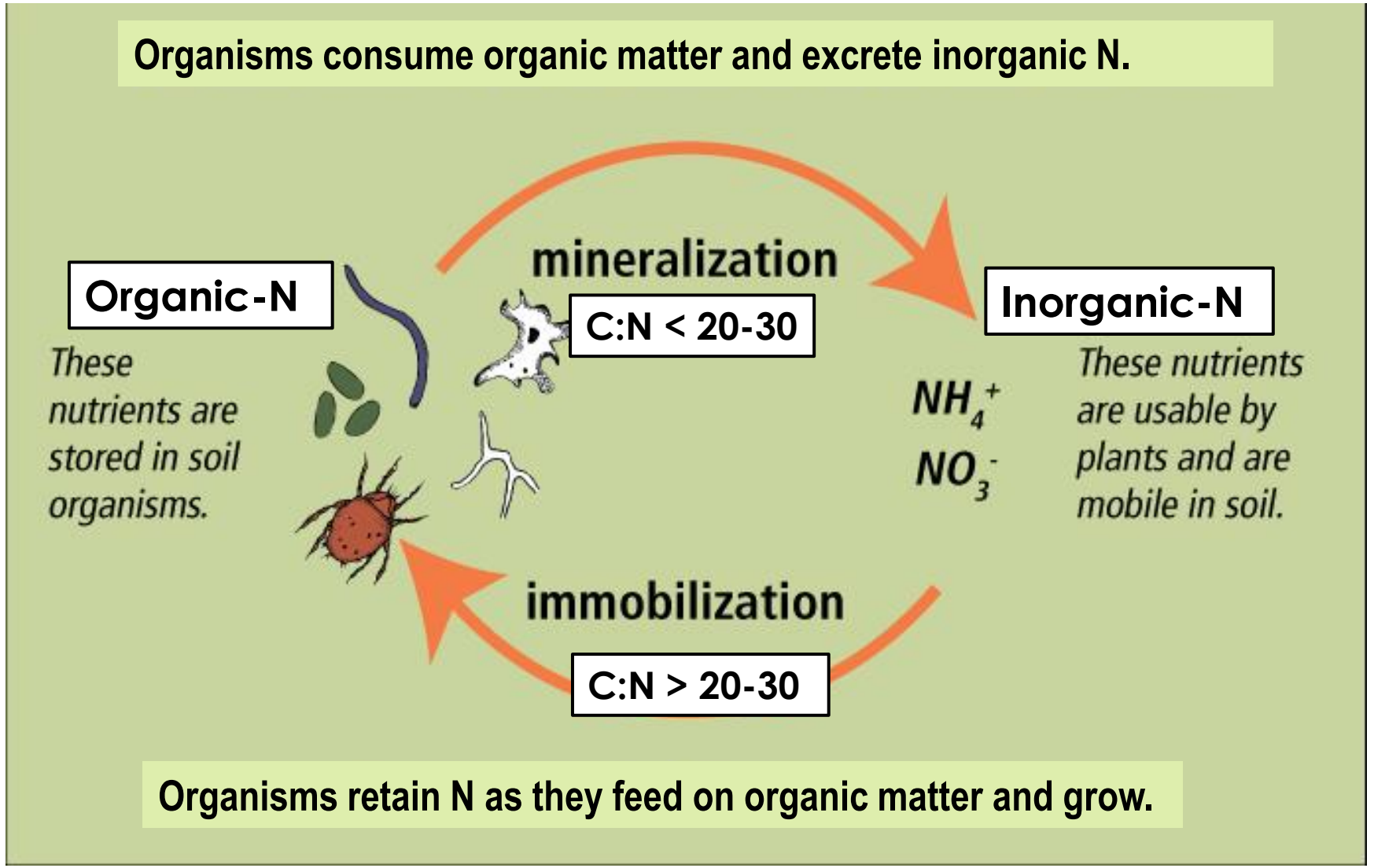
* Plants can absorb small amounts of organic N and some crop plants can do more than others

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

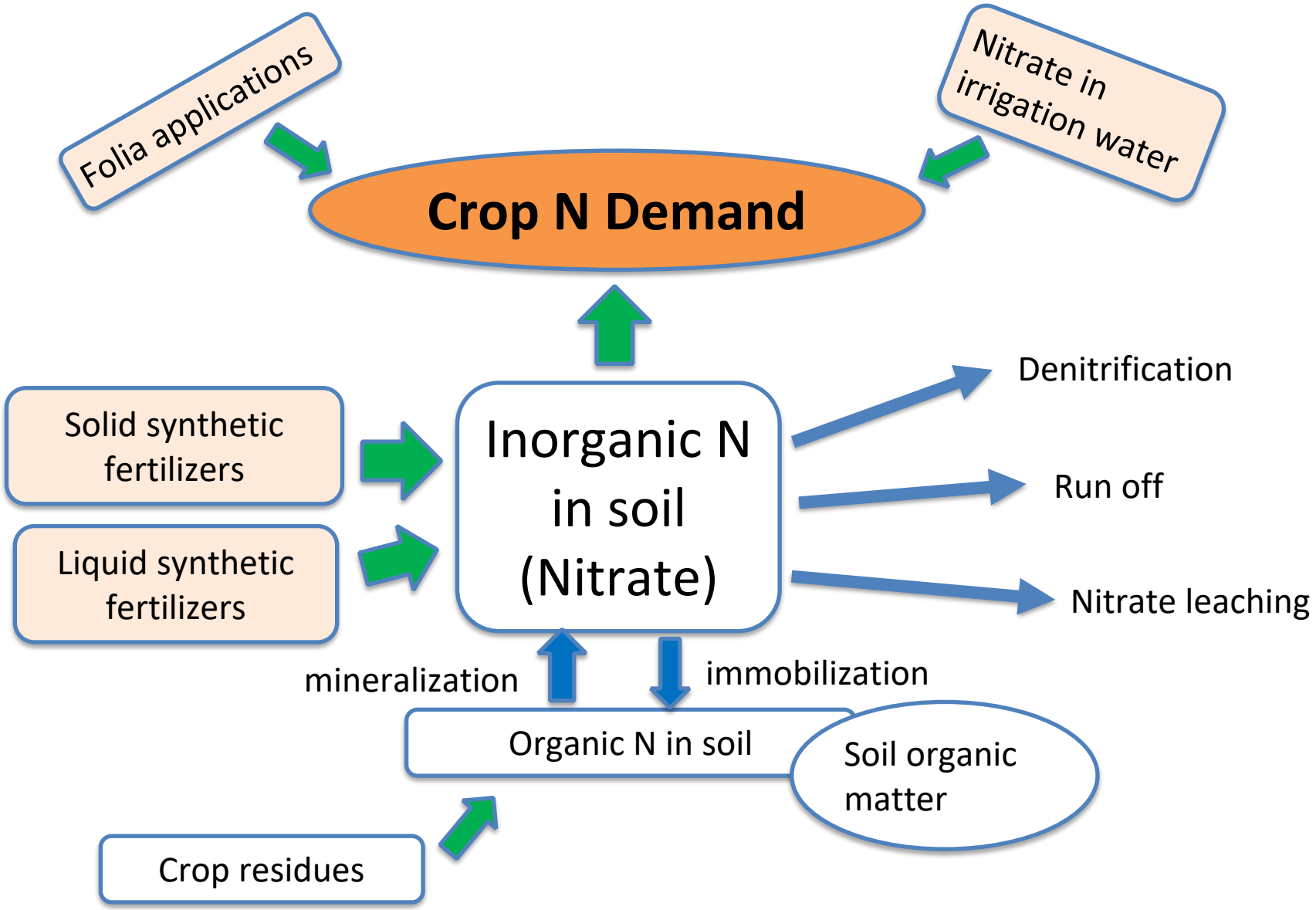
Nitrogen mineralization & immobilization

- 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 NH_4^+ into soil solution
- **N immobilization:** Uptake of NO_3^- or NH_4^+ from soil solution and incorporation into microbial tissue

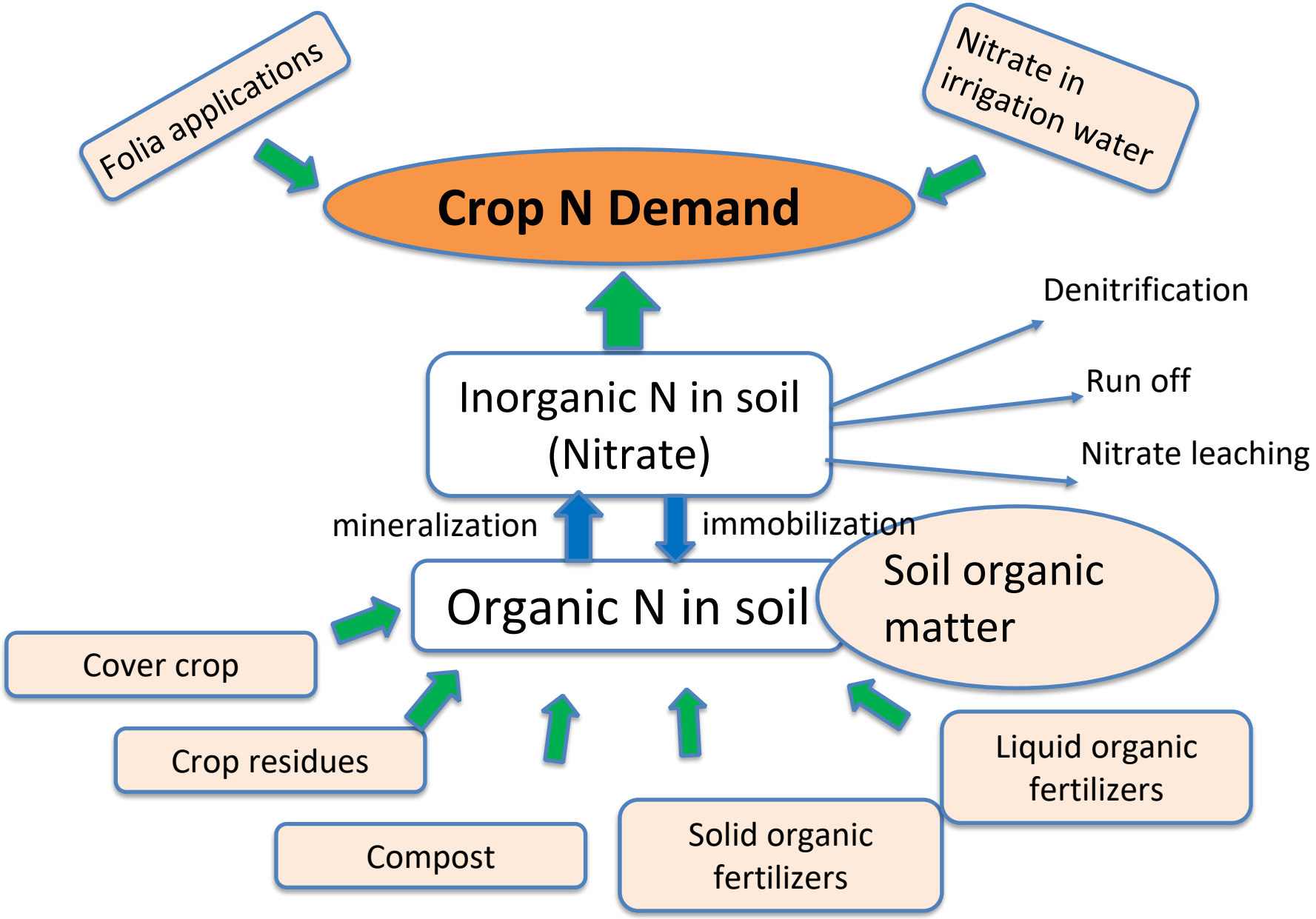
N mineralization vs. N immobilization



(Adopted from USDA-NRCS, 2017)



N dynamics in conventional systems



N dynamics in organic systems

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

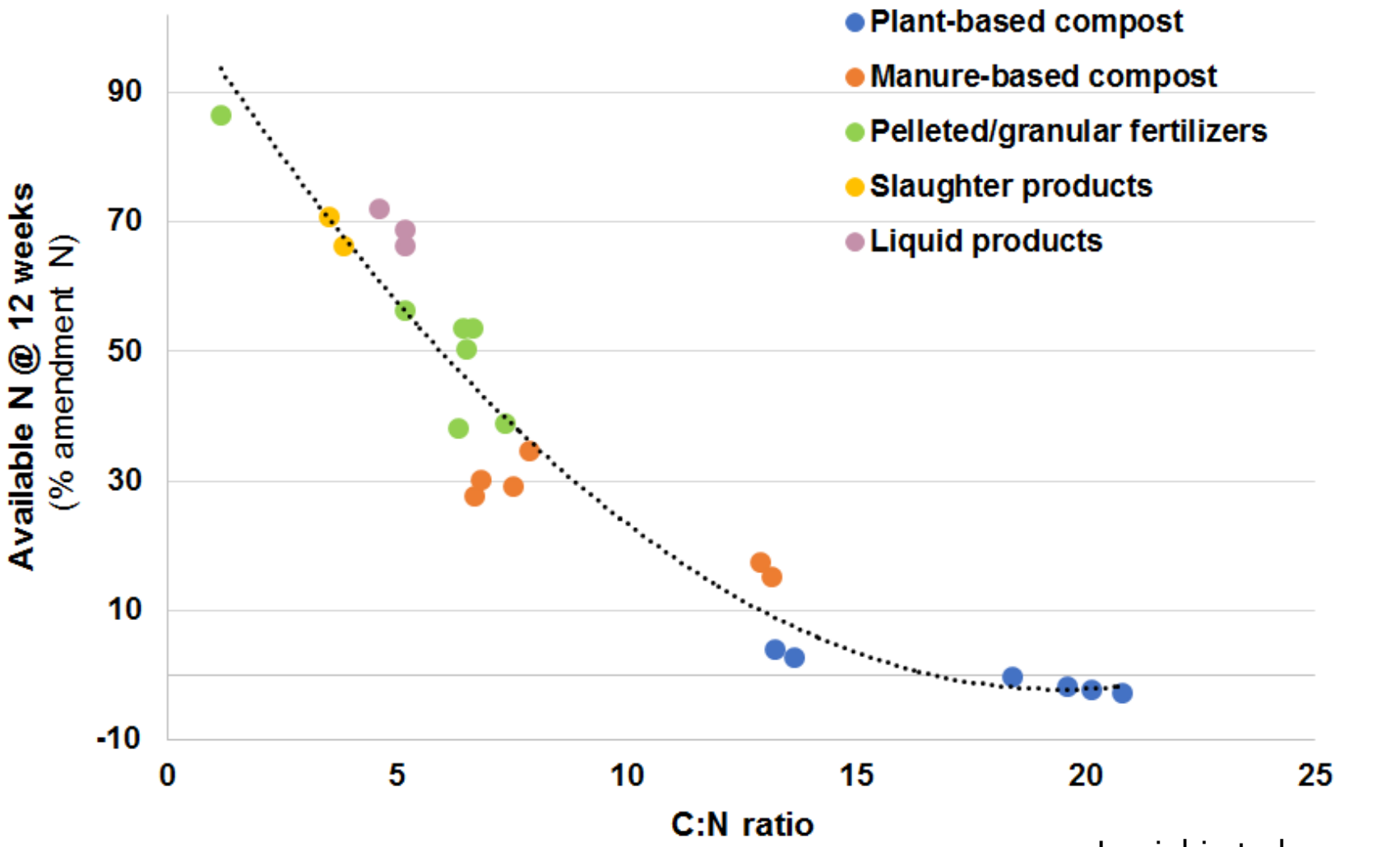
Amendment incubation

Overview of amendments tested

Material	Typical N content (%)	Typical C:N ratio	N available after 12 weeks
Municipal yard trimmings composts	0.5 - 2.0	13 - 20	-3 - 4%
Poultry manure composts	2.0 - 5.0	6 - 8	30 - 35%
Granular fertilizers	2.0 - 7.0	5 - 7	38 - 60%
Blood & feather meals	13 - 15	3 - 4	65 - 70 %
Liquid fertilizers	2.0 - 4.0	4 - 6	50 - 100%
Guano	12 - 13	3 - 4	80 - 90%

Lazicki et al., 2020

Effect of C to N ratio on N release



Lazicki et al., 2020

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

Open questions

- Can we describe N mineralization over time with equations that can be used in decision support tools (e.g. CropManage)?
- How variable are different groups of amendments?

⇨ Need a bigger dataset

Our approach

- Compiled data from the literature
- Used model to simulate net N mineralization at 77 °F and optimal moisture

Why use a model?

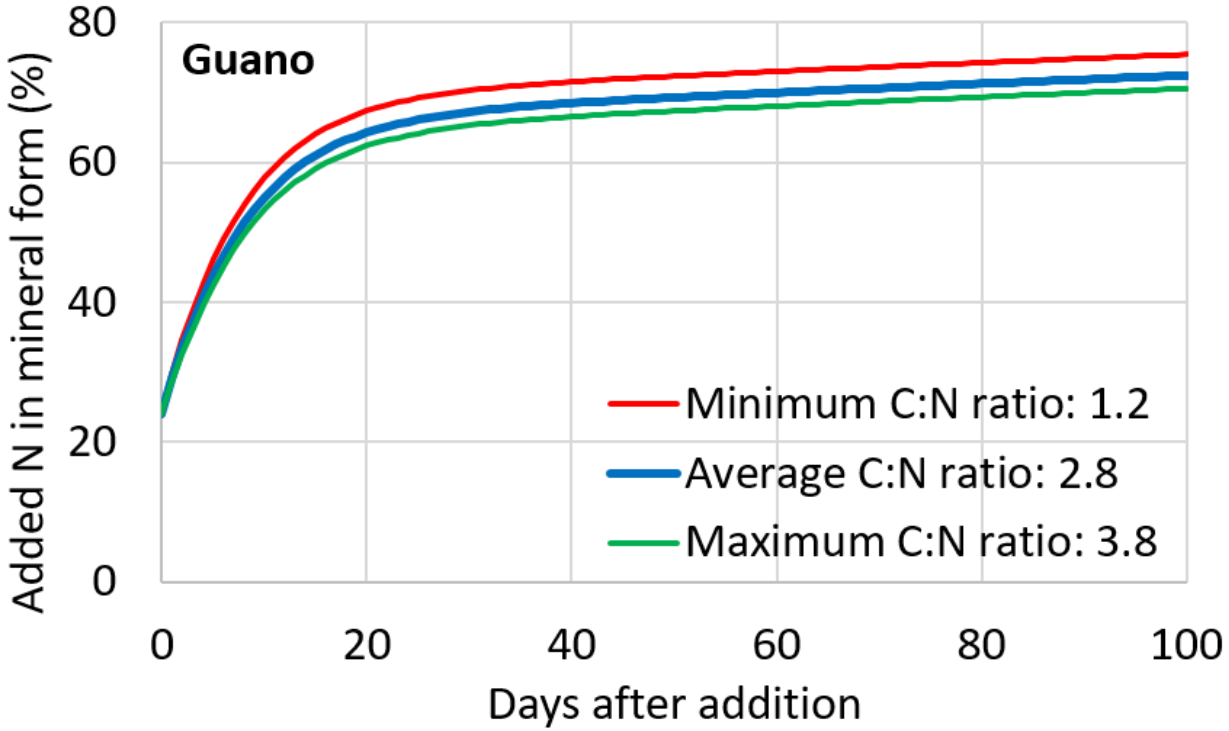
- Studies differed with respect to
  - Temperature
  - Duration

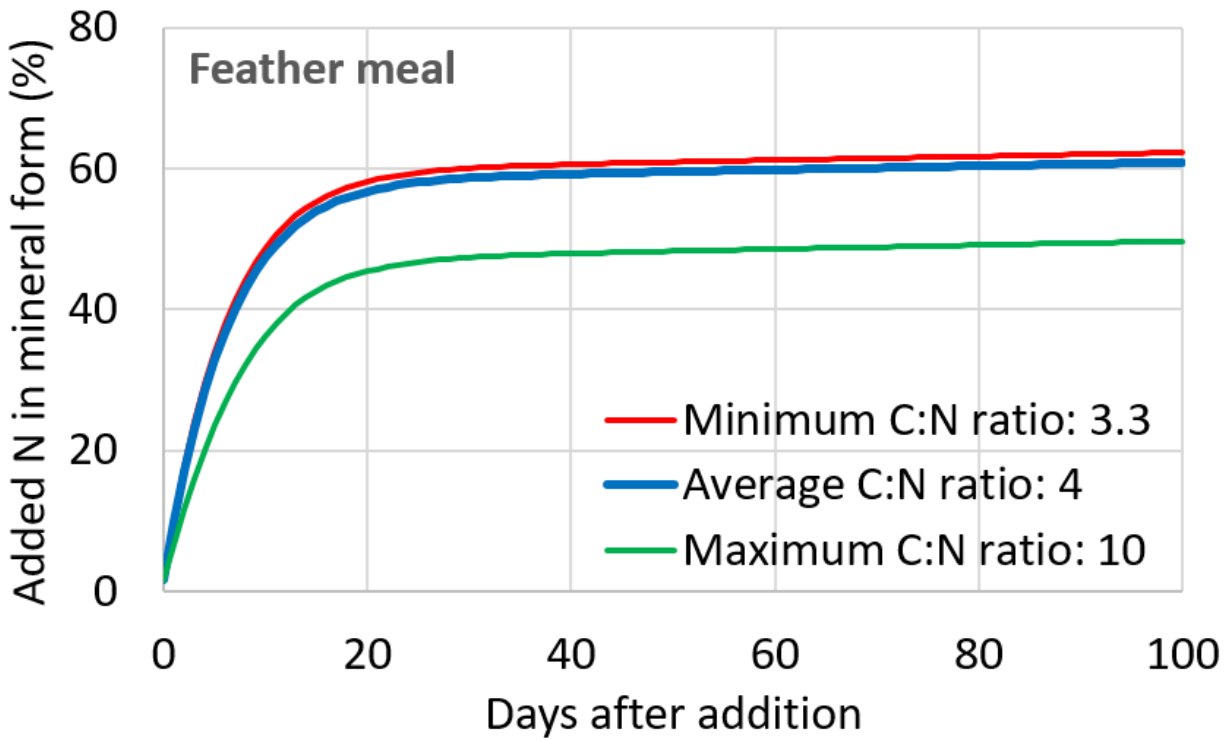
The dataset

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

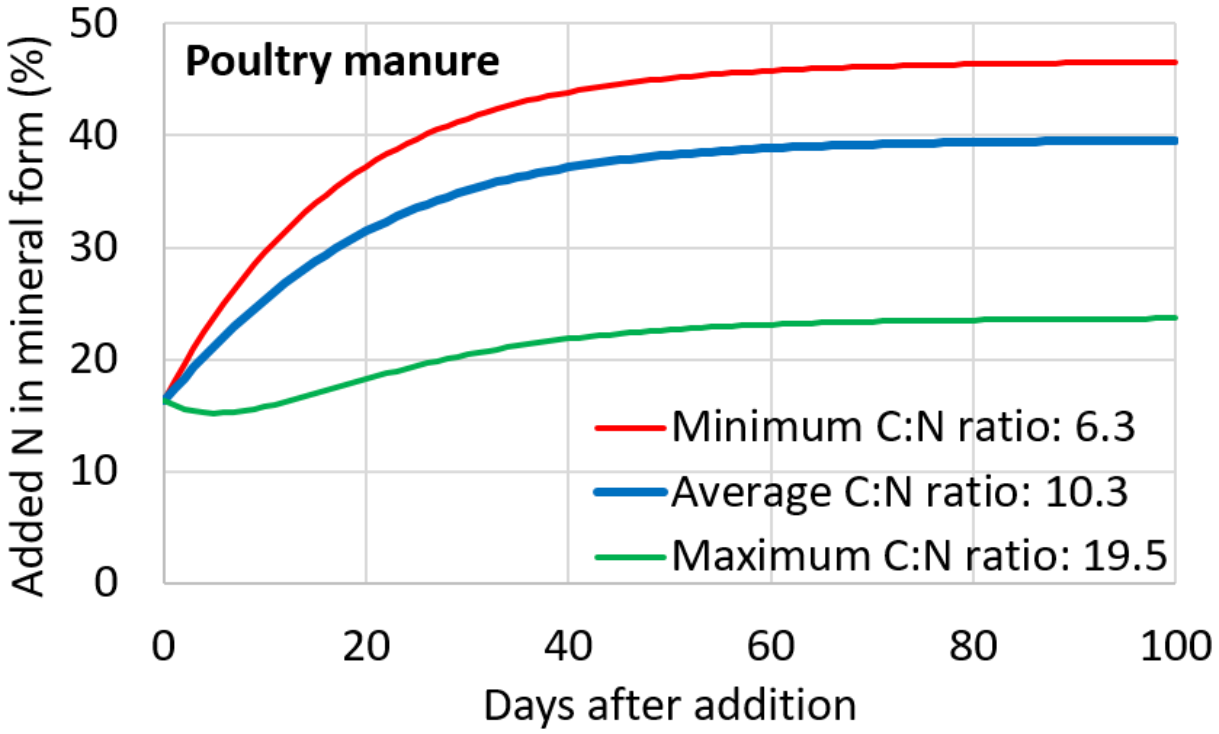
Guano and feather meal

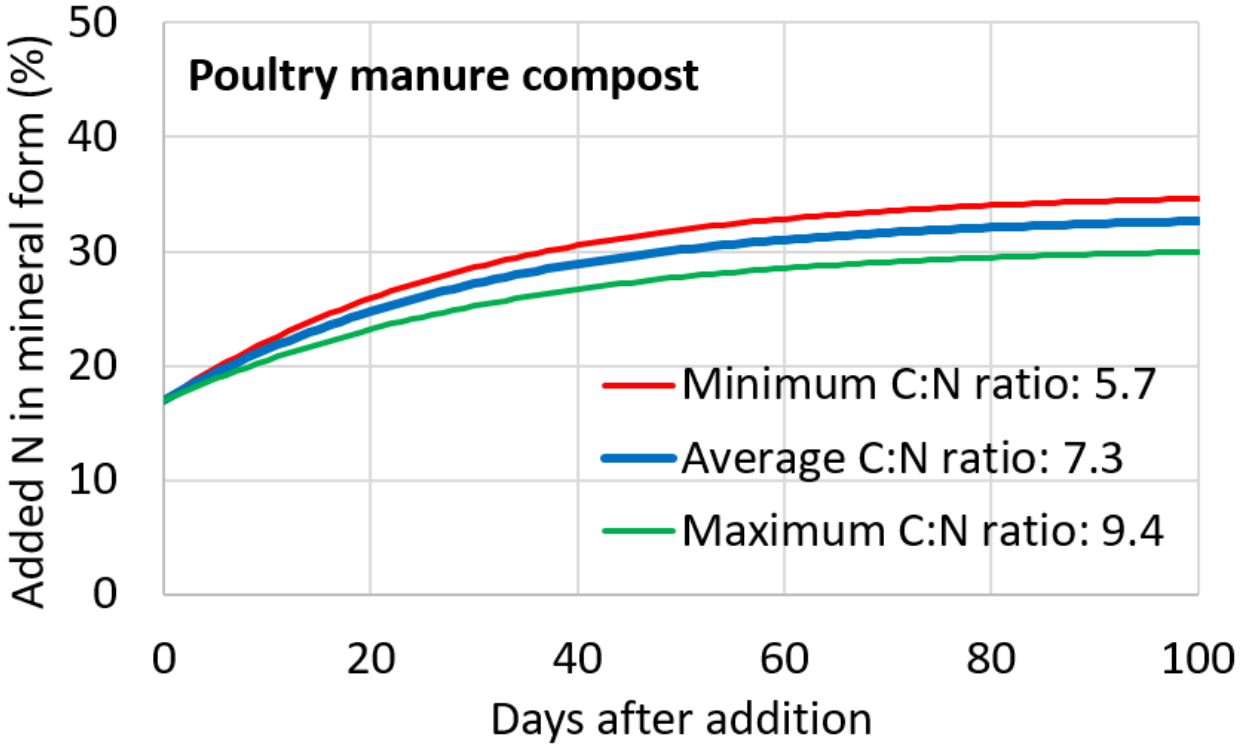




Geisseler et al., 2021

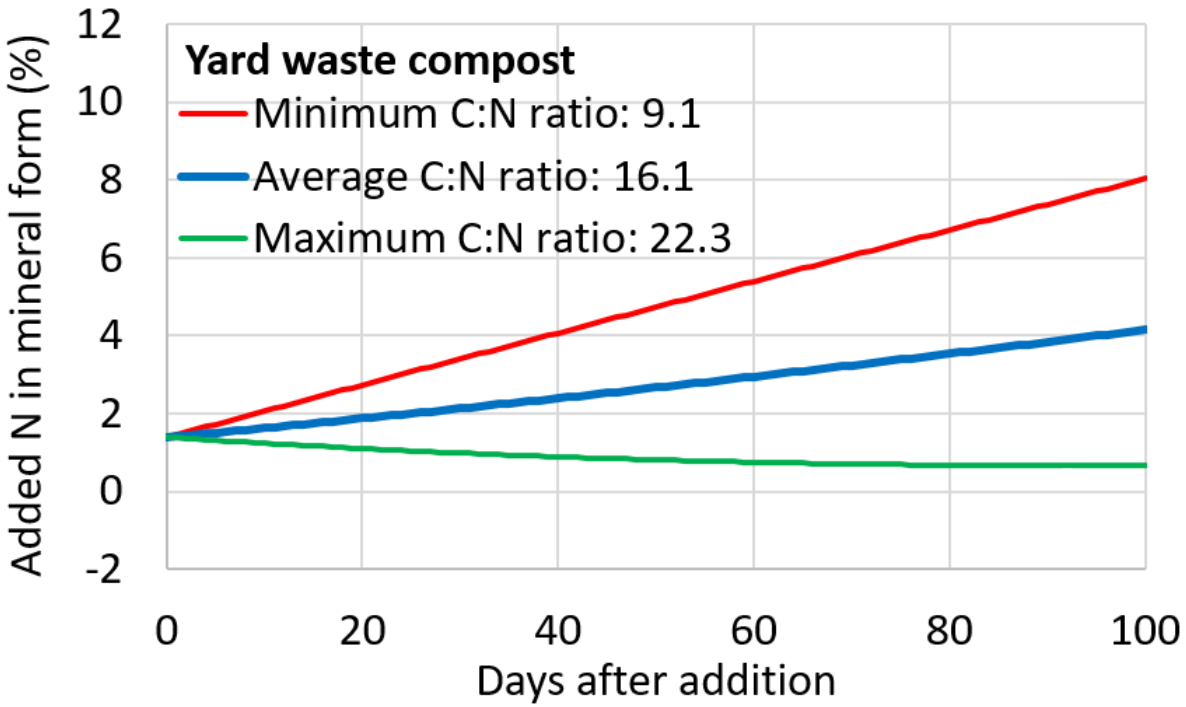
Poultry manure and poultry manure compost

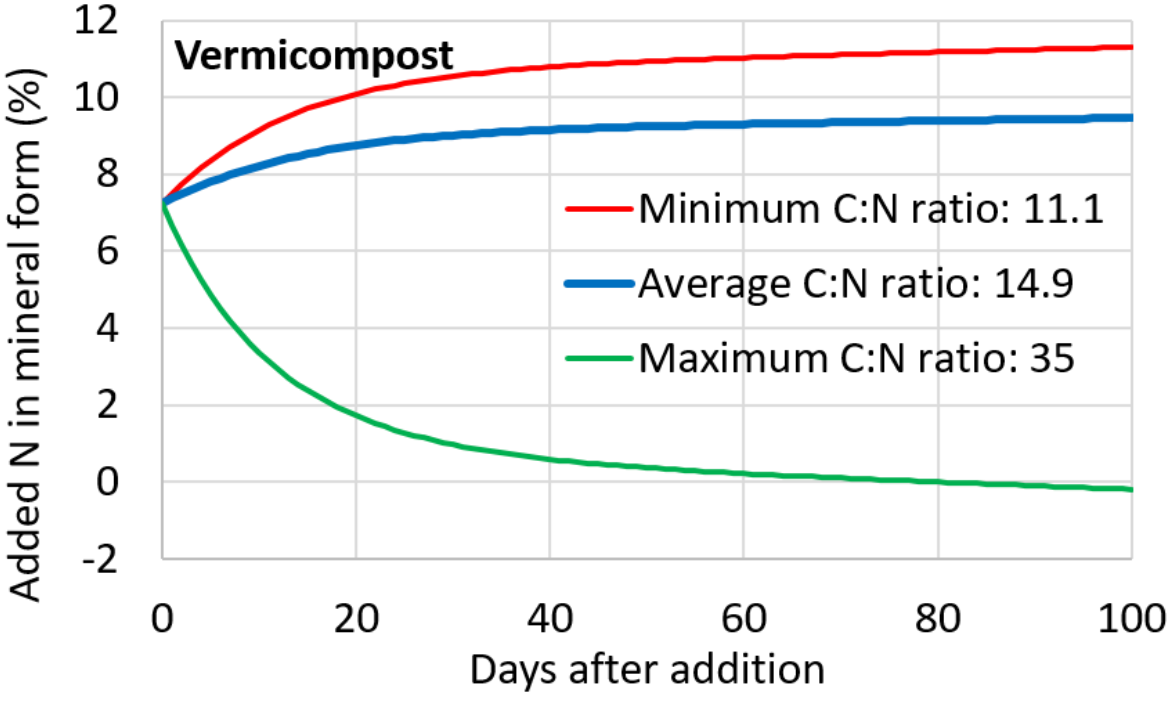




Geisseler et al., 2021

Yard waste compost and vermicompost





Geisseler et al., 2021

Net N mineralization rates

After 100 days, at 77 °F, optimal moisture

Material	Net N mineralization (% of N added)		
	Average	Min	Max
Guano	72.5	70.6	75.5
Feather meal	60.9	49.7	62.2
Poultry manure	39.6	23.7	46.6
Poultry manure compost	32.7	30.0	34.6
Vermicompost	9.5	-0.2	11.3
Yard waste compost	4.2	0.7	8.0

Geisseler et al., 2021

The online tool

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

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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*: 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.

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*: Sacramento Valley - Yolo

Type of amendment*: Feather meal

Application rate*: 1 tons/ac

Application date*: 04 / 01 / 2021

Period of interest: 6 Months

Depth of incorporation*: 8 inches

* Required input.

Amendment Properties

Amendment dry matter: 95 %

Total nitrogen: 14.5 % in dry matter

Carbon to nitrogen ratio: 4

Mineral nitrogen: (ammonium and nitrate) 0.06 % in dry matter

Soil Properties

Soil organic matter: 3 %

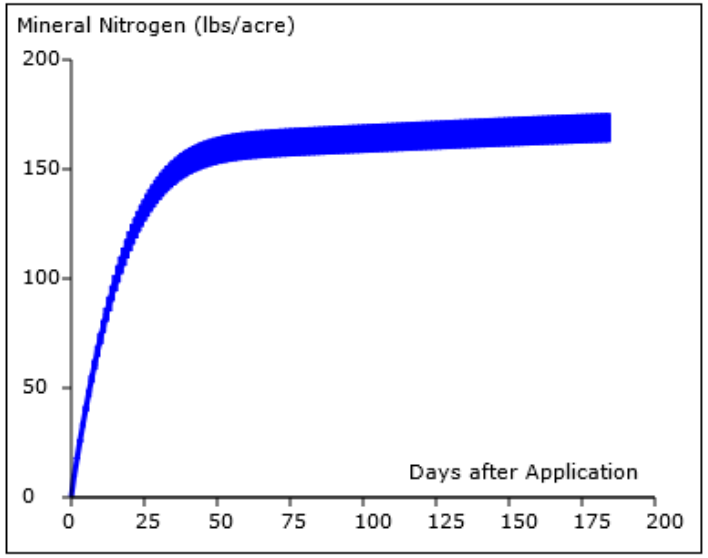
Residual soil nitrate: 10 ppm Nitrate-N

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:	276 lb/ac
Total mineral N applied:	1.3 lb/ac
Estimated available N:	162 - 176 lb/ac
Percent available:	59 - 64 %

The online tool

Output: Poultry manure, Sacramento Valley

Amendment Application

Region*: Sacramento Valley - Yolo

Type of amendment*: Poultry Manure

Application rate*: 5 tons/ac

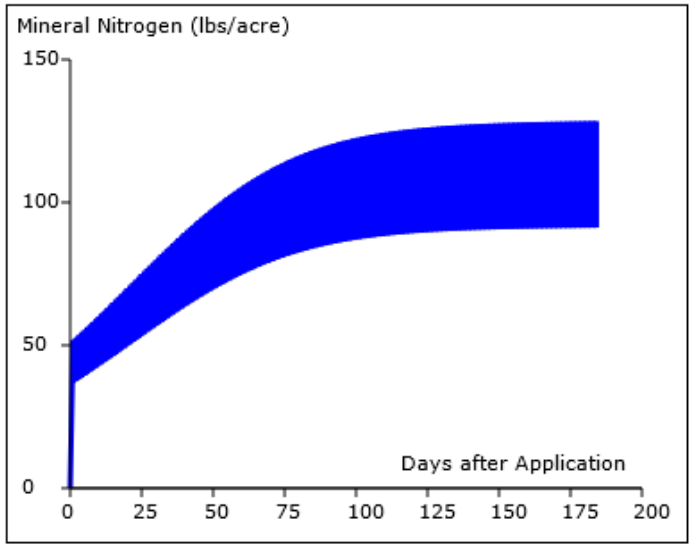
Application date*: 04 / 01 / 2021

Period of interest: 6 Months

Depth of incorporation*: 8 inches

* Required input.

Nitrogen Mineralization



Amendment Application

Region*: Sacramento Valley - Yolo

Type of amendment*: Poultry Manure

Application rate*: 5 tons/ac

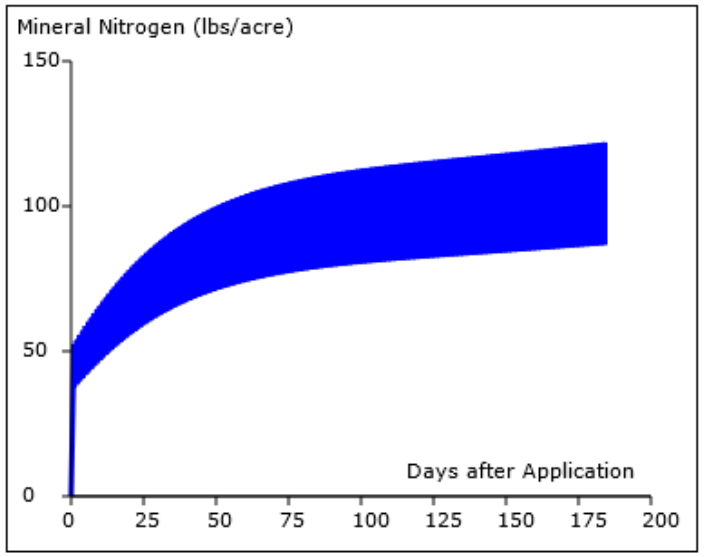
Application date*: 10 / 01 / 2021

Period of interest: 6 Months

Depth of incorporation*: 8 inches

* Required input.

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

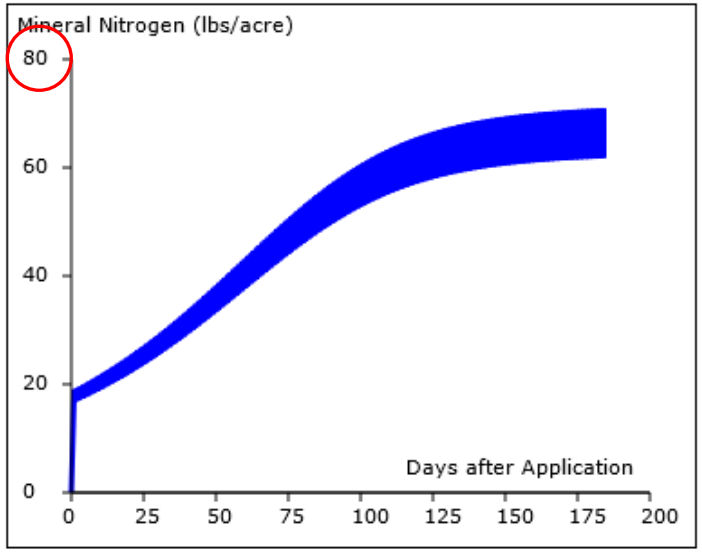
Application date*: 04 / 01 / 2021

Period of interest: 6 Months

Depth of incorporation*: 8 inches

* Required input.

Nitrogen Mineralization



Amendment Application

Region*: Tulelake Basin

Type of amendment*: Poultry Manure Compost

Application rate*: 5 tons/ac

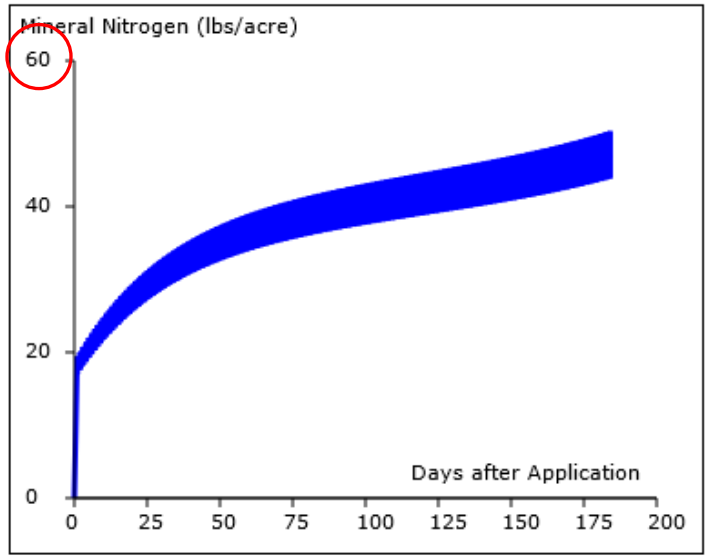
Application date*: 10 / 01 / 2021

Period of interest: 6 Months

Depth of incorporation*: 8 inches

* Required input.

Nitrogen Mineralization



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Question?

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