Organic Agriculture in California and Nitrogen Management in Organic Systems

UCCE Organic Agriculture Workshop, San Diego

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UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources

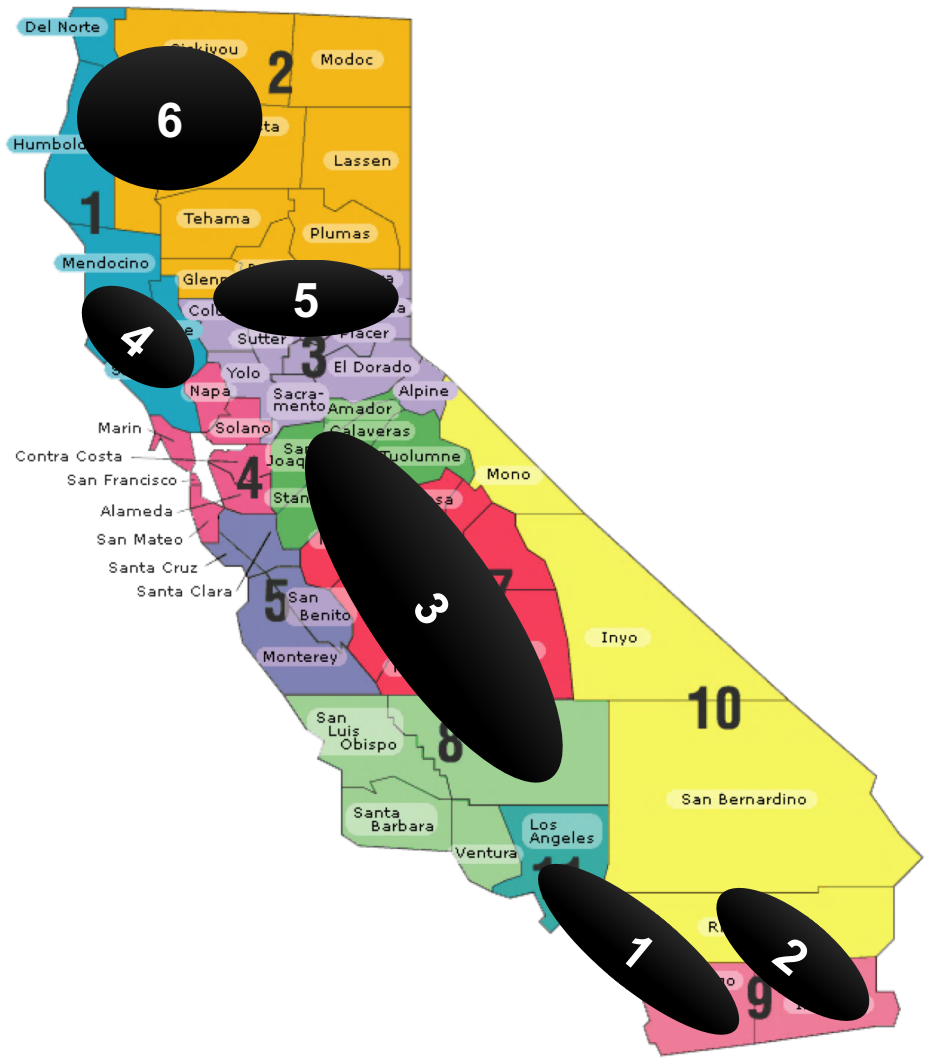
❖ *Focus on carrying out a collaborative, multifaceted **research and outreach program** with the goal of **addressing challenges facing organic agricultural production systems of California**, including pest and pathogen control, fertility management, weed control and efficient water use.*

UC SANTA CRUZ
Center for Agroecology

❖Learning about CA organic farms and their needs and connecting them with available resources to make their operations more sustainable

ORGANIC FARMING RESEARCH FOUNDATION

Visiting the Top 20 Organic Counties in California



#	Month/Year	County
1	Dec 2022	Los Angeles (93)*, San Diego (635)
2	March-April 2023	Imperial (75), Riverside (342)
3	May-June 2023	Kern (100), Tulare (153), Madera (100), Kings (50), Fresno (296), Stanislaus (58), San Joaquin (71)
4	Aug-Sep 2023	Mendocino (198), Lake (159), Napa (165)
5	Feb-May 2024	Butte (123), Glenn (56), Solano (57), Sutter (58), Nevada (65)
6	June-Sep 2024	Humboldt (189), Siskiyou (83), Shasta (59)

* ( ) = Number of organic farms in 2020 (CDFA, 2021).

Funded by CDFA State Organic Program

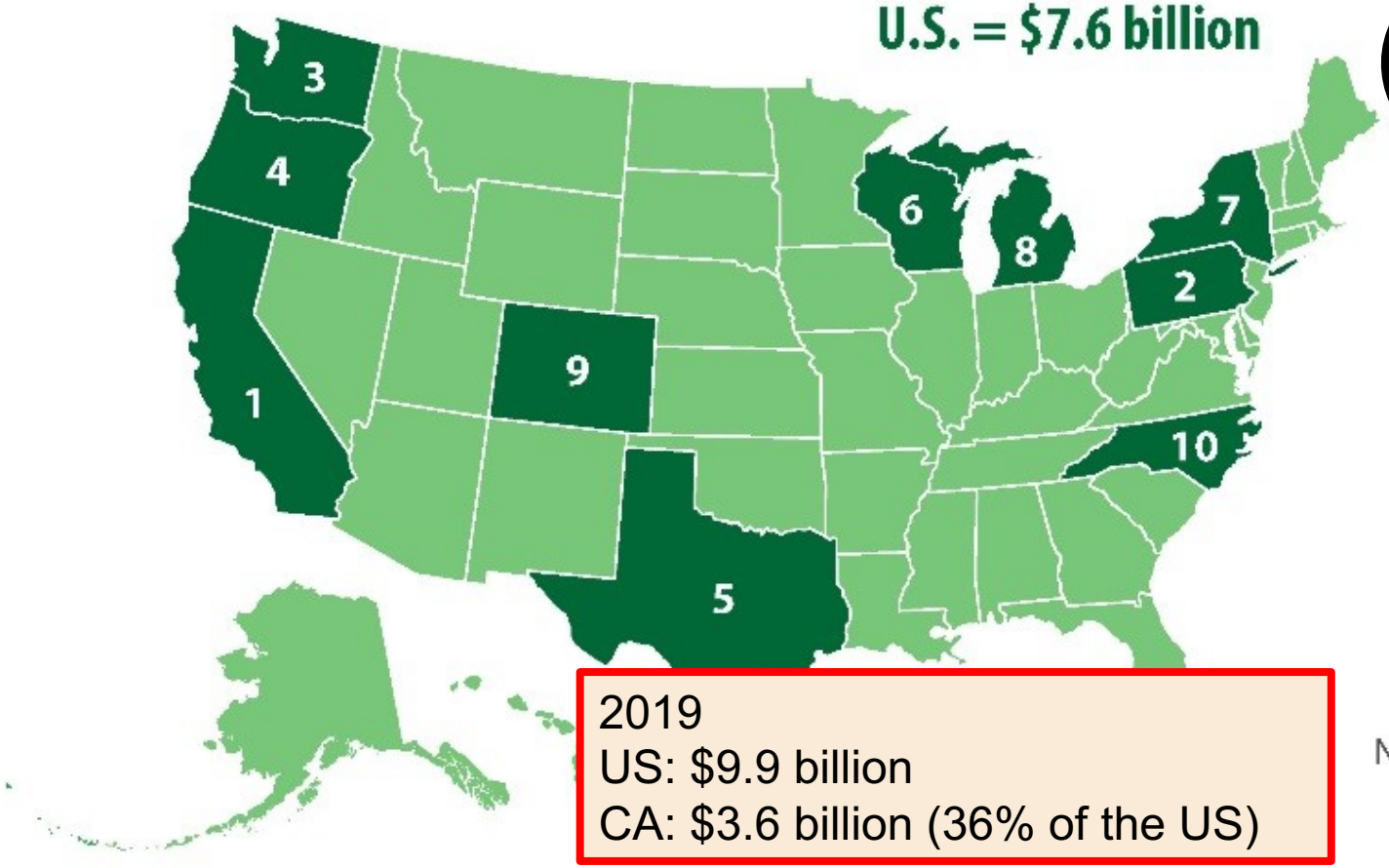
Organic Systems Researchers

(Feb. 2021.v2)

Rob Wilson – Intermountain Research and Extension Center Director, Modoc, Siskiyou (potatoes, onions, small grains, alfalfa)
Charlie Brummer – UCD Plant Breeding Center Director, Siskiyou, Yolo, Statewide (breeding of forages, alfalfa, spinach, SCOPE)
Sarah Light – UCCE Agronomy Advisor, Sutter, Yuba, Colusa (agronomy, annual crops)
Margaret Lloyd – UCCE Small Farm Advisor, Yolo, Solano, Sacramento (fresh market vegetables, berries)
Allison Krill-Brown – UCD Assoc. Specialist, Sacramento Valley (breeding of wheat, barley, spinach)
Saarah Kuzay – UCD Student Wheat Breeder, Northern CA (breeding of small grains)
Cameron Pittelkow– UCD Assist. Professor, Yolo (establishing an organic research field at UCD)
Amelie Gaudin – UCD Assoc. Professor, Yolo, Statewide (almonds, vineyards, tomatoes)
Rachel Vannette – UCD Assis. Professor, Yolo, Solano (soil health, biocontrol, pollination, tree fruits, orchard, tomatoes)
Cristina Lazcano – UCD Assis. Professor, Yolo, Statewide (soil biodiversity & health, wine grapes, corn, strawberries, tomatoes)
Allen Van Deynze – UCD Assoc. Director, Plant Breeding Center, Yolo, Monterey (breeding of peppers, spinach, tomatoes)
Katharina Ullmann – UCD Director, Student Farm, Yolo (breeding of peppers, tomatoes, dry beans, wheat, zinnias. Forb edge planting for pollinators)
Daniel Geisseler – UCD Assoc. Specialist, Central Valley (nutrient management, annual crops)
Neal M Williams – UCD Professor, Northern CA (pollination, bee diversity, bee habitats in working landscape)
Sonja Brodt – UC SAREP Academic Coordinator, Yolo, Statewide (farmer training, biologically integrated farming systems, elderberry)
Timothy Bowles – UCB Assist. Professor, Sacramento Valley, Central Coast (applied agroecology, vegetables)
Jennifer Sowerwine – UCB Specialist, East bay, Statewide (urban agroecology, food safety, food justice)
Houston Wilson –California Organic Institute Director, UCR Assist. Specialist, Central Valley, Statewide (entomology, orchards, vineyards)
Stacy Philpott – UCSC Professor, Santa Clara, Santa Cruz, Monterey (insects, birds, urban garden & farms)
Daniel Karp – UCD Assist. Professor, Central Coast (landscape agroecology, vegetables, berries)
Jeff Mitchell – UCD Specialist, Sacramento, San Joaquin, and Salinas Valleys (cropping systems, vegetables, cover crops)
Eric Brennan – USDA-ARS Research Horticulturalist, Central Coast (vegetables, strawberries)
Richard Smith – UCCE Vegetable, Weed Farm Advisor, Central Coast (cool season vegetables)
Joji Muramoto – UCSC Assist. Specialist, Central Coast, Statewide (agroecology, strawberry, vegetables)
Carol Shennan – UCSC Professor, Central Coast, Statewide (agroecology, strawberry, vegetables)
Mark Bolda – UCCE Berry Farm Advisor, Central Coast (strawberry, cane berries)
Peter Henry – USDA-ARS Research Plant Pathologist, Central-South Coast (strawberries)
Kathryn De Master – UCB Assoc. Professor, Central Coast (sociology in strawberry production)
Surendra Dara – UCCE Farm Advisor, Central Coast (entomology, biologicals, specialty crops)
Milton McGiffen – UCR Vegetable Specialist, CA from Fresno south (vegetables)
Ashraf Tubeileh – Cal Poly SLO, Assist. Professor, Central Coast (cropping systems)
Diego Nieto – Driscoll's. Entomologist, Statewide (biological control in berries)
Arianna Bozzolo – Rodale Institute Research Director, Ventura (horticulture)
Annemiek Schilder – UCCE Director, Ventura (Plant pathology, berries, vegetables)
Oleg Daugovish – UCCE Berry Vegetable Farm Advisor, Ventura (berries, vegetables)
Alda Pires – UCD Assoc. Specialist, Statewide (urban ag, food safety, animal health)
Catherine Brinkley – UCD Assoc. Professor, Statewide (organic marketing, land preservation)
Damian Parr – UCSC Lecturer, Statewide (sust. ag. education & research)
Jan Perez – UCSC Food System Specialist, Statewide (sust. ag. evaluation & research)
Jenny Broome – Driscoll's, Senior Research Manager (integrated organic berry disease management)
Reza Ehsani – UC Merced, Professor (mechanization, automation, and engineering systems for fruits and veges)
Tom Tomich – UCD Professor, Statewide (sustainability science and policy)

Top 10 States in Organic Sales, 2016

Accounting for 77% of total U.S. certified organic sales



38% of the US

	$ million
California	$2,889
Pennsylvania	$660
Washington	$636
Oregon	$351
Texas	$297
Wisconsin	$255
New York	$216
Michigan	$201
Colorado	$181
North Carolina	$145

2019
US: $9.9 billion
CA: $3.6 billion (36% of the US)

Source: USDA NASS 2016 Certified Organic Survey

USDA

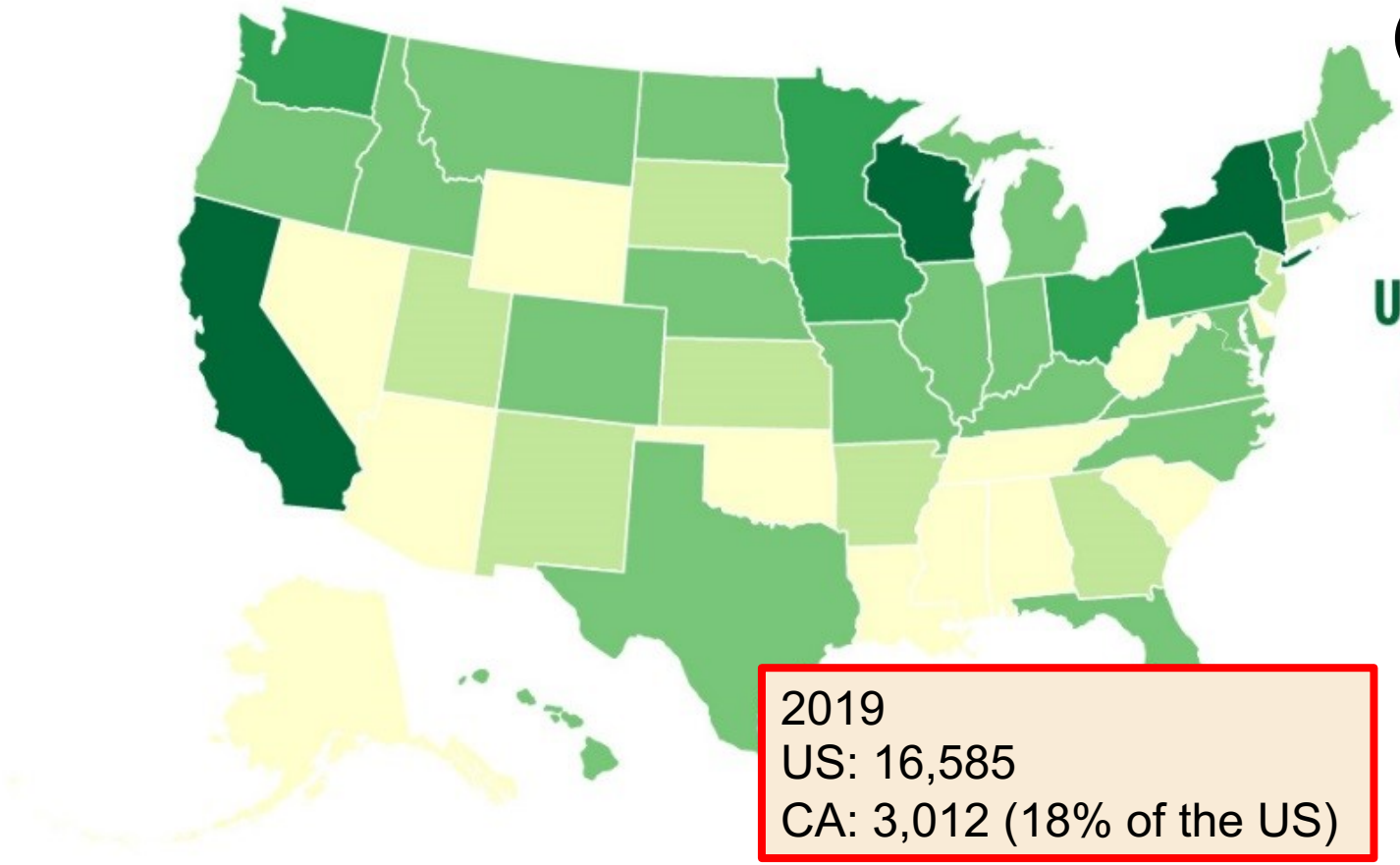
United States Department of Agriculture
National Agricultural Statistics Service

Find out more at **www.nass.usda.gov**

Number of Certified Organic Farms by State, 2016

California continues to lead in certified farms with more than 2,700, up 3% from 2015

19% of the US



U.S. = 14,217

up 11%

< 50
50–99
100–499
500–999
1,000 +

2019
US: 16,585
CA: 3,012 (18% of the US)

Source: USDA NASS 2016 Certified Organic Survey

USDA

United States Department of Agriculture
National Agricultural Statistics Service

Find out more at **www.nass.usda.gov**

Top 10 Valued Commodities in California

(2016 in Billion dollars)

(CDFA, 2019)

Total Values (Conv. + Org.)	
1. Milk and cream	$6.0
2. Grapes	$5.6
3. Almonds	$5.2
4. Cattle and calves	$2.5
5. Lettuce	$2.0
6. Strawberries	$1.8
7. Pistachios	$1.5
8. Tomatoes	$1.3
9. Walnuts	$1.2
10. Oranges	$0.83

Organic Values	
1. Milk and cream	$0.25 (4.2%)*
2. Strawberries	$0.20 (11%)
3. Grapes	$0.20 (3.6%)
4. Carrots	$0.16 (22%)
5. Sweet potatoes	$0.07 (N/A)
6. Almonds	$0.07 (1.4%)
7. Raspberries	$0.07 (18%)
8. Salad mix	$0.06 (N/A)
9. Eggs	$0.06 (5.3%)
10. Tomatoes, processing	$0.06 (5.4%)

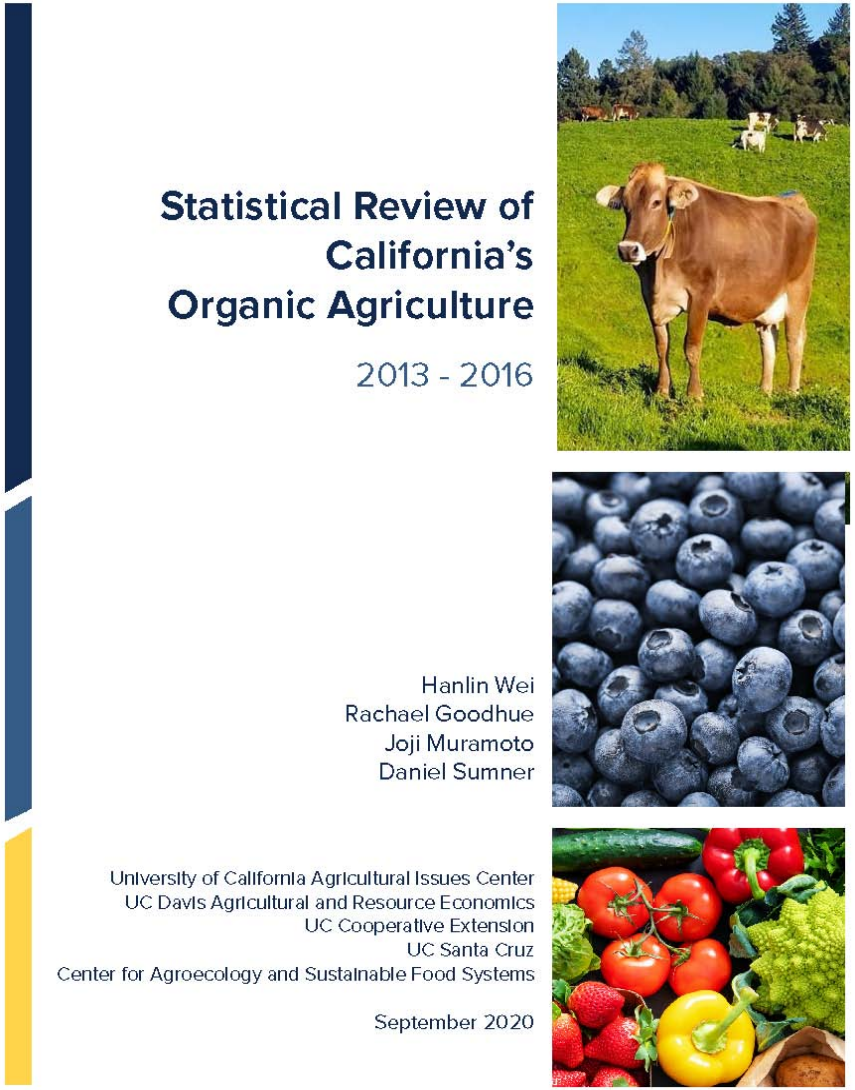
* ( ): organic %

California Organic Facts and Statistics (2016)

- The oldest existing organic farm in CA: ***Star Route Farms***, Bolinas, Marin Co. (since 1974)
- **4.7%** of total farms in CA are certified organic* *2017 Ag census

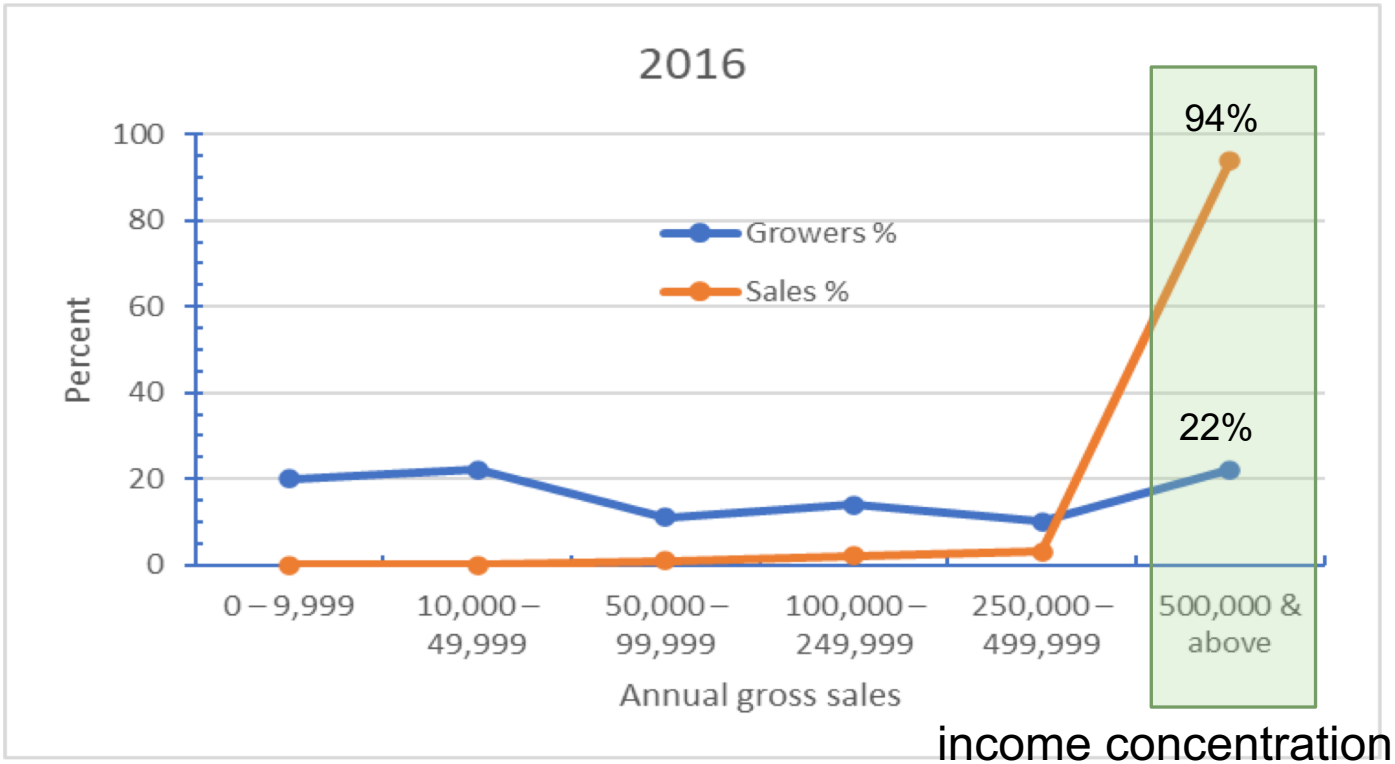
- **Quizzes: Top 3 Counties in CA***
  - *Organic acreage (excludes pasture and rangeland)*? Kern (50k), Kings (32k), Sonoma (21k)
  - *Organic farm #*? San Diego (635), Sonoma (412), Riverside (342)**
  - *Organic farm %?* Santa Cruz (18%), Marin (18%), Monterey (16%)
  - *Organic farm gross sales?* Kern (734M), Monterey (723M), Merced (279M)**

* 2017 Ag census, **2020 CDFA



Changes in organic sector in CA

Year	# of organic growers	Annual gross sales ($)	Ave. annual gross sales/org. grower ($)
1994	1,129	$78,331,295	$69,381
2005	1,795	$510,905,932	$284,627
2016	3,109	$3,126,586,000	$1,005,656



income concentration

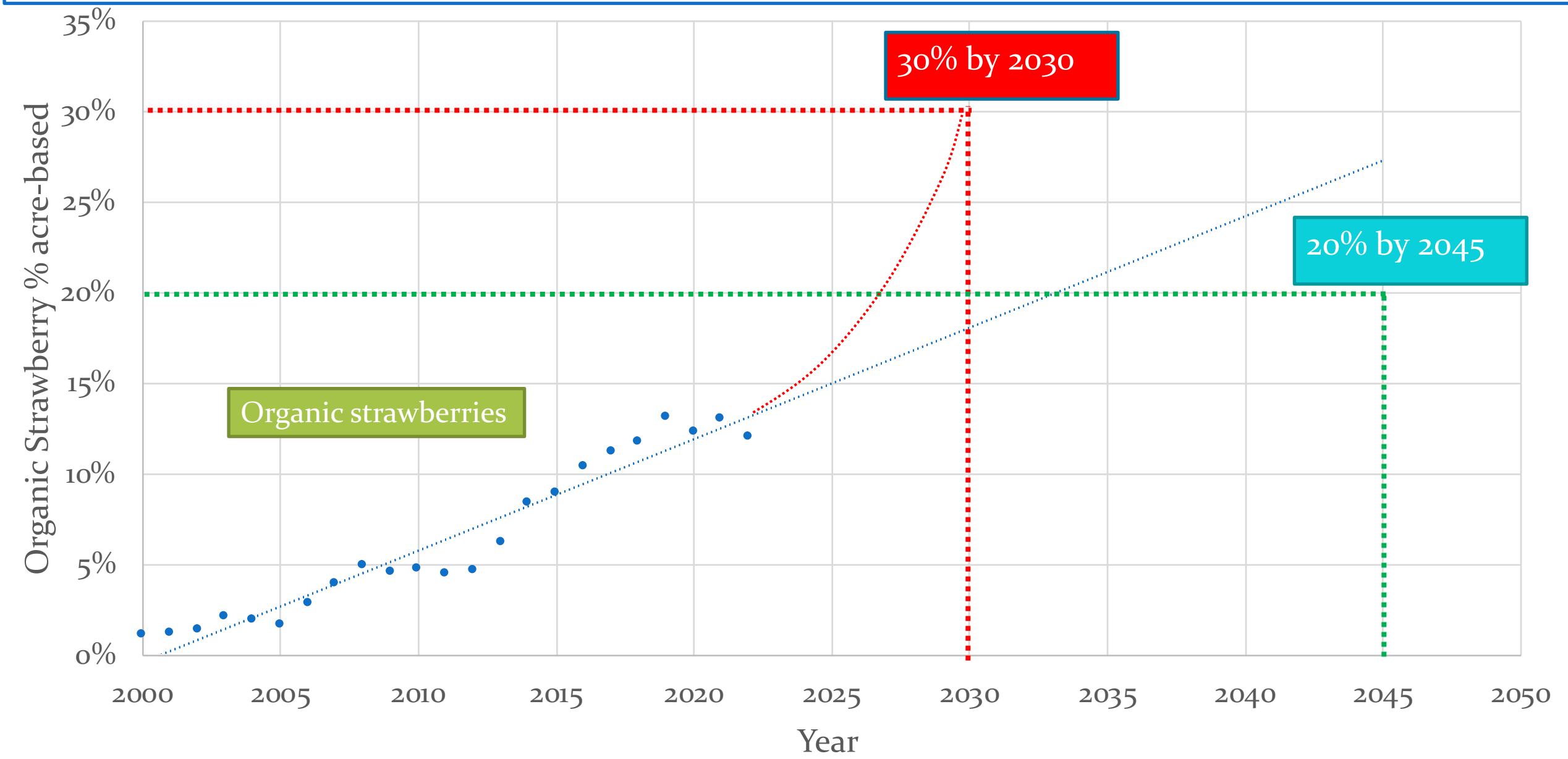
Organic Strawberry Acreage In California 1997-2021

Organic/Conventional Comparative On-Farm Strawberry Experiment at the Swanton Berry Farm 1987-1990 (Gliessman et al., 1996)

13.0 % of total strawberry acres in CA in 2021

Data source: 1997-1999: CDFA, 2000-2021: California Strawberry Commission

State Goal:
Increase organic agriculture to 20 or 30% of all cultivated acres by 2030 or 2045



Current Share Organic Acreage

Crop	Total Acres [a]	Organic Acres [b]	Percent Organic
Almonds [c]	1,250,000	26,567	**2.1%**
Broccoli	89,500	11,976	**13.4%**
Carrots	60,300	19,439	**32.2%**
Citrus	269,700	19,049	**7.1%**
Grapes (Table) [c]	130,000	9,444	**7.3%**
Grapes (Wine) [c]	620,000	25,036	**4.0%**
Lettuce	199,100	44,044	**22.1%**
Spinach	42,100	24,424	**58.0%**
Strawberries	33,100	5,501	**16.6%**
Tomatoes [d]	248,900	12,801	**5.1%**

[a] Source: California Department of Food and Agriculture (CDFA). 2021. California Agricultural Statistics Review 2020- 2021. Agricultural Organics Report 2020-2021.
[b] Source: California Department of Food and Agriculture (CDFA). 2021. Agricultural Organics Report 2020-2021.
[c] Includes bearing and non-bearing acres
[d] Includes both processing and fresh market tomatoes.

Public/Private Support for Organic Ag in CA

2019: CE Organic Position Specialist, Center for Agroecology, UCSC

Rodale Institute California Organic Center

2020: UCCE Organic Agriculture Institute (OAI. ClifBar)

2021: CalPoly SLO The Grimm Family Center for Organic Production and Research (Grimmway Farms)

CDFA California Farm to School Incubator Program

2022: CDFA Organic Agriculture Technical Assistance 1.85M to OAI

CDFA 0.5M to CE Organic Production Specialist for statewide extension

USDA Organic Transition Initiative (300M)

“USDA is alone in the world allowing hydroponics (no soil!) and CAFOs* as certified organic (not in Canada, Mexico, and EU).”
Dave Chapman, Long Wind Farm, Vermont

- Concentrated animal feeding operations; an animal feeding operation in which over 1000 animal units (1000 cows, 700 dairy cows, 2500 pigs, 125 thousand chickens, 82 thousand egg laying hens) are confined for over 45 days a year.

real Organic project

1. Increase Soil Fertility
2. Promote Biological Diversity
3. Rotate Animals on Pasture
4. Improve the Sustainability of Farm Systems
5. Build Community

- Farmer led movement
- Free certification
- Additional label

Total: 903 farms certified

(50% increase from 10/24/21. ~6% of total organic farms in the US.)

1. VT: 101 farms
2. CA: 98 farms
3. NY: 91 farms
4. ME: 59 farms
5. WI: 58 farms

(As of 10/21/2022)

Regenerative Organic Certified™

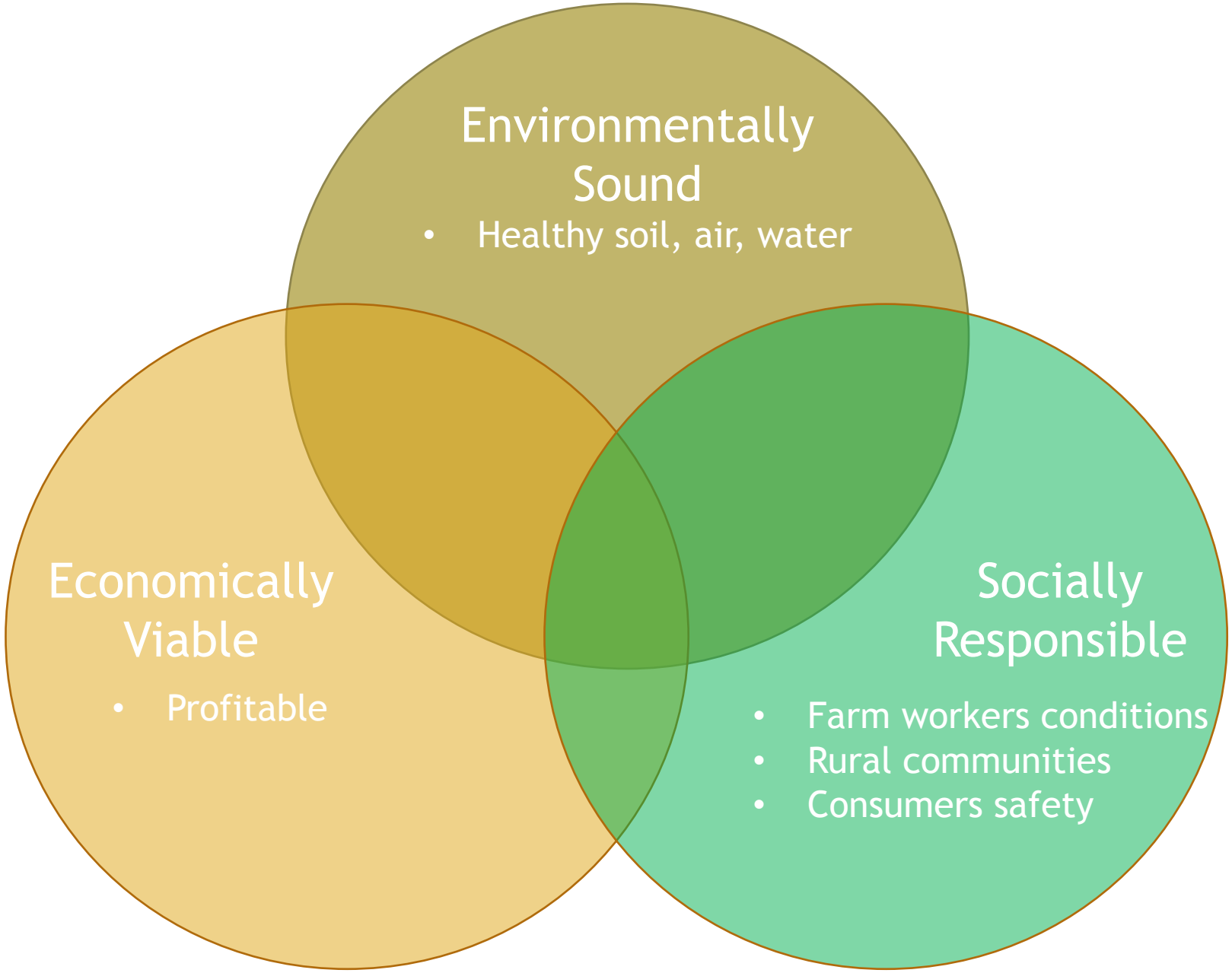
1. Soil Health
2. Animal Welfare
3. Social Fairness

- Fee based ($350-$750)
- Allies include:
  - Patagonia, Dr. Bronner's All-One, PUR Project, etc.

USDA National Organic Program (2002) Definition of “Organic Production”

A production system that is managed in accordance with the Act and regulations in this part to respond to site-specific conditions by integrating cultural, biological, and mechanical practices that foster ***cycling of resources, promote ecological balance, and conserve biodiversity***.

Sustainable Agriculture and Organic Farming



Agroecology Defined (Center for Agroecology, 2020)

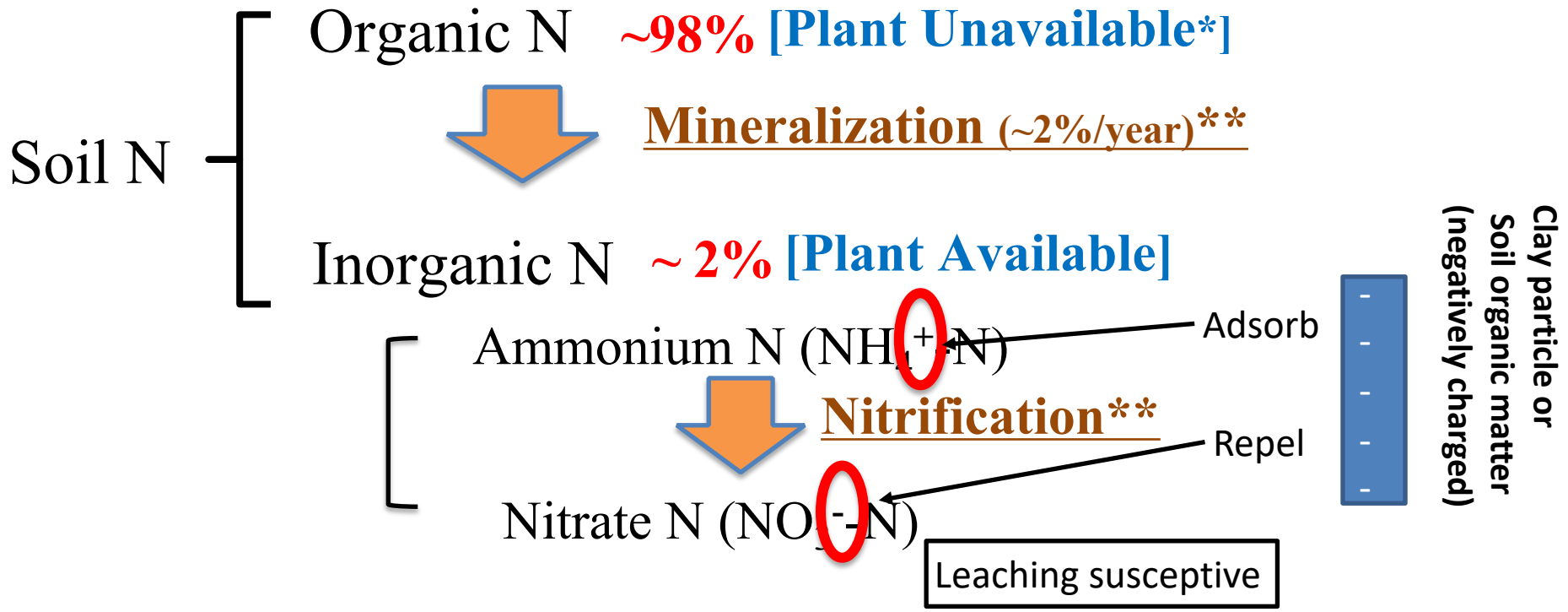
- We define agroecology as the integrative study of the entire food system, encompassing ecological, economic and social dimensions.
- We acknowledge that to create ecologically sound, economically viable, and socially just food systems, agroecology must integrate science and research, technology and practices, indigenous knowledge, and movements for social change.
- We embrace agroecology as a transdisciplinary, participatory, action-oriented, and politically-engaged transformation of the food system.
- We recognize the foundations of agroecology as a peasant social movement, and its current context in food sovereignty movements across the world.

Nitrogen Management in Organic Production

Why Nitrogen (N)? 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



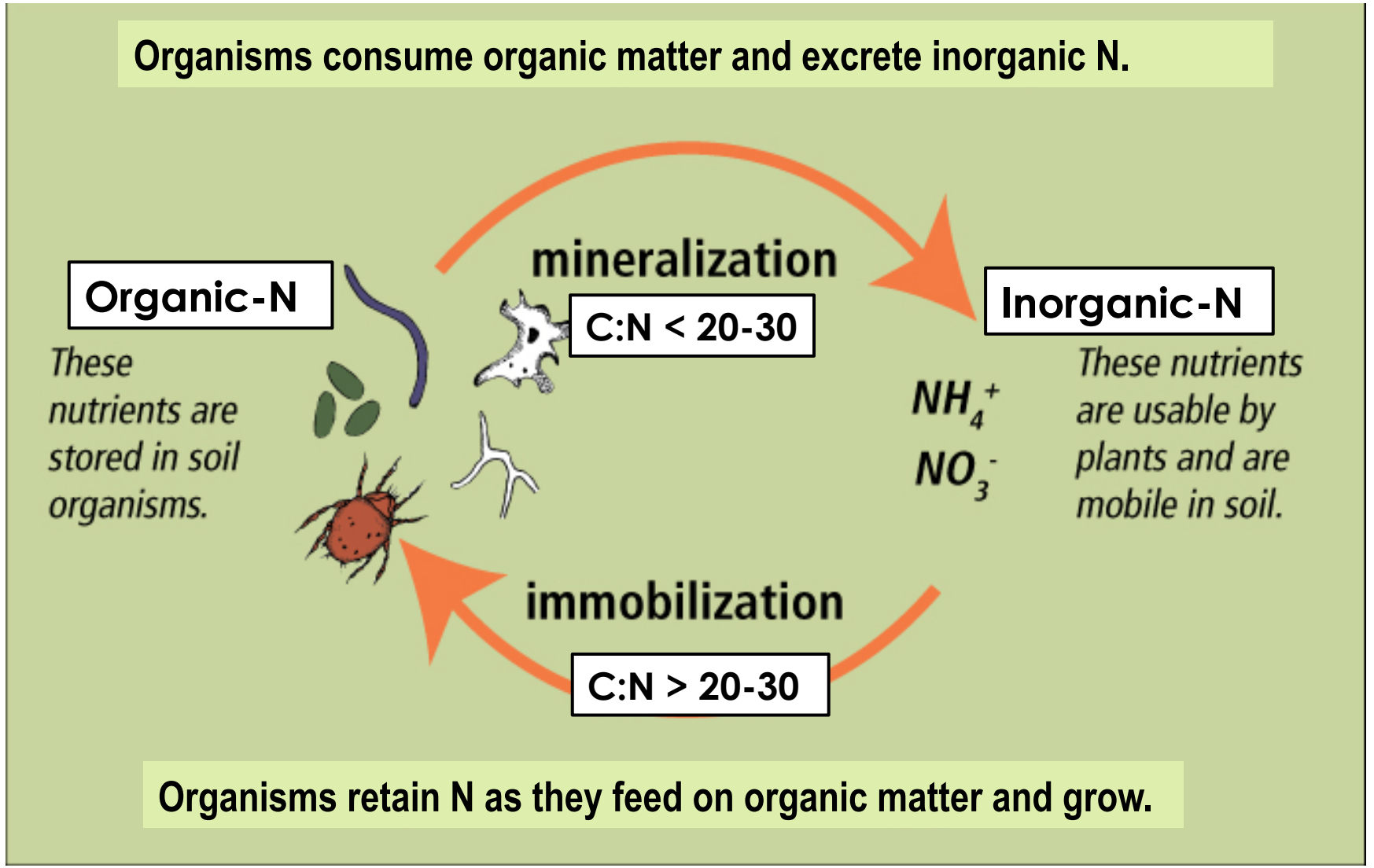
* Plants can absorb small amounts of organic N and some crop plants can do more than others

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

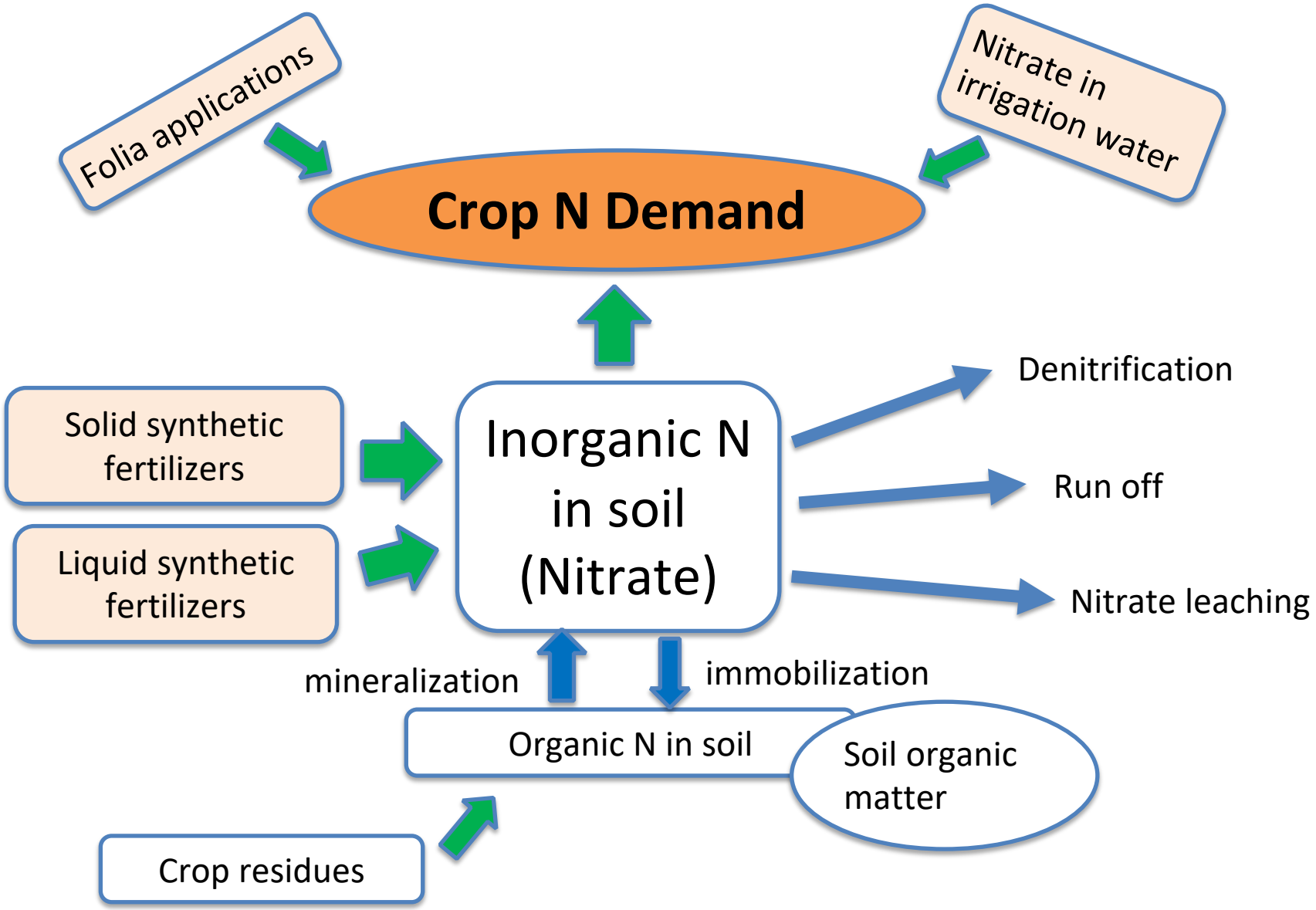
Nitrogen mineralization & immobilization

- 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

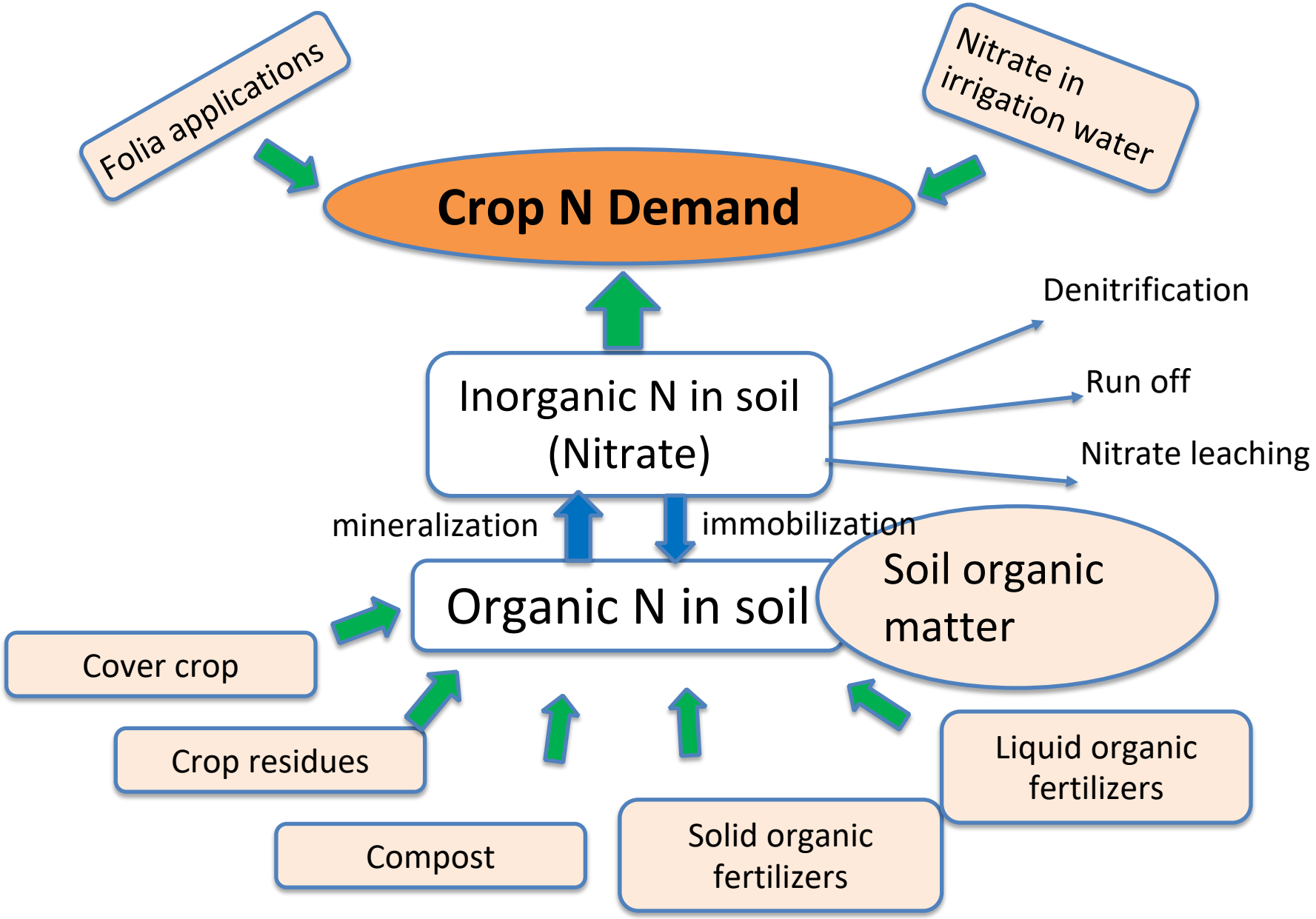
N mineralization vs. N immobilization



(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
- Plant-soil microbe-soil organic matter interactions

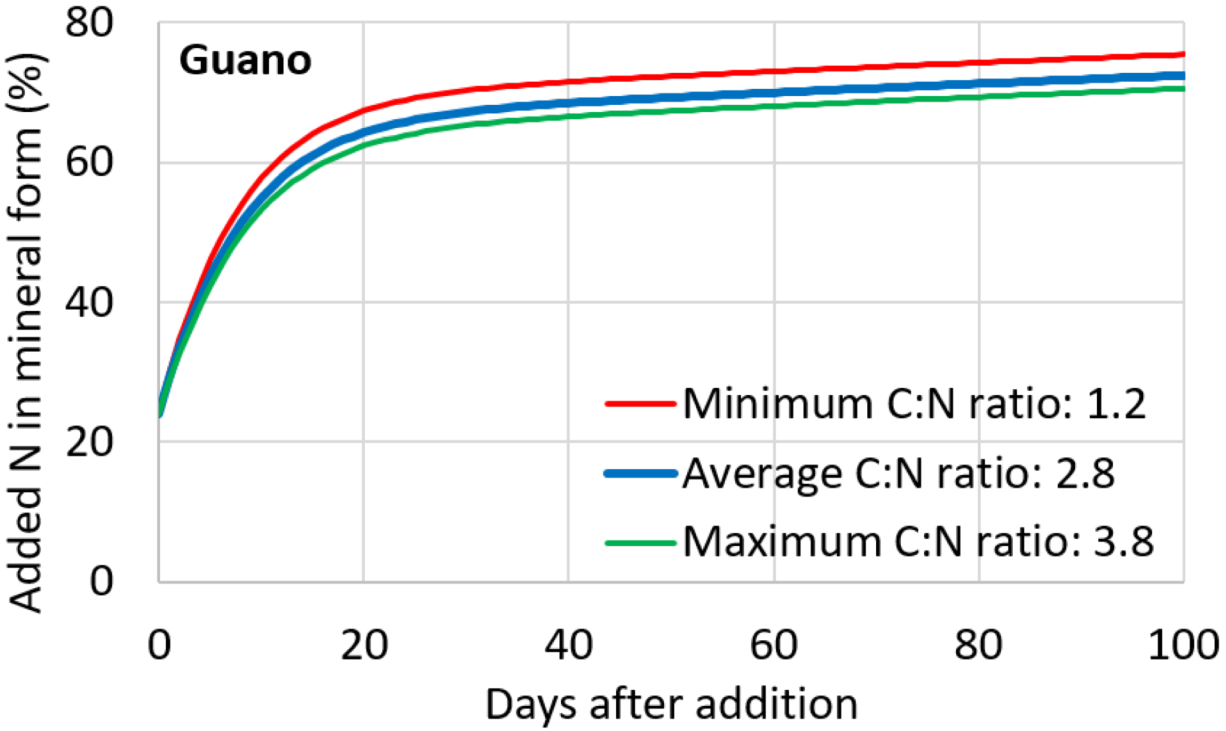
Net N mineralization rates

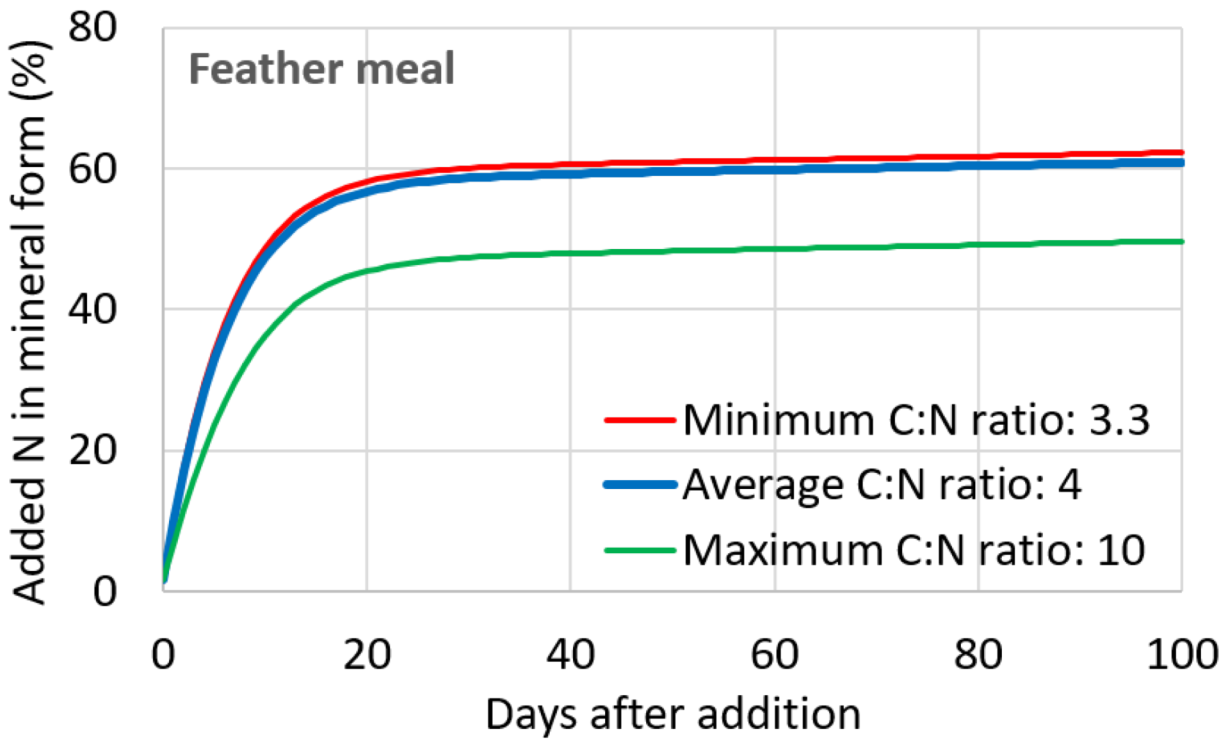
After 100 days, at 77 °F, optimal moisture

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., J. Env. Qual. 2021

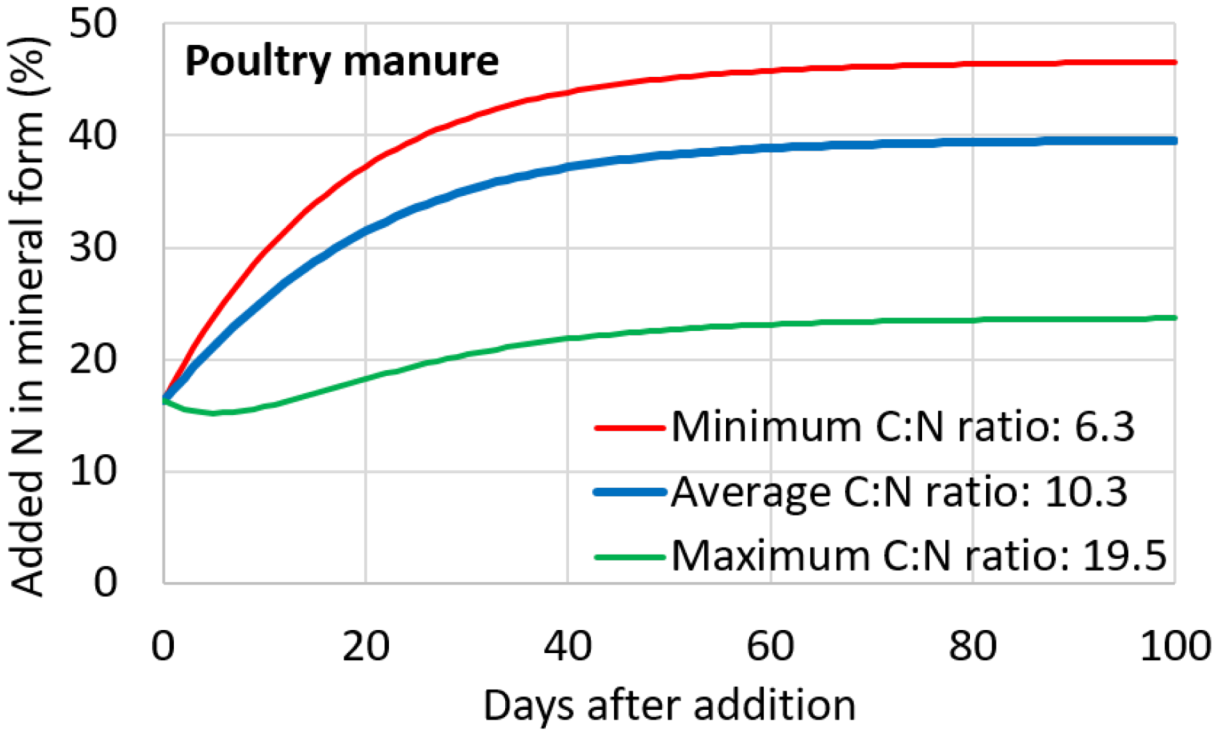
Guano and feather meal

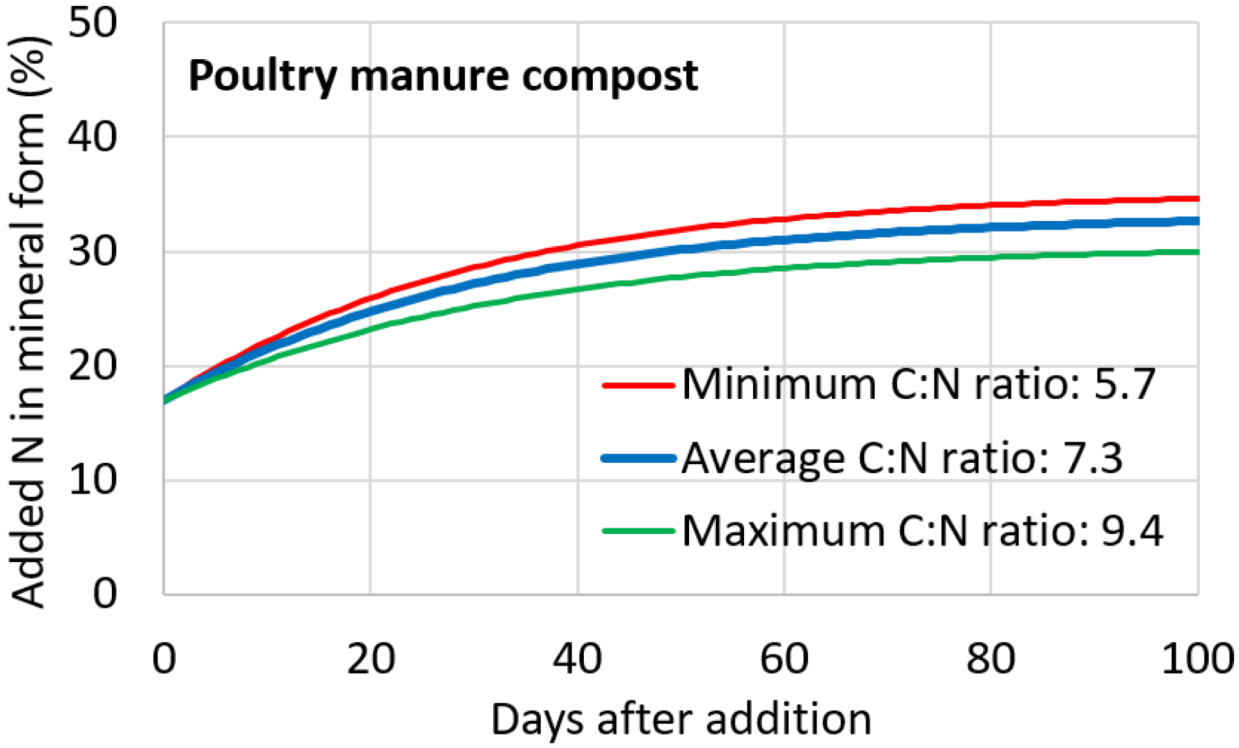




Geisseler et al., 2021

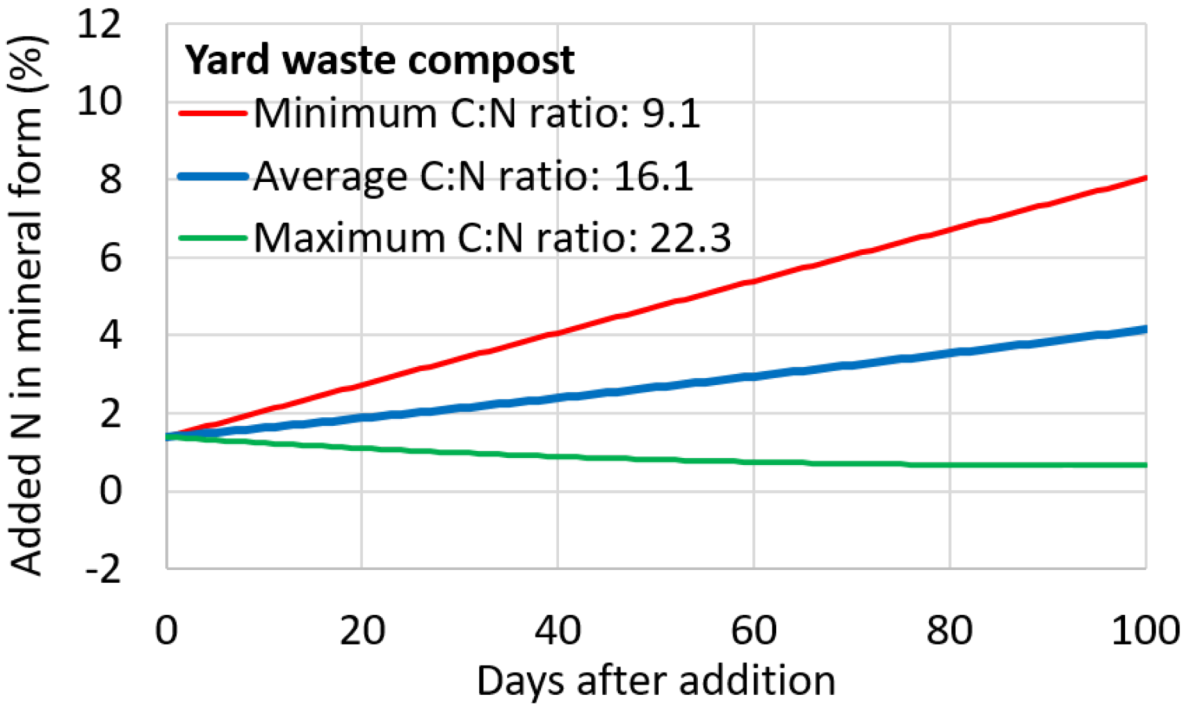
Poultry manure and poultry manure compost

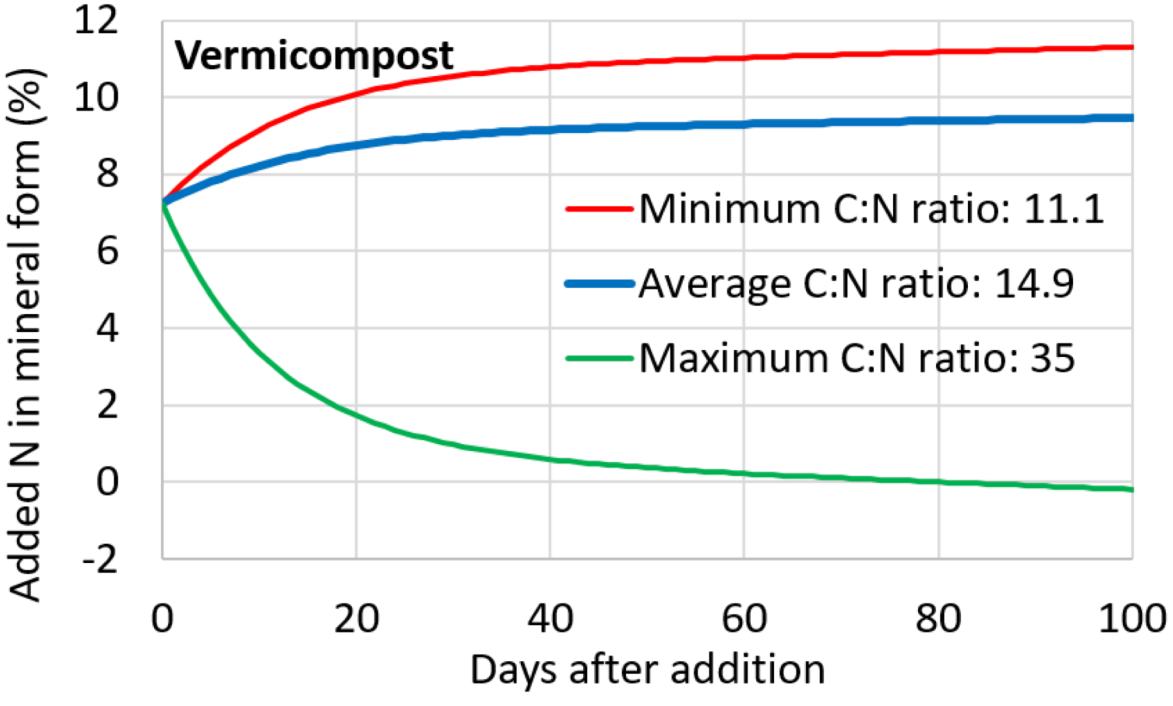




Geisseler et al., 2021

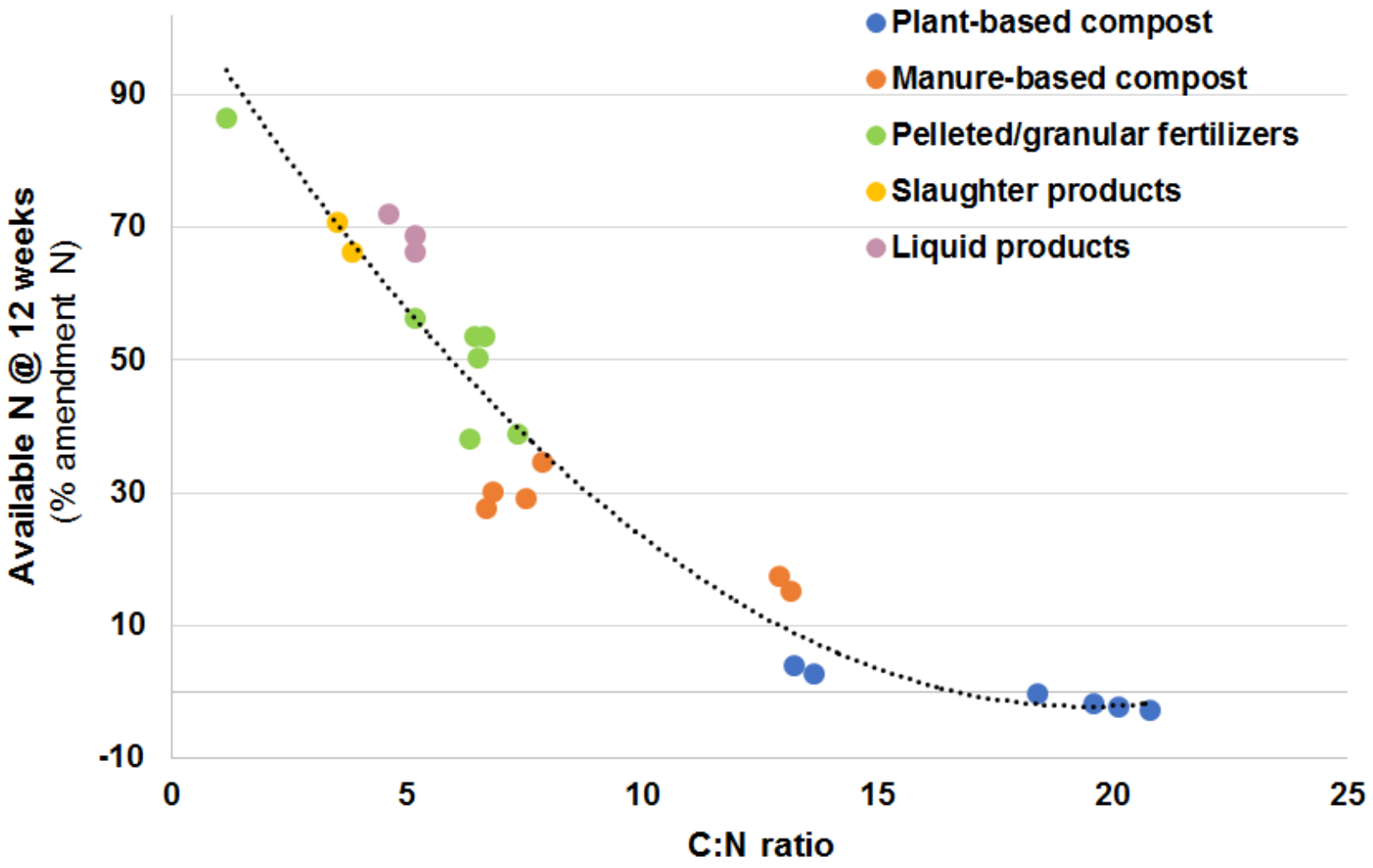
Yard waste compost and vermicompost





Geisseler et al., 2021

Effect of C to N ratio on N release



Lazicki et al., 2020

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!

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: %

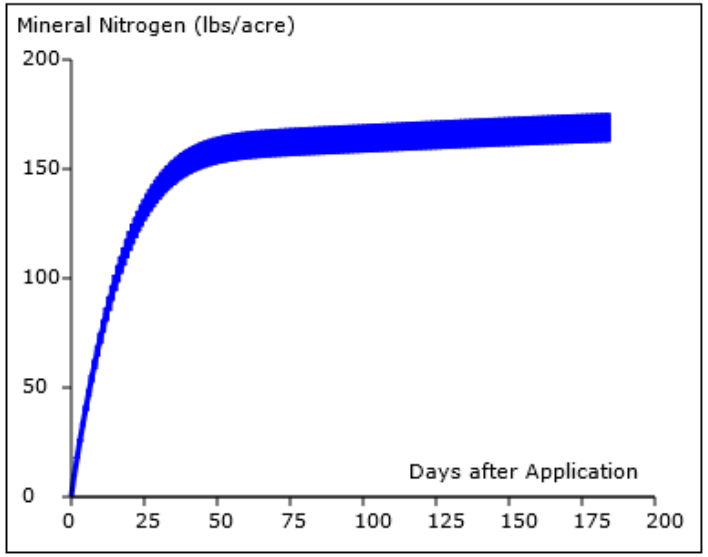
Residual soil nitrate: ppm Nitrate-N

Display Results/Changes

The online tool

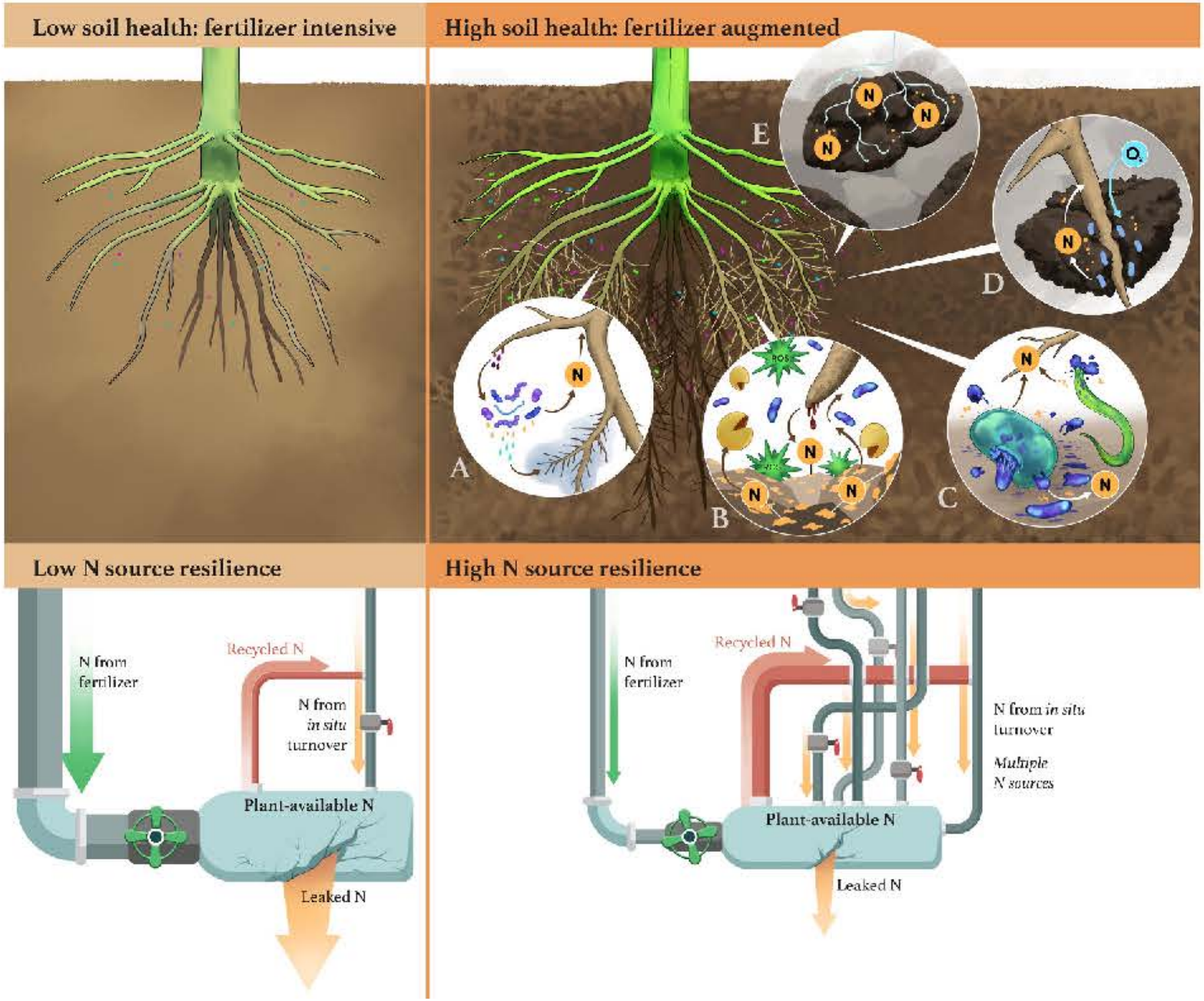
Output: Feather meal, Sacramento Valley

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 %



Healthy Soil and N Provision

A: Root exudates-> hormones
B: Root exudates->MAOM-N
C: Predators feed on microbes
D: Good structure soil stimulates N release
E: Mycorrhizae access N

(Grandy et al. 2022)

Acknowledgements

- CDFA State Organic Program
- CDFA Fertilizer Research and Education Program
- Jan Gonzales, UCCE San Diego
- Ramiro Lobo, UCCE San Diego


Question?
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