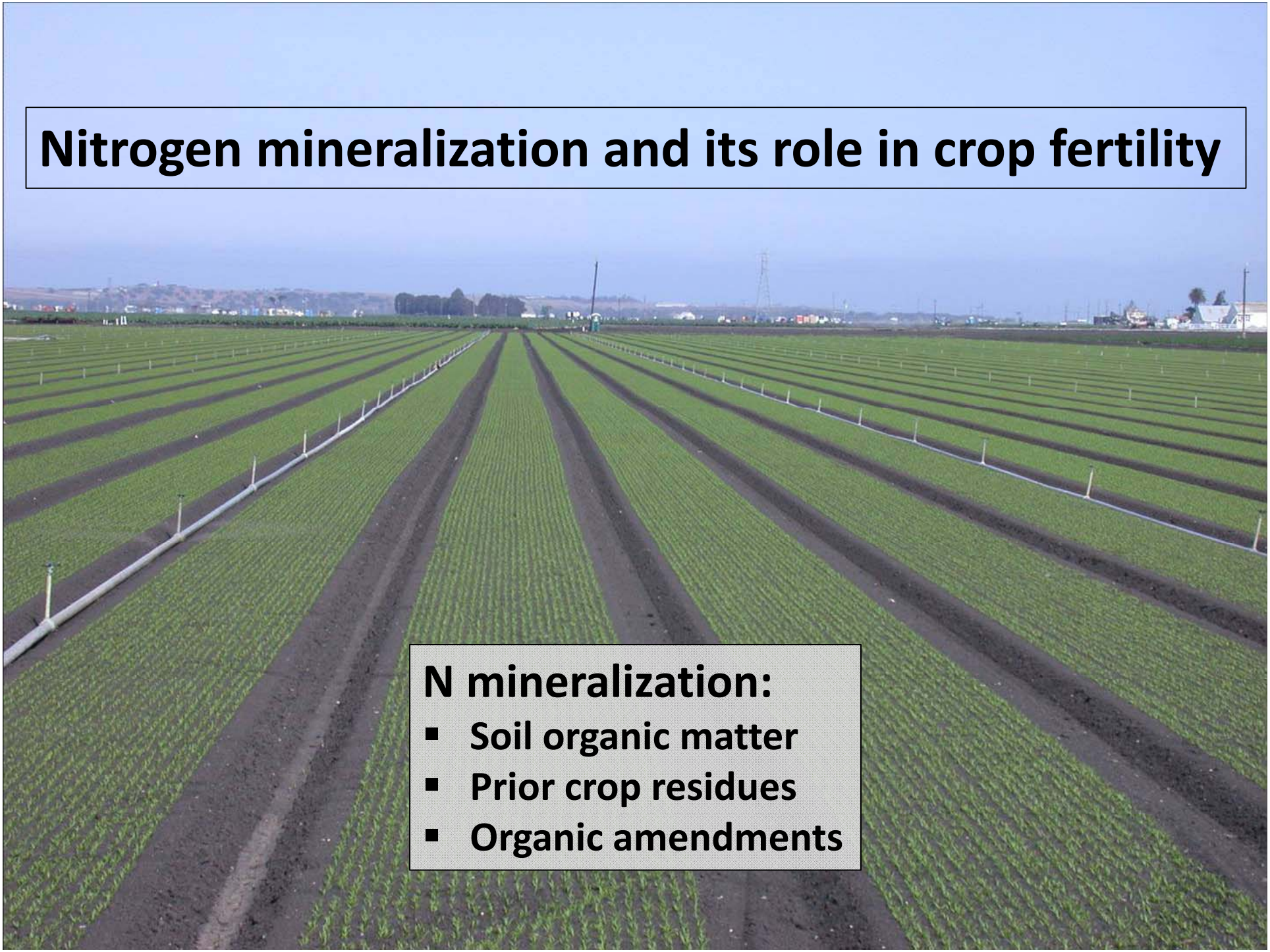
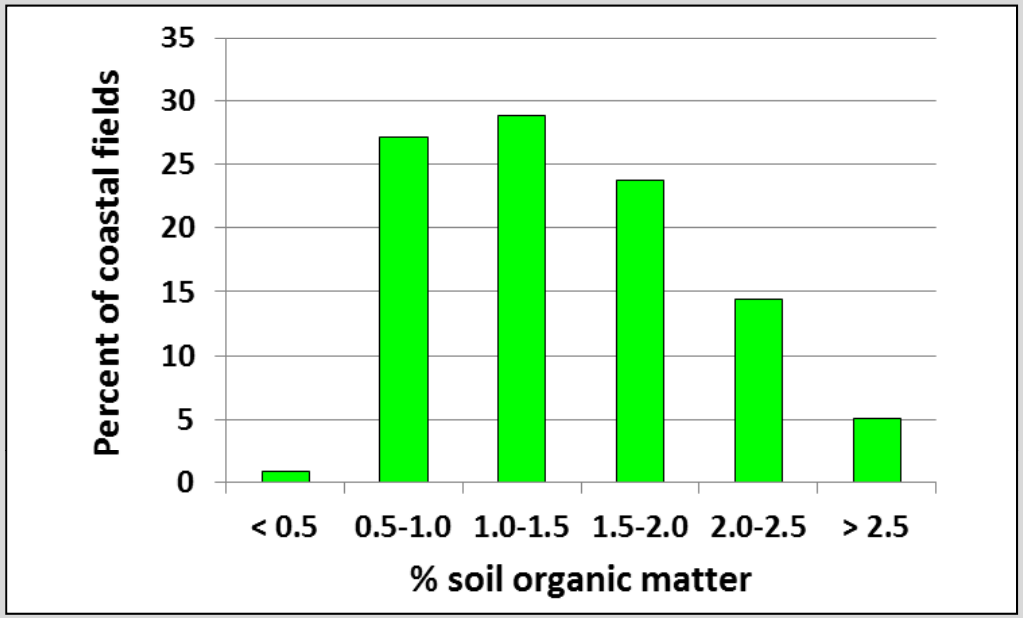
Nitrogen mineralization and its role in crop fertility



N mineralization:

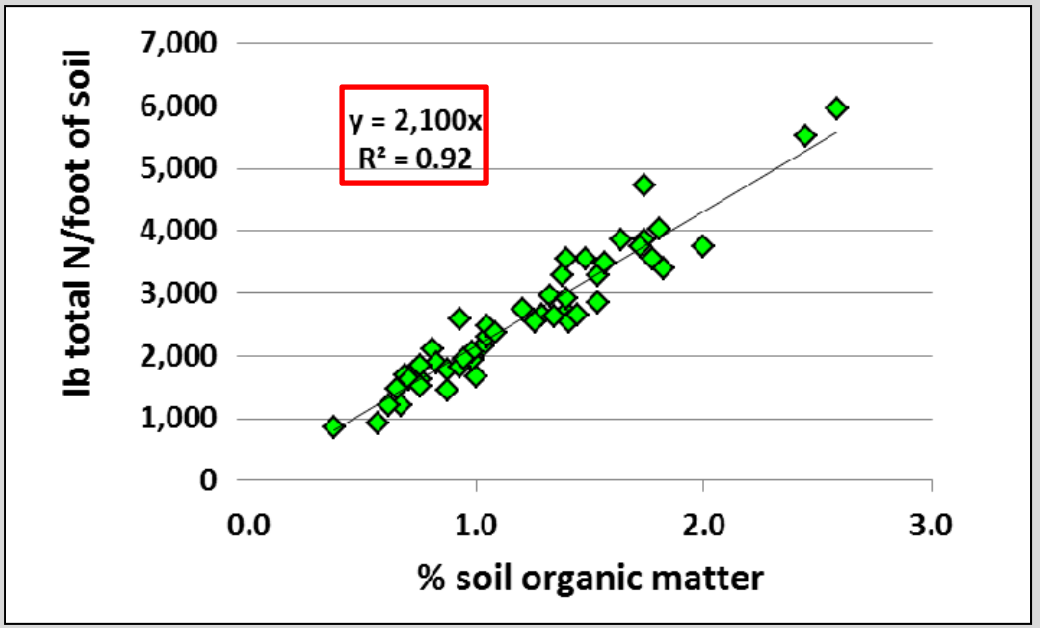
- Soil organic matter
- Prior crop residues
- Organic amendments

Organic matter in coastal soils:



Soil organic matter in a survey of coastal fields

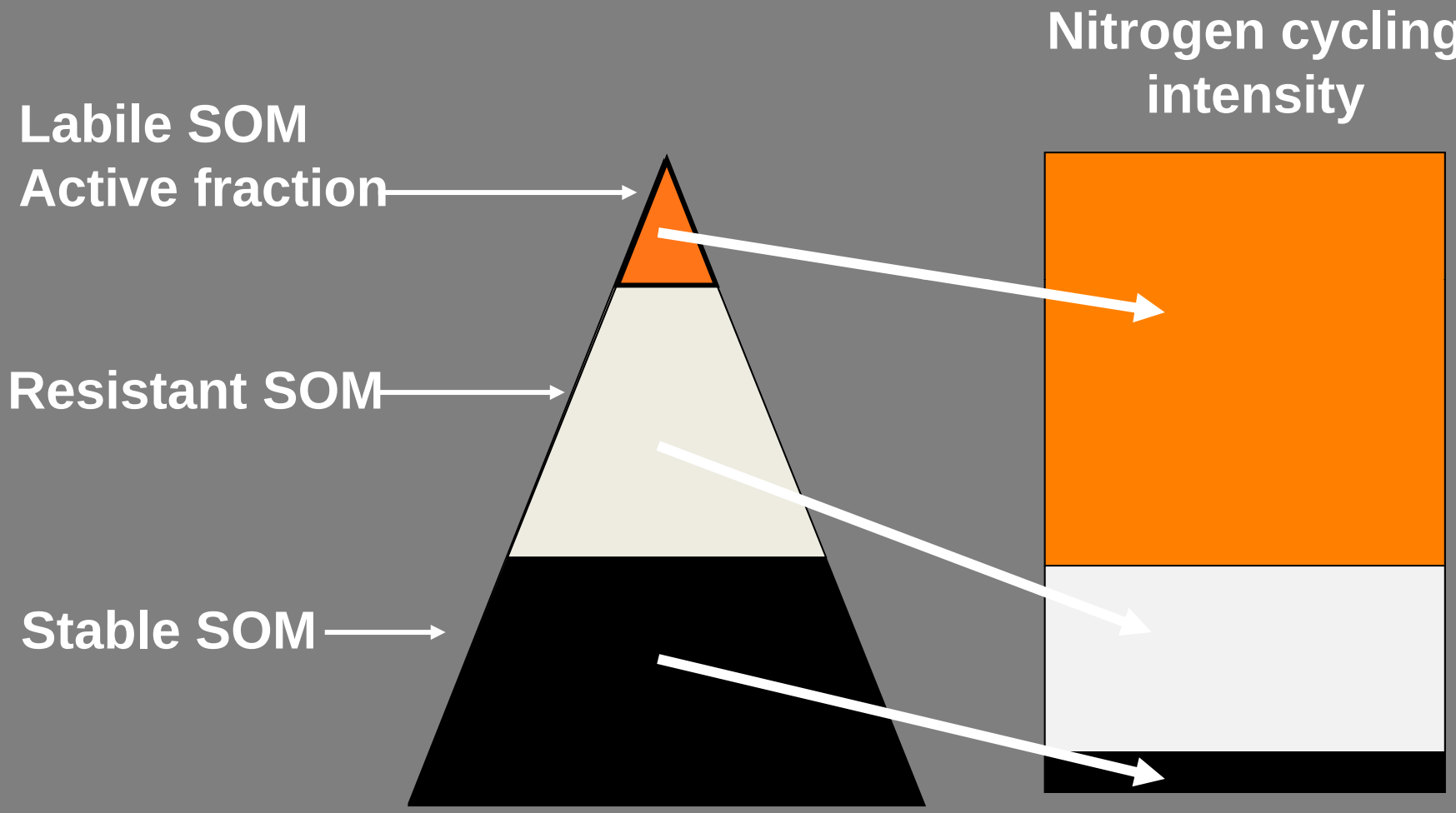
Each % organic matter represents about 2,100 lb total N/acre ft



To what depth does N mineralization occur?

- **> 50% in the top foot**

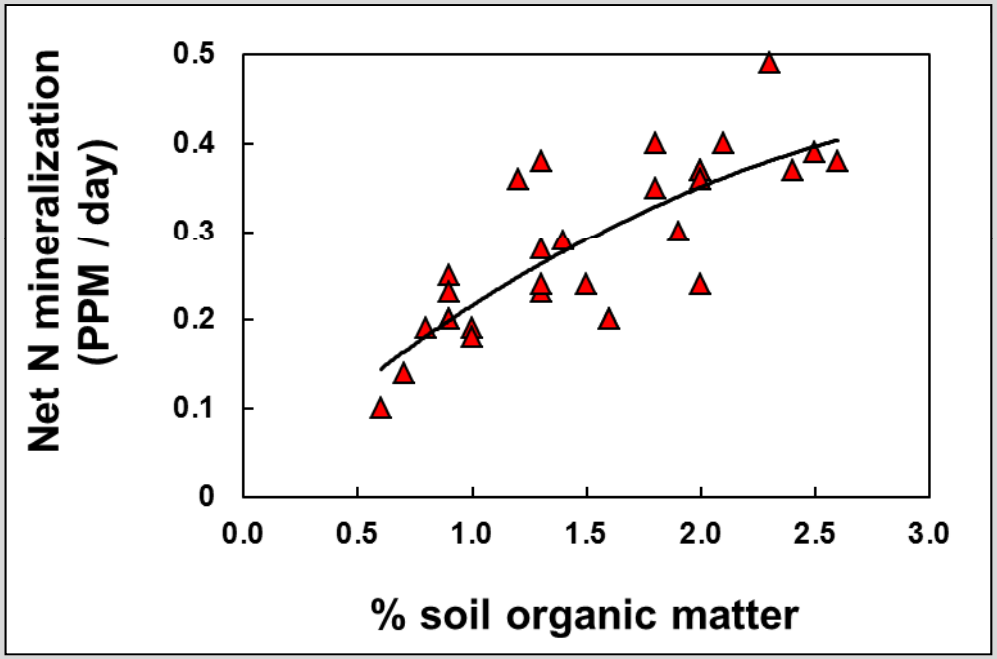
Contribution of soil organic matter fractions to available soil nitrogen



Estimating net soil N mineralization potential:

- Long-term controlled incubation

30 coastal soils incubated for 8 weeks



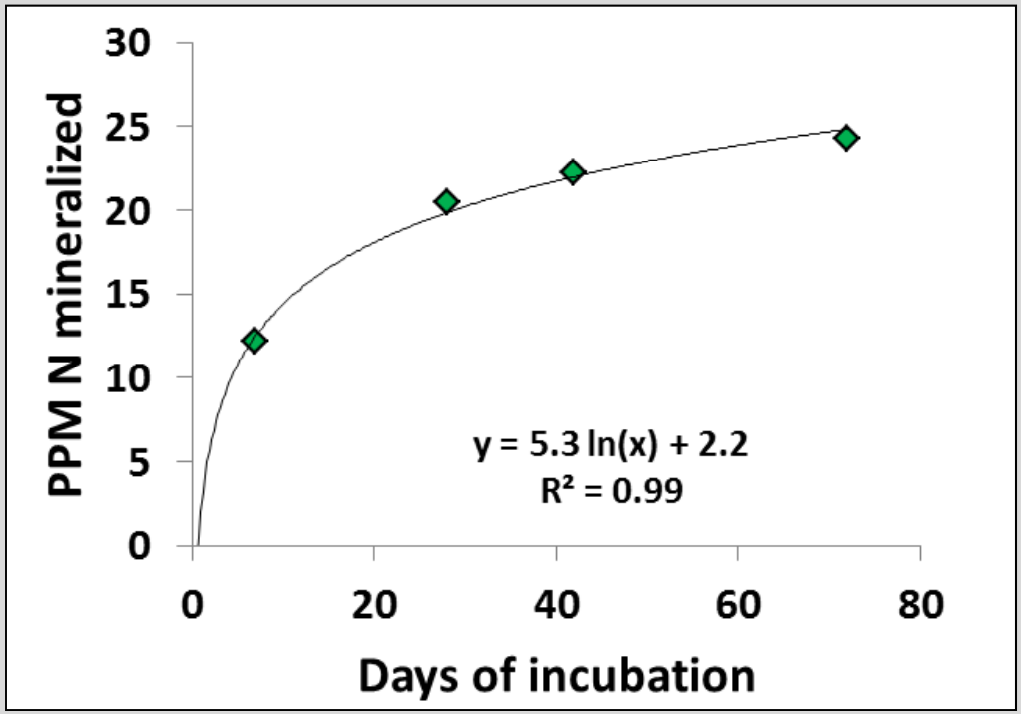
- On average between 1-2% of soil organic N in the top foot of soil was mineralized
- 1-2% organic N_{min} x 2,000 lb soil N/acre ≈ 20-40 lb N / % soil organic matter

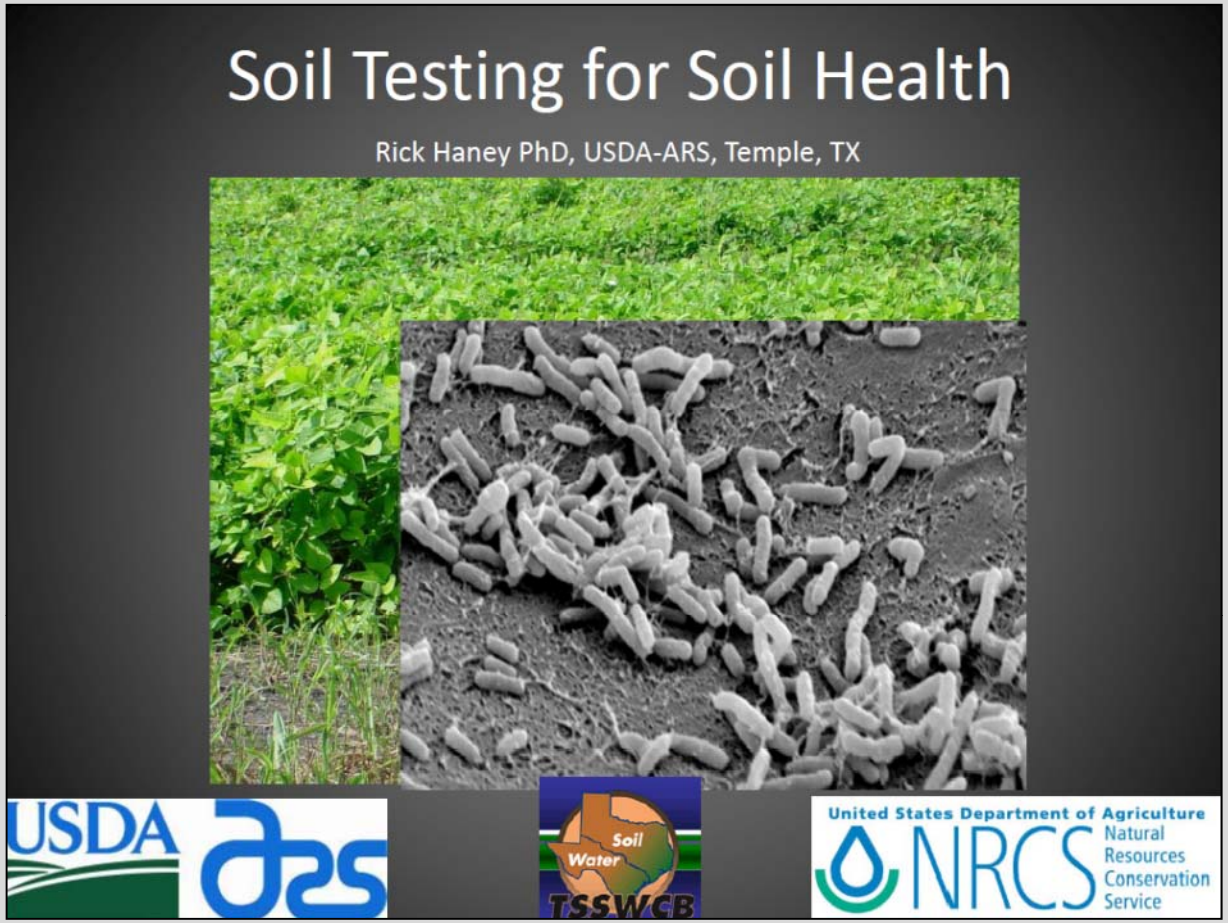
Estimating net soil N mineralization potential:

- N mineralization dynamics over time

- Drying and screening soil disrupts aggregates, and soil microbes
- Rewetting causes a burst of microbial activity, indicative of longer-term N_{min}

Mean of 15 soils incubated for 70 days:





‘Soil health index’

- **Integrated measure of soil biology, and nutrient supplying power**
- **Requires measurement of soil C mineralization, water extractable organic C and N (WEOC, WEON)**

the Solvita® soil respiration test

Estimating net soil N mineralization potential:

- **Laboratory surrogate measurements**

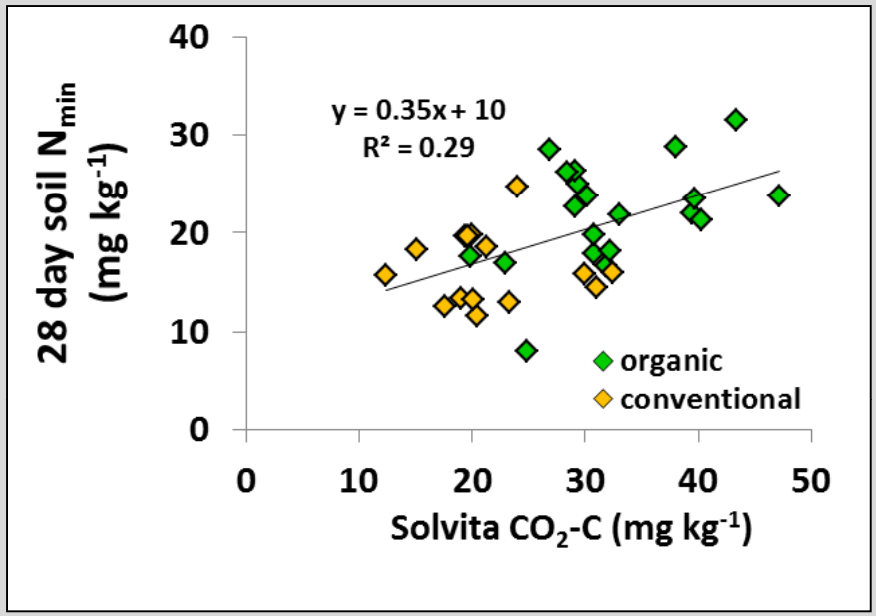
'Solvita' CO_2-C mineralization protocol

Evaluated 35 soils from annual crop rotations

- **20 organically managed soils from Sacramento Valley**
- **15 conventionally managed soils from Sacramento and Salinas Valleys**

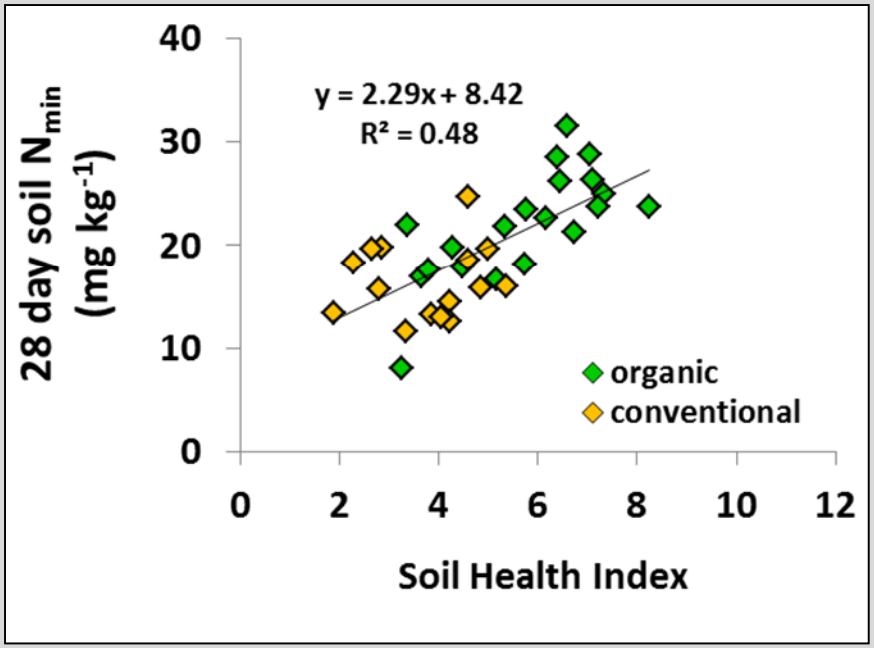
Estimating net soil N mineralization potential:

- Laboratory surrogate measurements



Solvita CO_2 moderately correlated with soil N_{min}

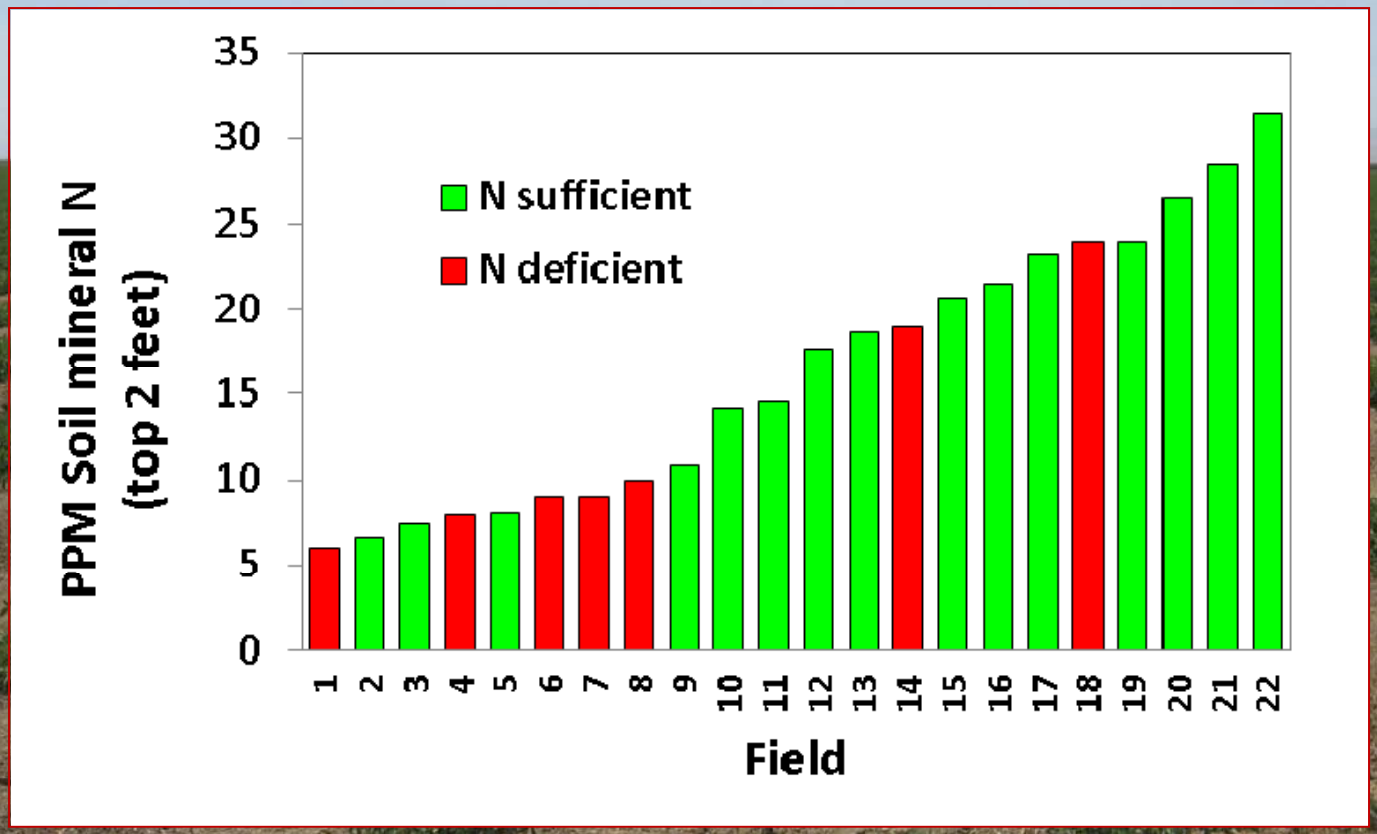
Combining Solvita CO_2 , WEOC and WEON into the NRCS Soil Health Index improved N_{min} prediction



In-season soil N_{min} plays a relatively small role in crop N supply

2012-13 organic processing tomato N sufficiency project:

- **assessed post-transplant soil residual NO_3-N in 22 fields**
- **determined late-season crop N sufficiency**

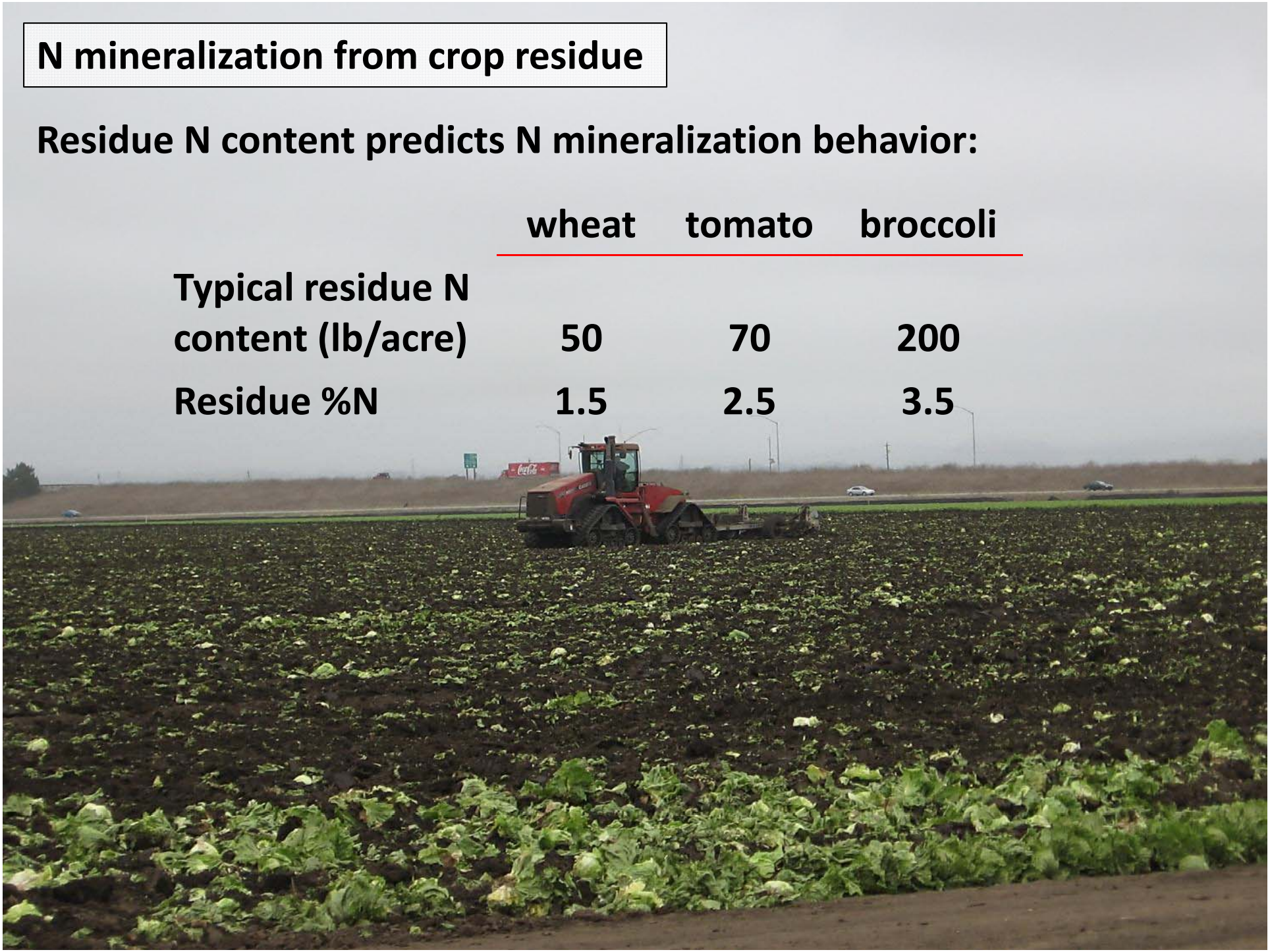


N mineralization from crop residue

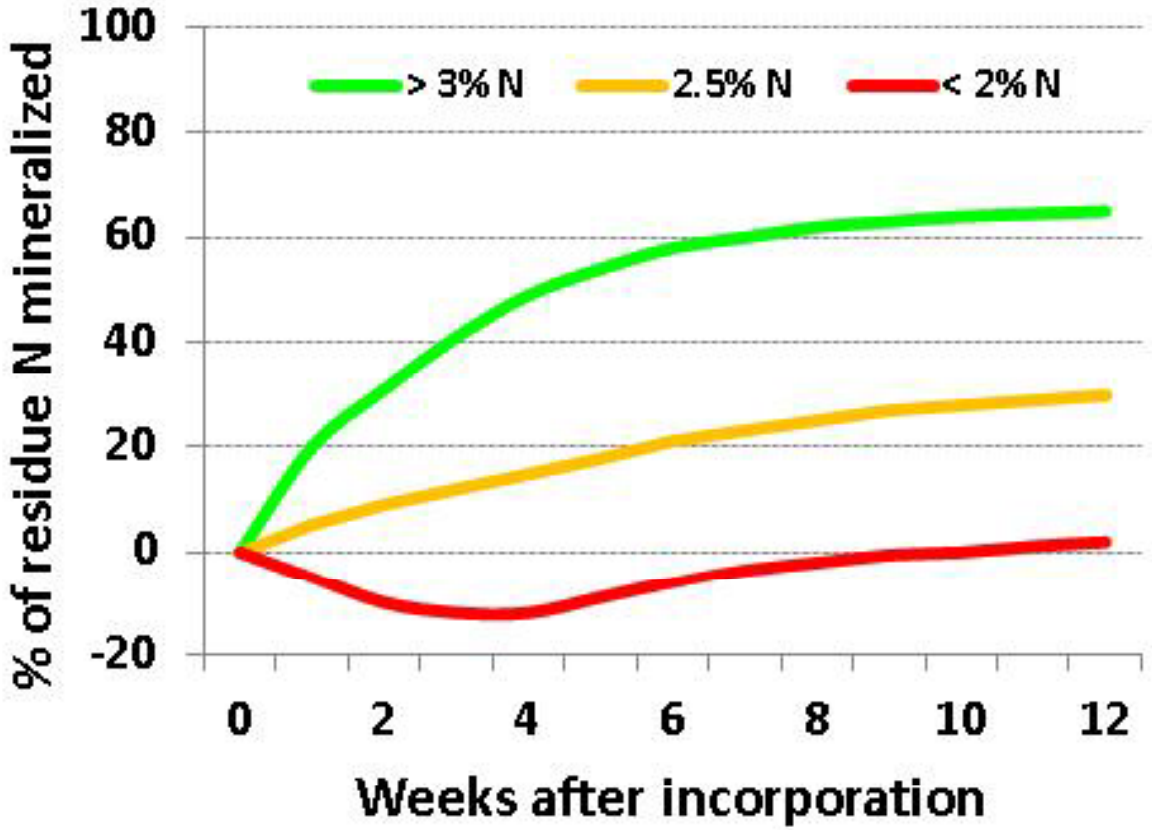
N mineralization from crop residue

Residue N content predicts N mineralization behavior:

	wheat	tomato	broccoli
Typical residue N content (lb/acre)	50	70	200
Residue %N	1.5	2.5	3.5



N mineralization from crop residue

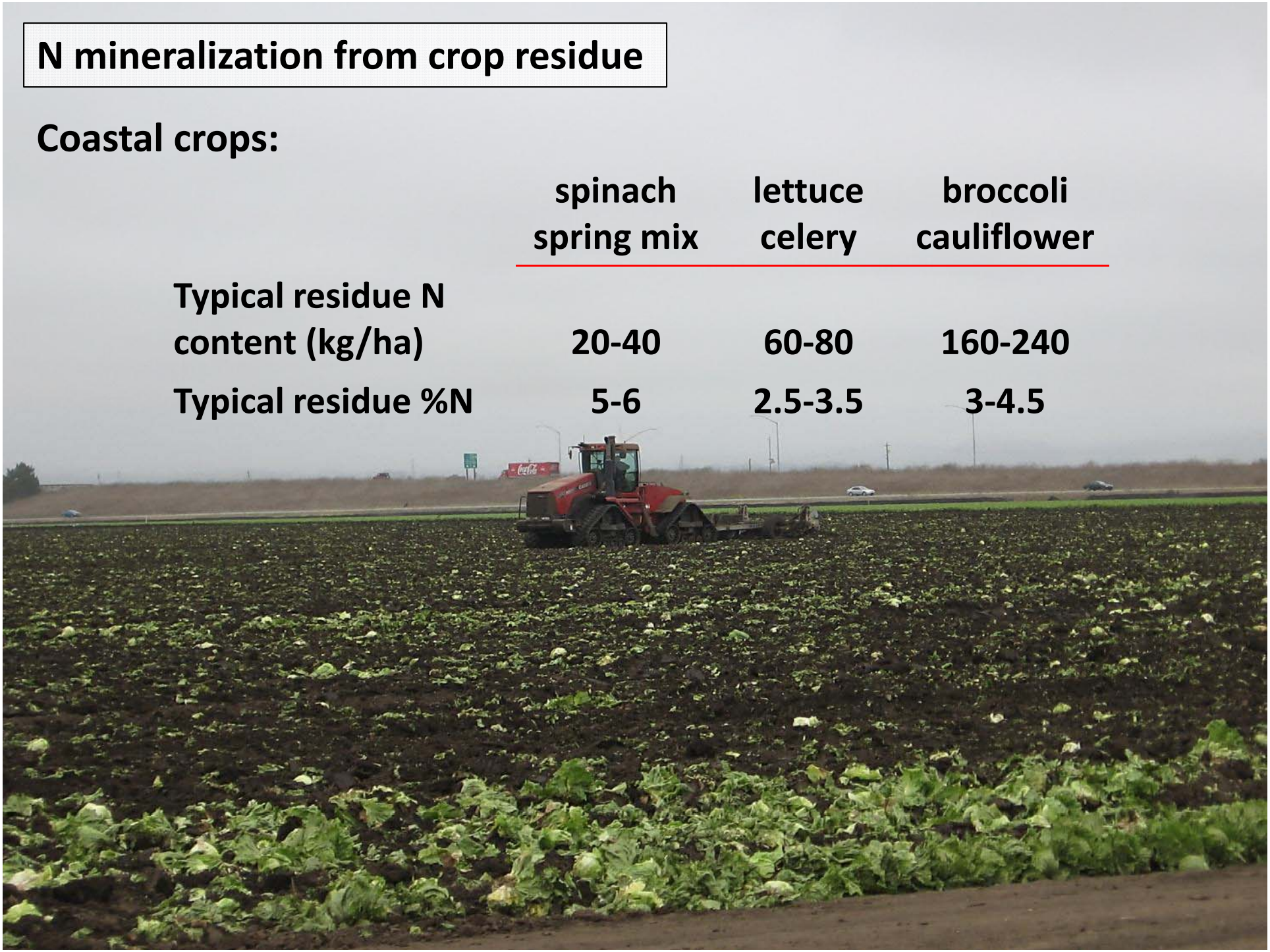


- **Greatest activity occurs in the initial 6-8 weeks after incorporation**

N mineralization from crop residue

Coastal crops:

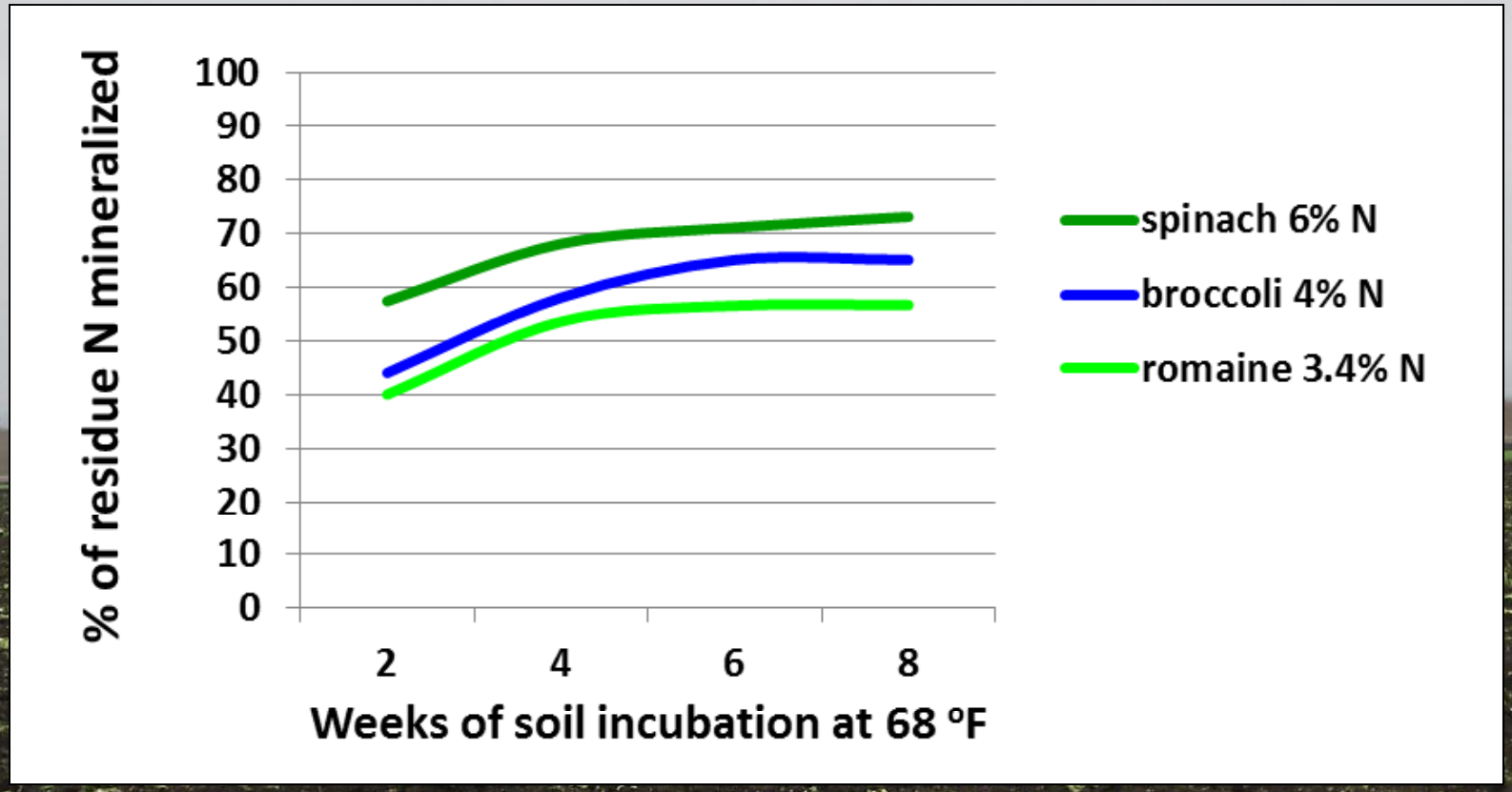
	spinach spring mix	lettuce celery	broccoli cauliflower
Typical residue N content (kg/ha)	20-40	60-80	160-240
Typical residue %N	5-6	2.5-3.5	3-4.5



N mineralization from crop residue

Laboratory incubation:

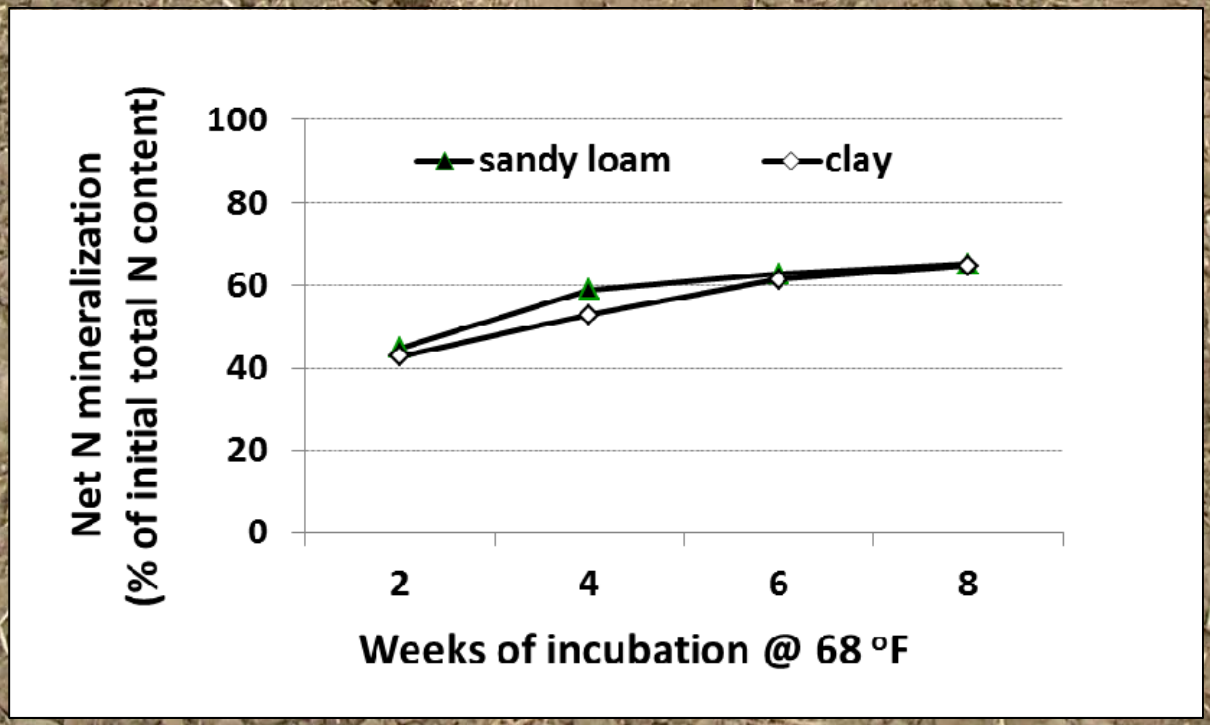
N mineralization from crop residue



- a high percentage of residue N is mineralized within weeks of incorporation
- within 4-6 weeks after incorporation, the rate of additional N_{min} slows
- the majority of residue effects on soil N availability can be directly measured by soil nitrate testing before fertilizing the subsequent crop

Does soil type affect residue breakdown?

Net N_{min} average of 7 vegetable crop residues:

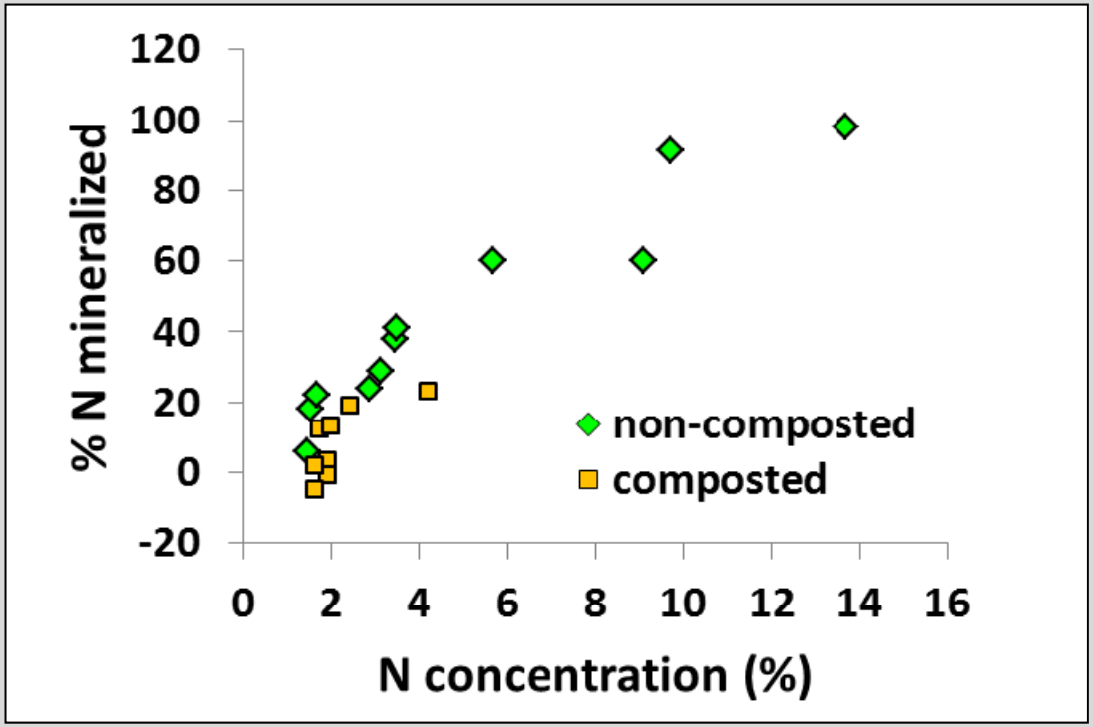


N mineralization from organic fertilizers and amendments

N mineralization dynamics depend on:

- **Percent N**
- **C:N ratio**
- **'Fresh' or composted**

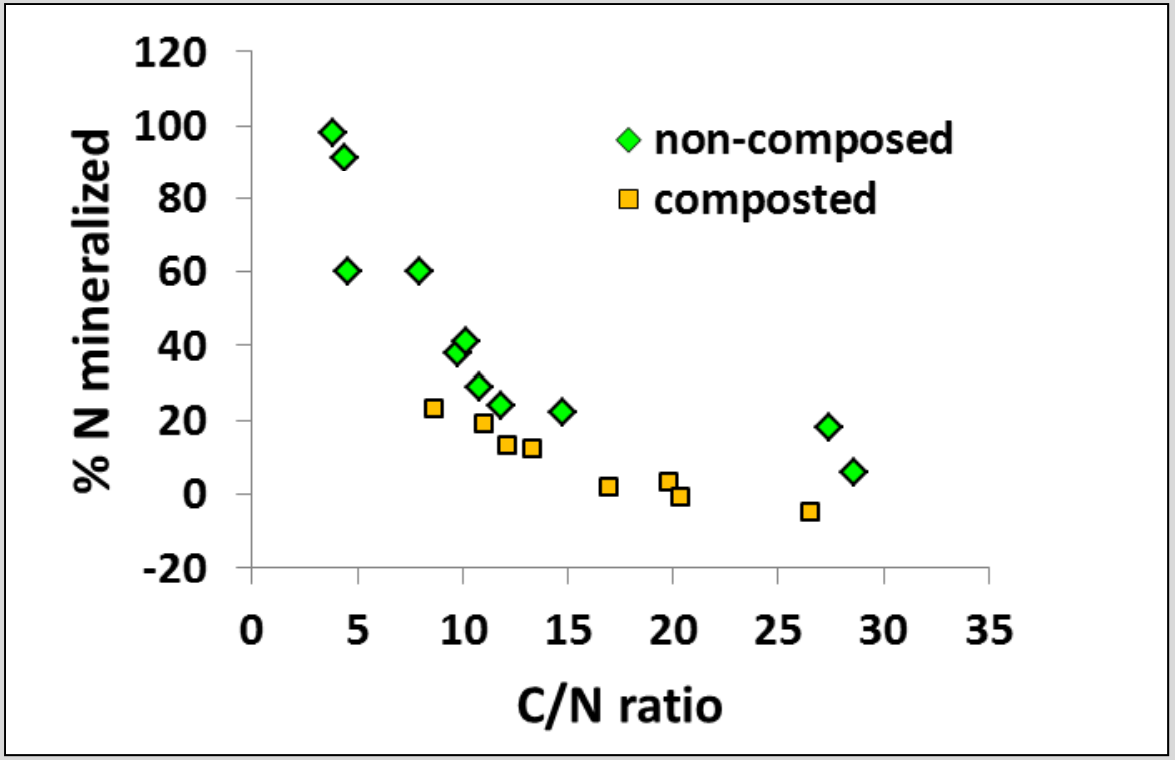
% N mineralized in full field season, Oregon:



(Gale et al., JEQ 35:2321-2332, 2006)

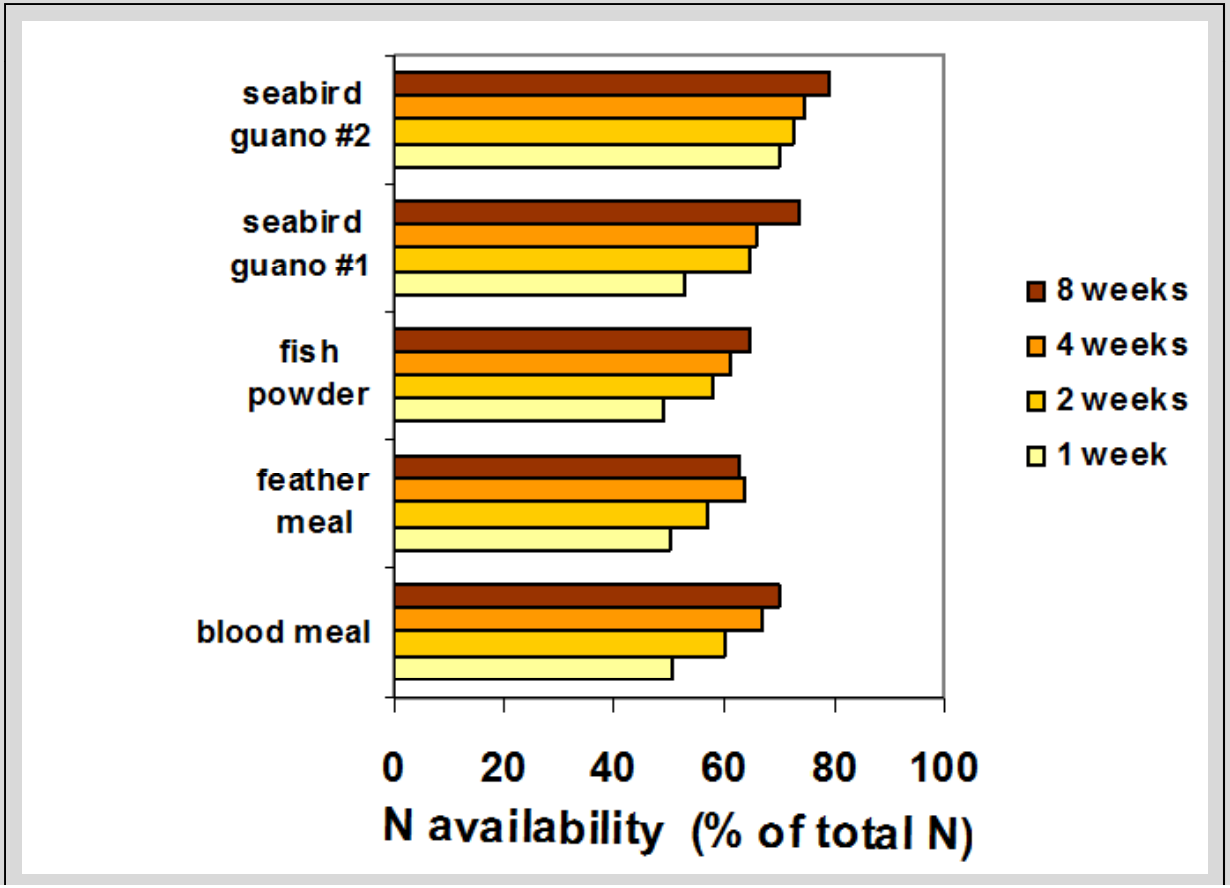
Relationship between %N and C:N ratio

	% C	% N	C:N ratio
Blood meal	49	15	3
Fish powder	45	12	4
Dewatered poultry manure	30	3.5	9
Poultry manure compost	20	2.5	8
Dairy manure compost	25	2.0	13



N availability of high-N organic fertilizers:

- Five high-N materials (> 10% N)
  - blood meal
  - feather meal
  - fish powder
  - two types of seabird guano
- Incubated in moist soil at 77 °F for 8 weeks



How about liquid organic fertilizers ?

Tradename	Feedstock	% N total	% N organic
Agrolizer*	fish	5.1	1.0
Marizyme*	fish	4.2	0.5
Phytamin 522	fish	5.4	4.1
Phytamin 434	guano, fish	3.5	1.0
Phytamin 421	soy meal & plant extracts	4.0	3.0
Biolyzer	grain fermentation	2.6	2.3

*removed from OMRI list

How about liquid organic fertilizers ?

Tradename	% N	% N available in 4 weeks
Agrolizer*	5.1	85
Marizyme*	4.2	89
Phytamin 522	5.4	88
Phytamin 434	3.5	80
Phytamin 421	4.0	80
Biolyzer	2.6	58

*removed from OMRI list

In summary:

- in-season soil N_{min} can be estimated (imperfectly); soil N_{min} is likely to be a reasonably small component of crop fertility
- vegetable crop residue N_{min} dynamics relatively quick; most of the prior crop influence can be picked up by PSNT sampling
- organic management increases N_{min} potential, but without significant residual NO_3-N in-season fertilization likely to be needed
- in-season organic fertilizers tend to be quite fast-acting