UC DAVIS
UNIVERSITY OF CALIFORNIA

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LAND, AIR AND WATER RESOURCES
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Climate Change • Sustainable Agriculture
Environmental Quality • Landscape Processes

Principles of nutrient management in organic fresh market tomatoes

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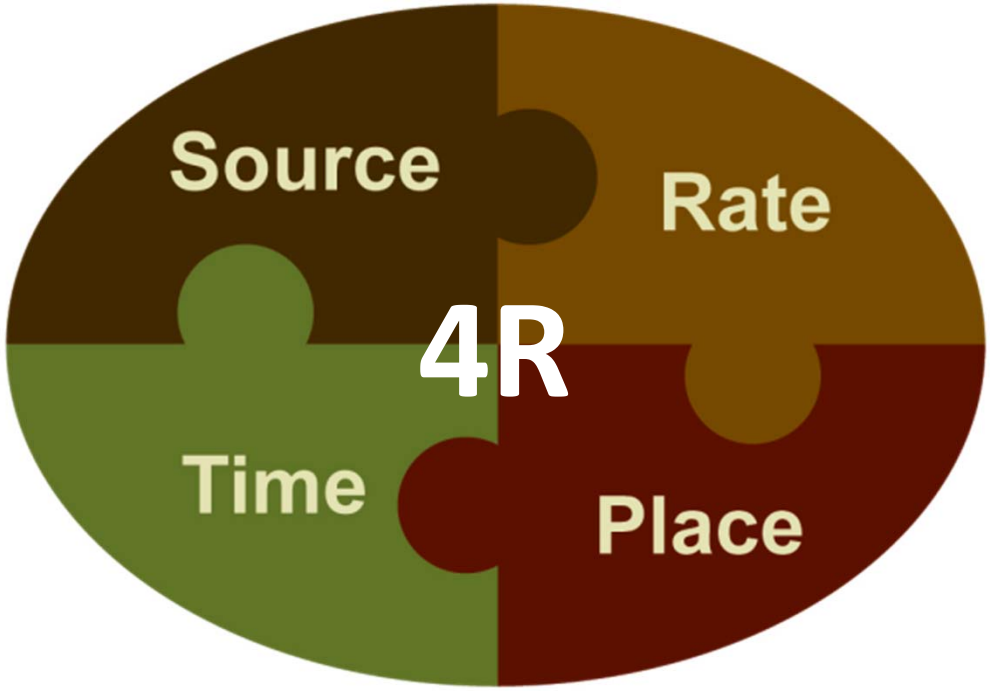
The 4 Rs of nutrient management



Nitrogen in compost

Organic N

Mineralization by soil microbes

Ammonium (NH_4^+)

Volatili-zation

Ammonia (NH_3)

Nitrification

Nitrate (NO_3^-)

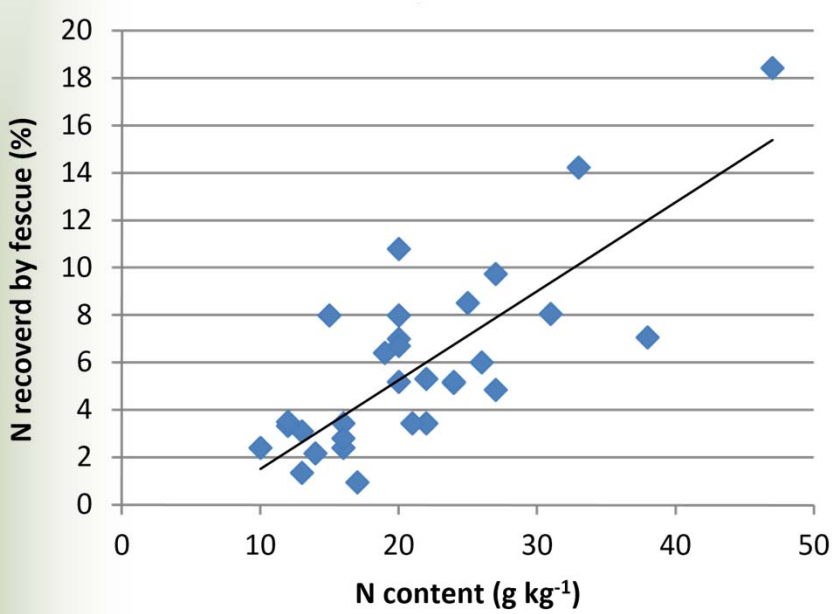
Denitrifi-cation

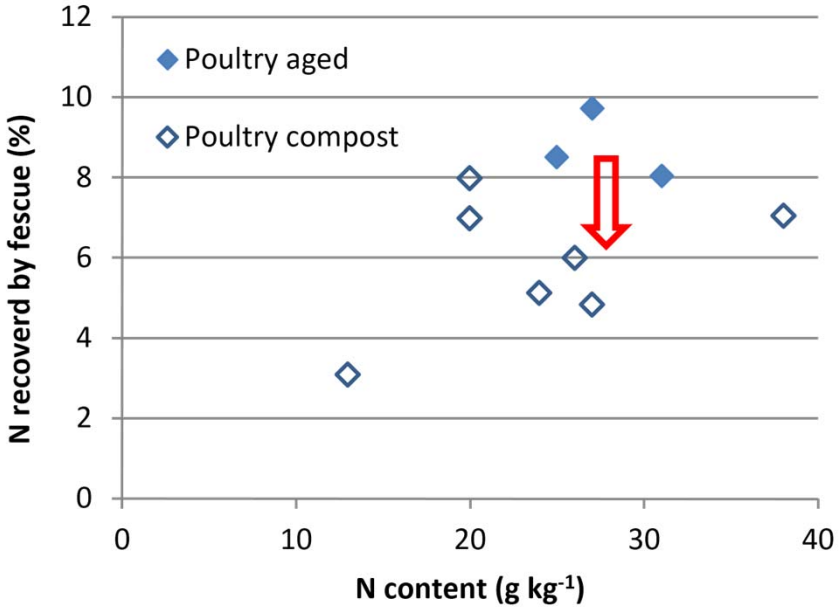
N_2, N_2O

Soil microbes

Leaching

N mineralization rate of organic amendments





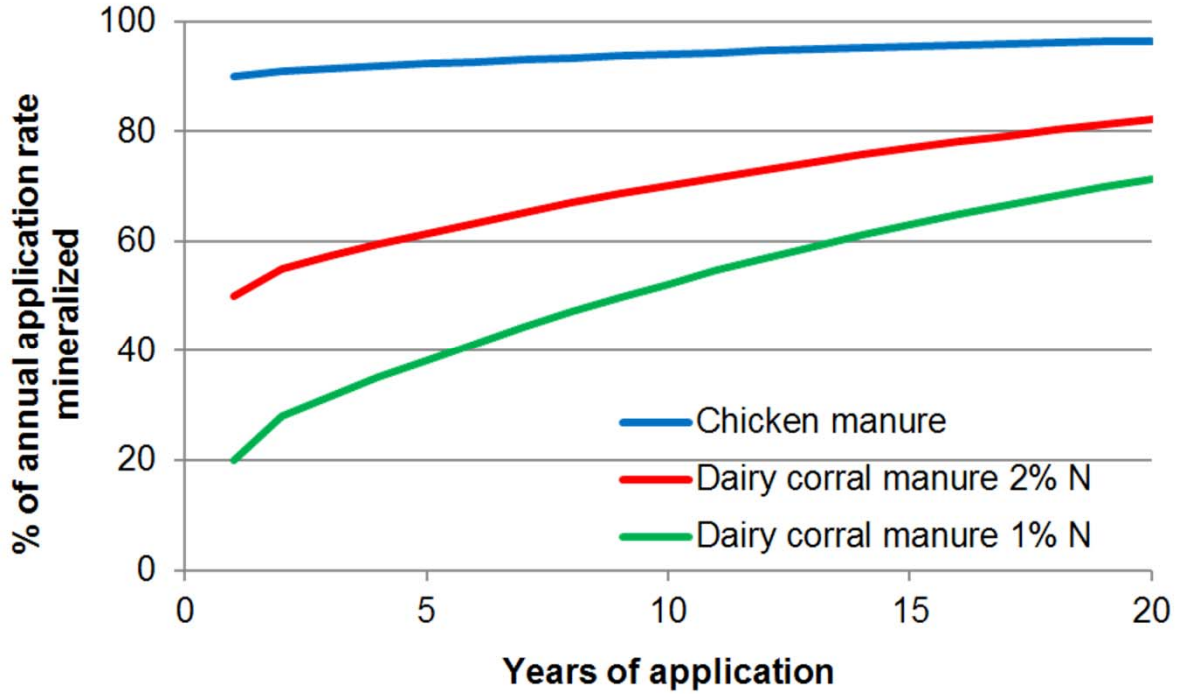
Hartz, 2000

Composting

- C is respired, N is generally preserved
  ⇨ N content (in %) increases
- Readily available material is decomposed, more recalcitrant material is left behind
  ⇨ Decomposition rate is lowered

Long-term effect of manure

Decay series				
Chicken manure		0.9	0.1	0.05
Dairy corral manure	2% N	0.5	0.1	0.05
Dairy corral manure	1% N	0.2	0.1	0.05



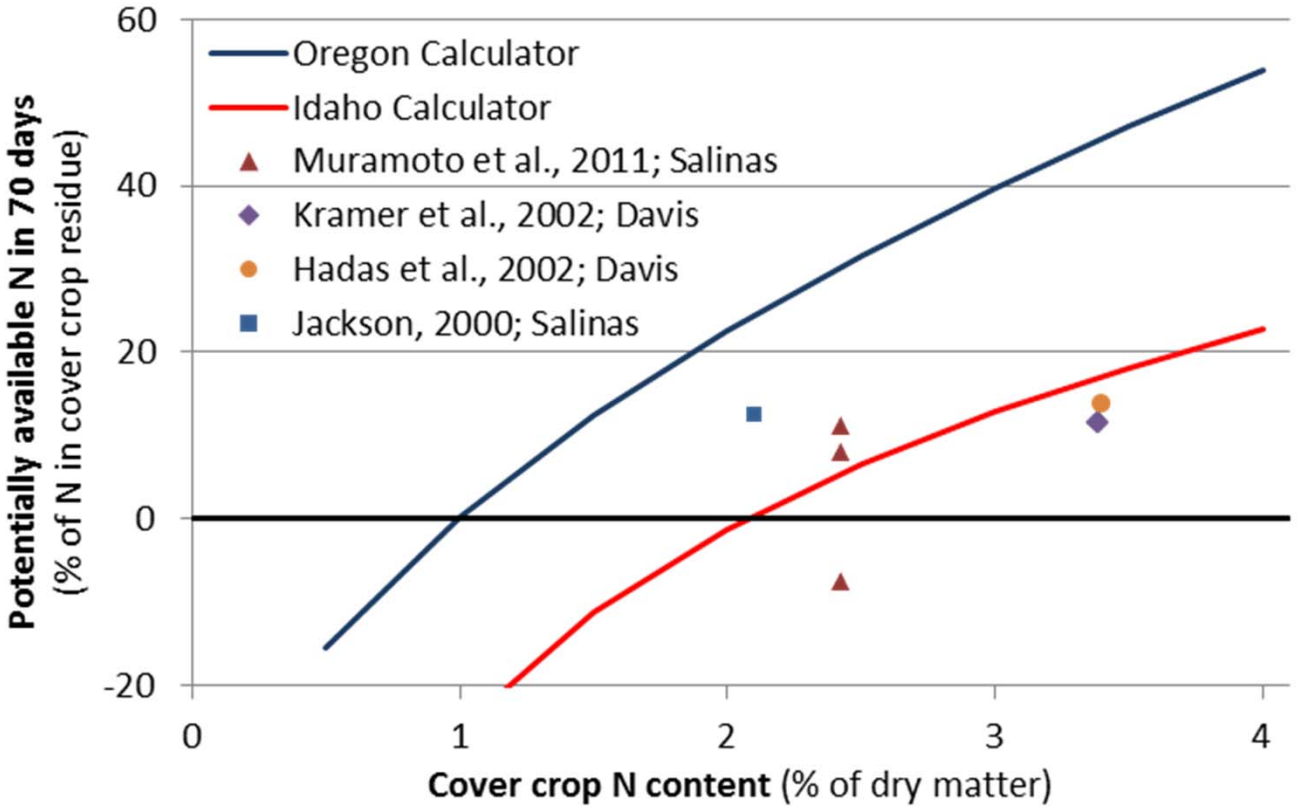
Pratt et al., 1973, 1976

Estimated availability of organic N in manures

Manure type	% applied organic N mineralized		
	Initial 4-8 weeks	Year 1	Year 2
Dairy lagoon water	15-35	40-50	15
Dairy lagoon sludge and slurry; corral manure	10-20	20-30	15
Dairy mechanical screen solids	5-15	10-20	5
Aerobically composted cattle or horse manure (finished or mature)	0-7	0-10	5
Solid poultry manure	20-35	50	15

Pettygrove et al., 2009; Hartz et al, 2000; Gale et al., 2006

Available N from cover crops

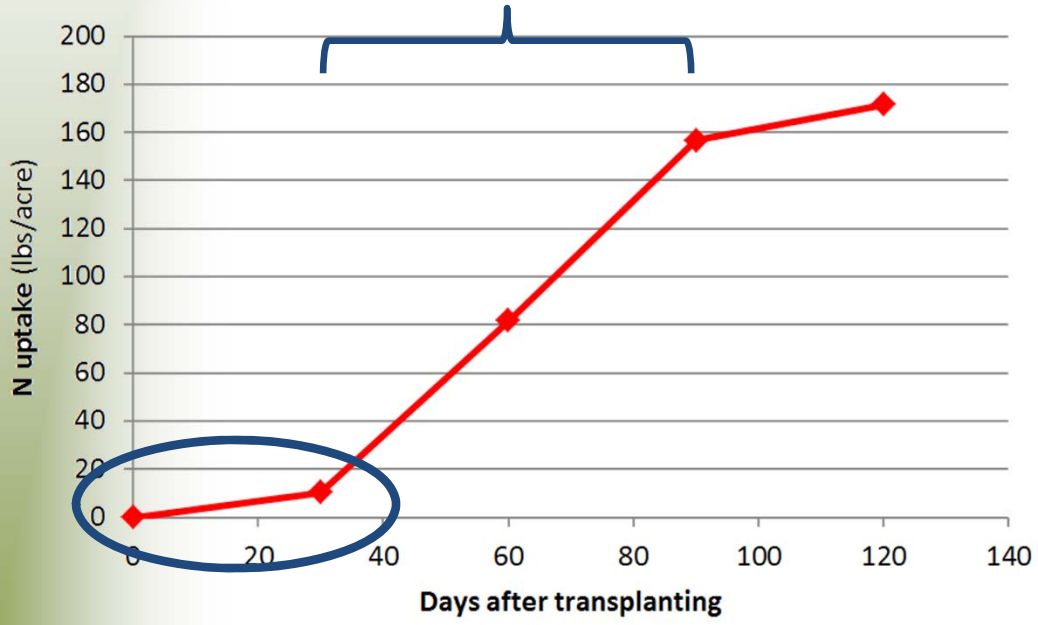


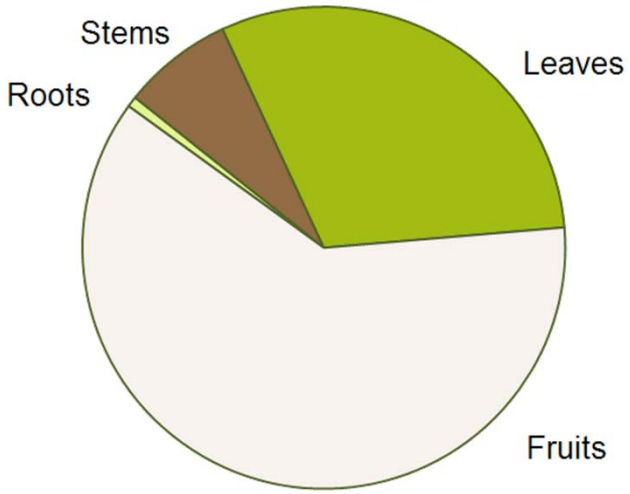
Oregon: http://smallfarms.oregonstate.edu/calculator

Idaho: http://www.extension.uidaho.edu/nutrient/CC_Calculator/CC_page.htm

Nitrogen uptake and partitioning

17 lbs N/acre per week





Marketable yield: 40 tons/acre

Ozores-Hampton et al., 2015

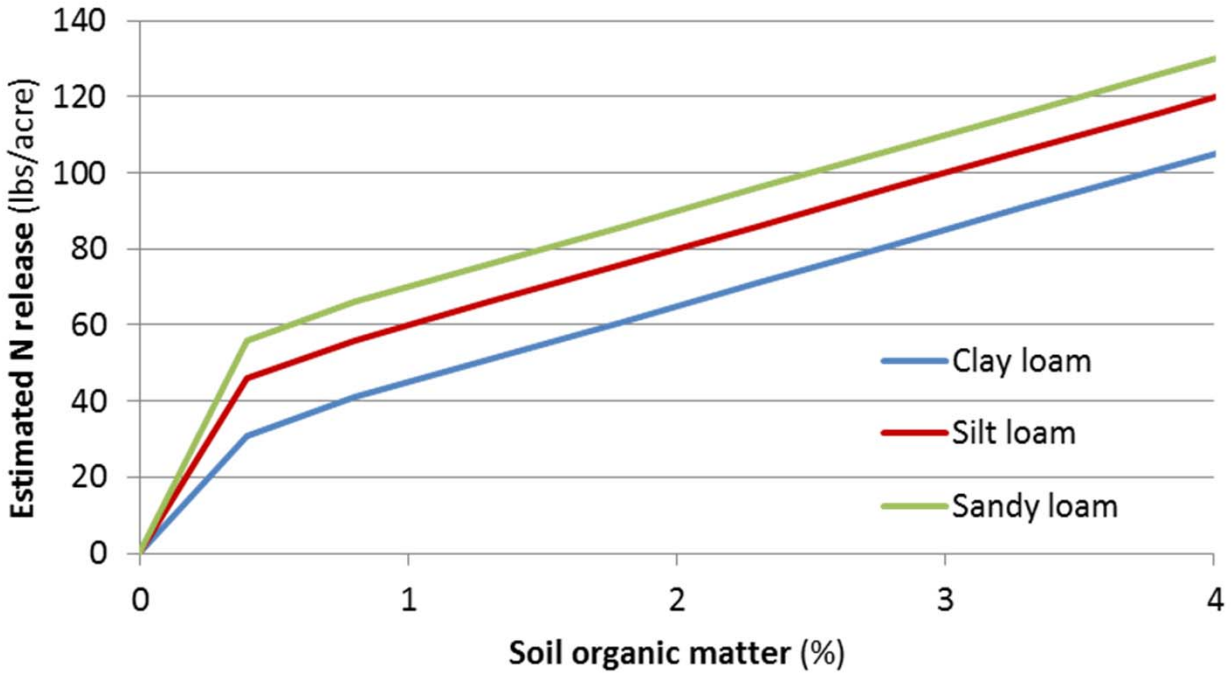
Assessing nitrogen availability

- Nitrogen budgets
- Soil nitrate test, compare with N uptake curve
- Plant tissue analysis

In-season corrections:

- Readily available, water soluble products may be very expensive

N mineralization from soil organic matter: Estimated N release



Estimated N release when SOM is >0.5%:

20 lbs N per % SOM plus 25-50 lbs N

Midwest Laboratories, 2005

How are residual nitrate and N mineralization potential related?

Origin of residual nitrate:

- Leftover N from last season
- N mineralized in spring

How much these two sources contribute depends on

- Last season's N management
- Winter rain
- Time last heavy rainfall occurred
- Temperature in spring

Phosphorus availability

- Common soil tests in California:
  - Olsen (bicarbonate): soil pH > 6
  - Bray1: soil pH > 6
- Soil tests are indices of inorganic P availability
- 30-80% of P in organic form

⇨May underestimate available P in soils with high and active soil organic matter content

⇨Compare P input with P export

Potassium availability

- Common soil tests in California:
  - Ammonium acetate extraction
- Index of available K^+ in soil
- K is not a component of organic molecules

Nitrogen, phosphorus and potassium in fruits

Source	N	P	K
	(lbs/ton of fruits)		
NRCS	3.07	0.57	5.13
IPNI	2.50	0.40	4.70
Kleiber, 2014	2.44	0.60	5.51
Ozores-Hampton et al., 2015	3.00	0.84	4.43
Average	**2.75**	**0.60**	**4.94**

	lbs/ton	Relative
N:	2.75	100
P_2O_5:	1.37	50
K_2O:	5.93	215

Nutrients in manure and compost

Material	N	P_2O_5	K_2O
Tomato fruits	**100**	**50**	**215**
Chicken manure	100	163	55
Poultry manure	100	76	39
Steer manure	100	71	171
Dairy manure	100	49	149
Horse manure	100	40	70
Pig manure	100	63	67
Compost	100	30	60

Penhallegon, 2005; California Master Gardener Handbook, 2002

Nutrients in organic amendments

Material	N	P_2O_5	K_2O
Tomato fruits	**100**	**50**	**215**
Hoof and horn meal	100	16	0
Blood meal	100	12	5
Bone meal	100	575	0
Fish meal	100	55	0
Soybean meal	100	17	21
Cottonseed meal	100	55	32

Penhallegon, 2005; California Master Gardener Handbook, 2002

Potassium-rich fertilizers

Material	N	P_2O_5	K_2O
	---------- (%) ----------		
Wood ashes	0	2	6
Kaolinite [1)]	0	0	12
Greensand [1)]	0	1.5	5
Potassium sulfate	0	0	50

[1)] Slowly available

Penhallegon, 2005; California Master Gardener Handbook, 2002

Potassium deficiency

Leaves: Mottled chlorosis (yellowing) and tip burn

Fruits: Yellow shoulder (K deficiency is not only cause)

Eric Sideman (http://www.mofga.org)

Addressing the issue

- Compare N, P, K removal and input across entire rotation
  - NRCS: http://plants.usda.gov/npk/main
  - IPNI: https://www.ipni.net/app/calculator/home
- Soil and tissue sampling to detect long-term trends
- Check for deficiency symptoms
- Add K fertilizer to small plots in field and check for differences in yield and quality

Thank you!