Accounting for plant-available nitrogen from cover crops in vegetable production systems

Dan M. Sullivan
OSU Extension Soil Scientist
&
Nick Andrews
OSU Small Farms Extension

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WESTERN SARE
Sustainable Agriculture Research & Education

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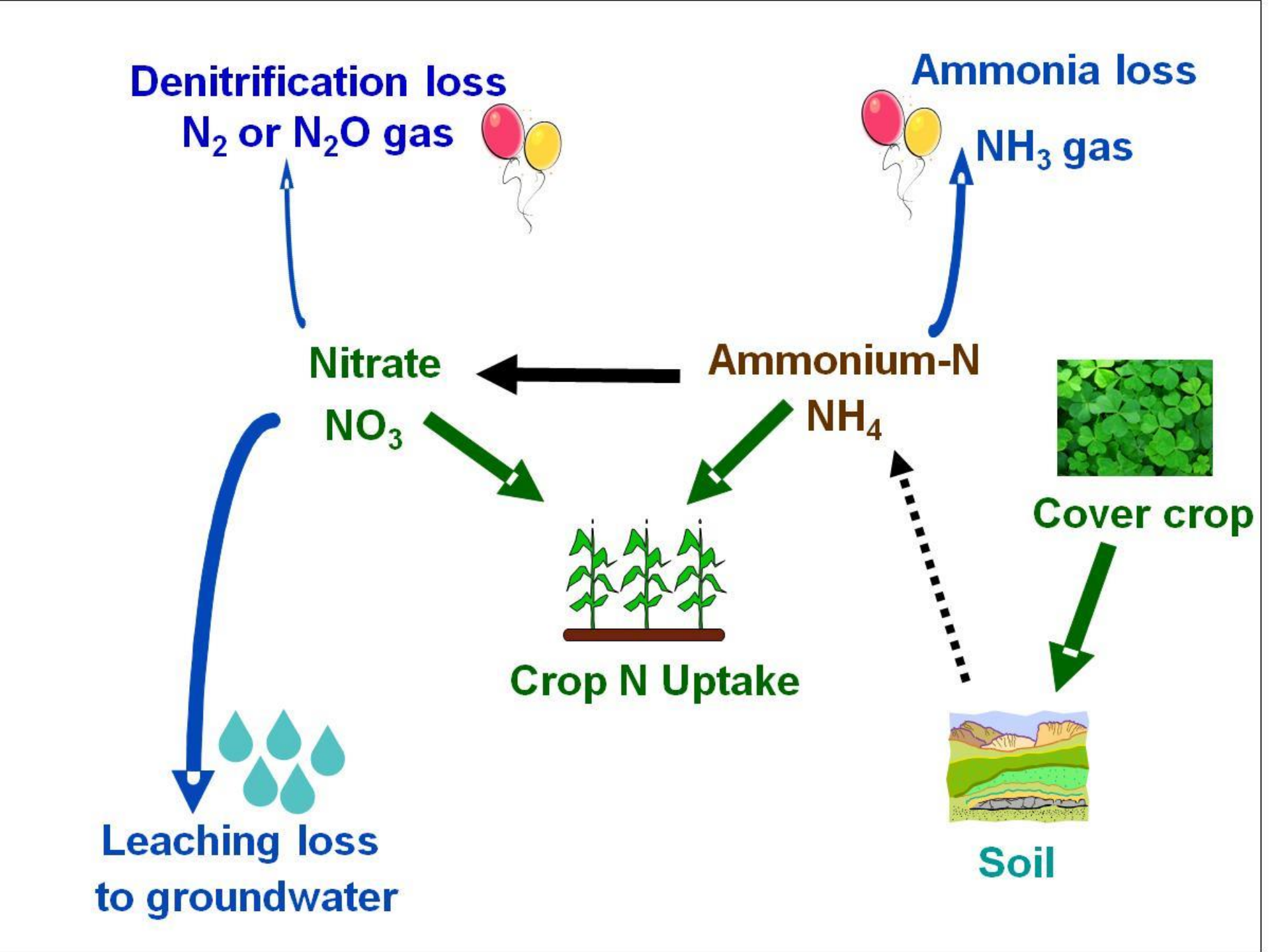
Extension Service


Denitrification loss
N_2 or N_2O gas
Ammonia loss
NH_3 gas
Nitrate
NO_3
Ammonium-N
NH_4
Cover crop
Crop N Uptake
Leaching loss
to groundwater
Soil

Mineralization: rate limiting process in OM -> plant available N

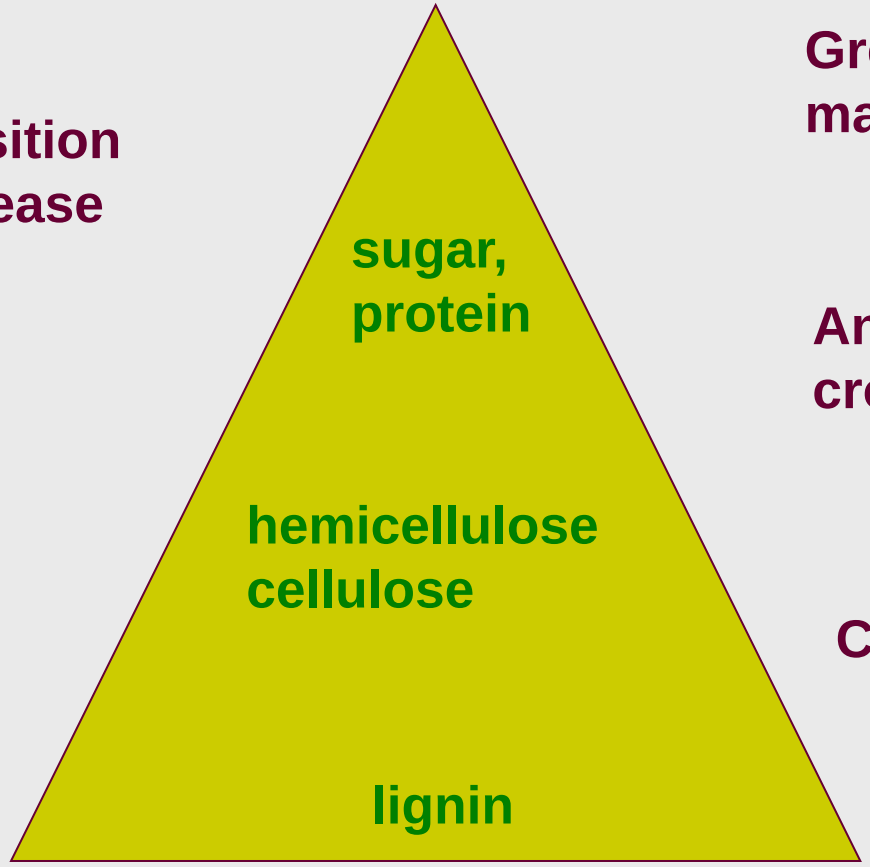
Release of N from "stable" organic matter

- 1 to 4% of soil organic N mineralized each year
- function of environment: temp, moisture, pH, aeration

Release of N from "fresh" organic matter additions

- function of C:N ratio
- release 0 to 60%+ of N

Organic matter "stability"



Green leafy plant material

Animal manure, crop residue (straw)

Compost

Humus

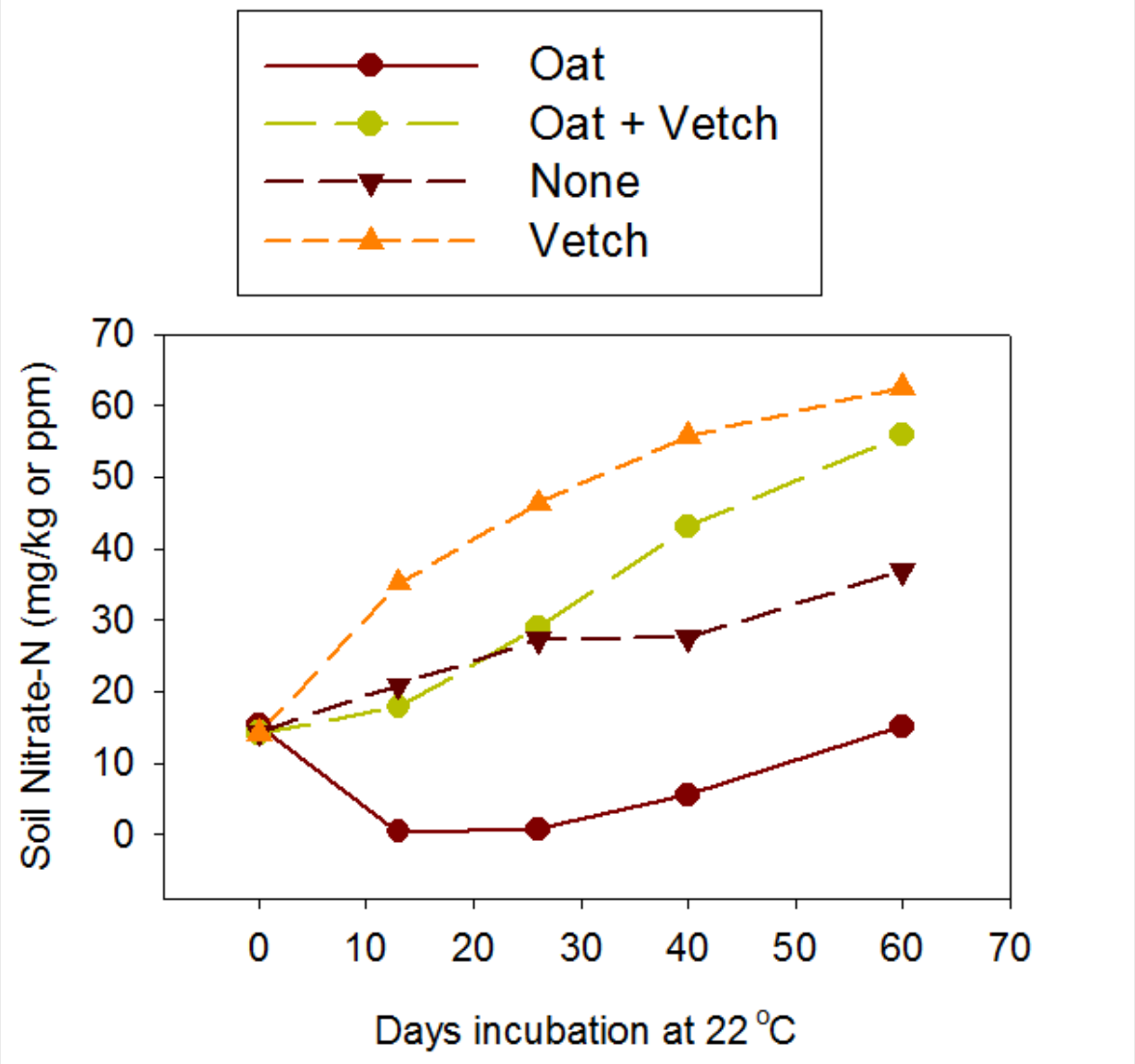
rapid decomposition and nutrient release

CO_2

very slow decomposition ("stable")

Adapted from: SARE Handboook 4, Building Soils for Better Crops, Fig 8.1

Incubation of cover crop in lab (nitrate-N accumulation = N mineralization)



Datta, Garrett et al., 2008

Soil Fertility in Organic Systems: A Guide for Gardeners and Small Acreage Farmers

A PACIFIC NORTHWEST EXTENSION PUBLICATION • PNW646

Step-by-step guide to determining an organic nitrogen fertilizer rate:

	Steps	Information source
1	General crop nitrogen recommendation	University nutrient management guides

Crop N requirement

Table 1. Nitrogen requirement of vegetable crops based on seasonal nitrogen uptake

Low Total N Need <120 lb/acre	Medium Total N Need <120-200 lb/acre	High Total N Need >200 lb/acre
Baby greens	Carrot	Broccoli
Beans	Corn, Sweet	Cabbage
Cucumbers	Garlic	Cauliflower
Radish	Lettuce	Celery
Spinach	Melons	Potato
Squashes	Onion	
	Peppers	
	Tomatoes	

— Gaskell et al. 2006, Soil Fertility Management for Organic Crops

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Cover crop PAN

1. Plant-available N (PAN)
2. Produced by soil biota. Called "mineralization"
3. Organic N to nitrate-N (plant-available)
4. Based on:
   - Biomass (dry matter)
   - Total N concentration in dry matter
   - Estimate (0 to 50%) of cover crop total N that is converted to plant-available nitrate-N

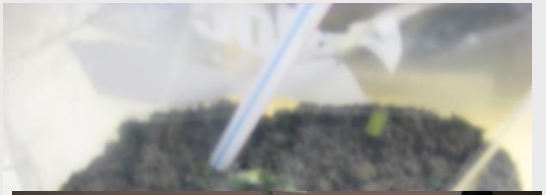
Predicting PAN from cover crops


101
202
203

Incubations to measure plant-available N

Cut cover crop or "amendment"

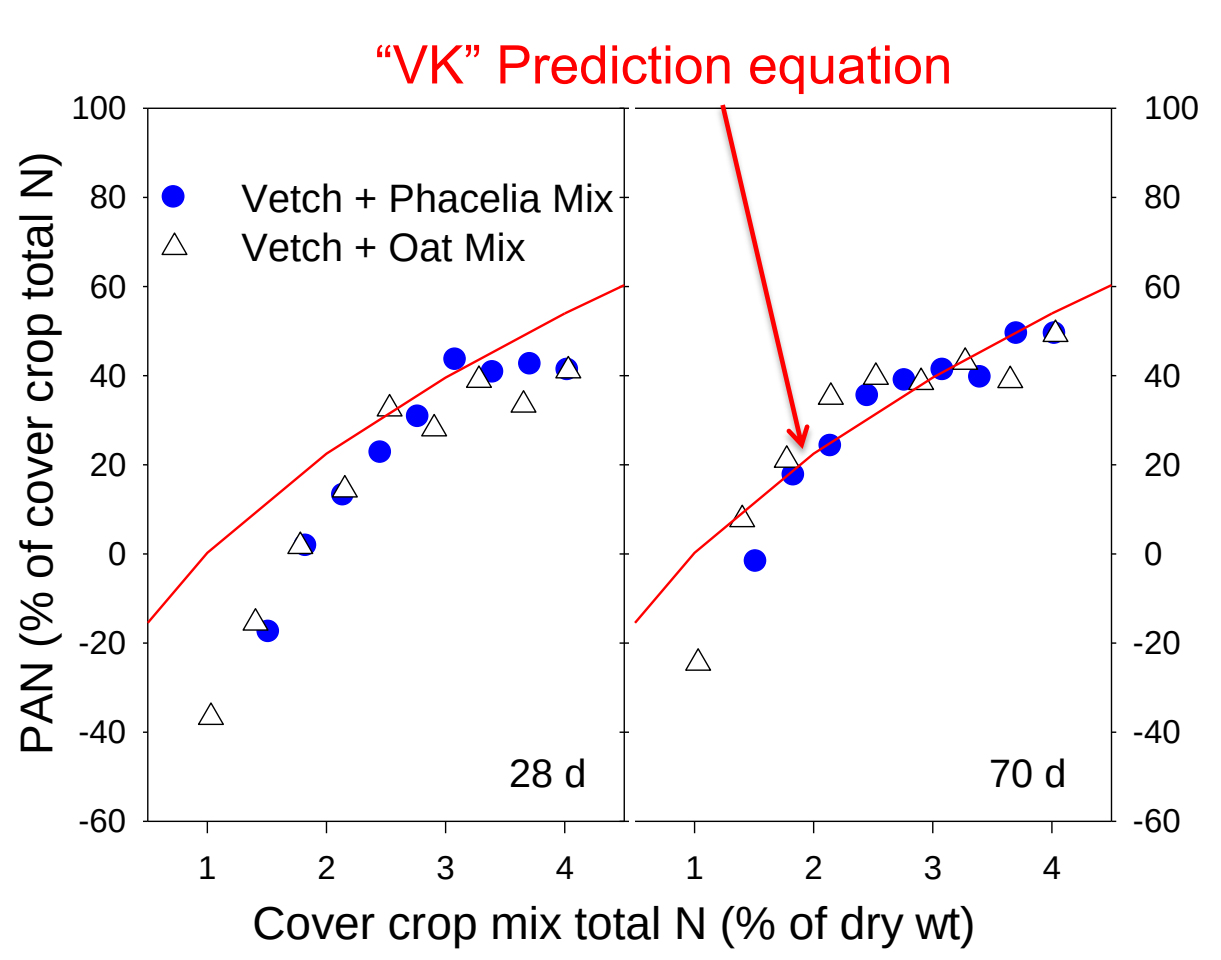
Add to 0.9 L (1-qt) freezer bag



Mix with moist soil (200 to 250g H_2O/kg)

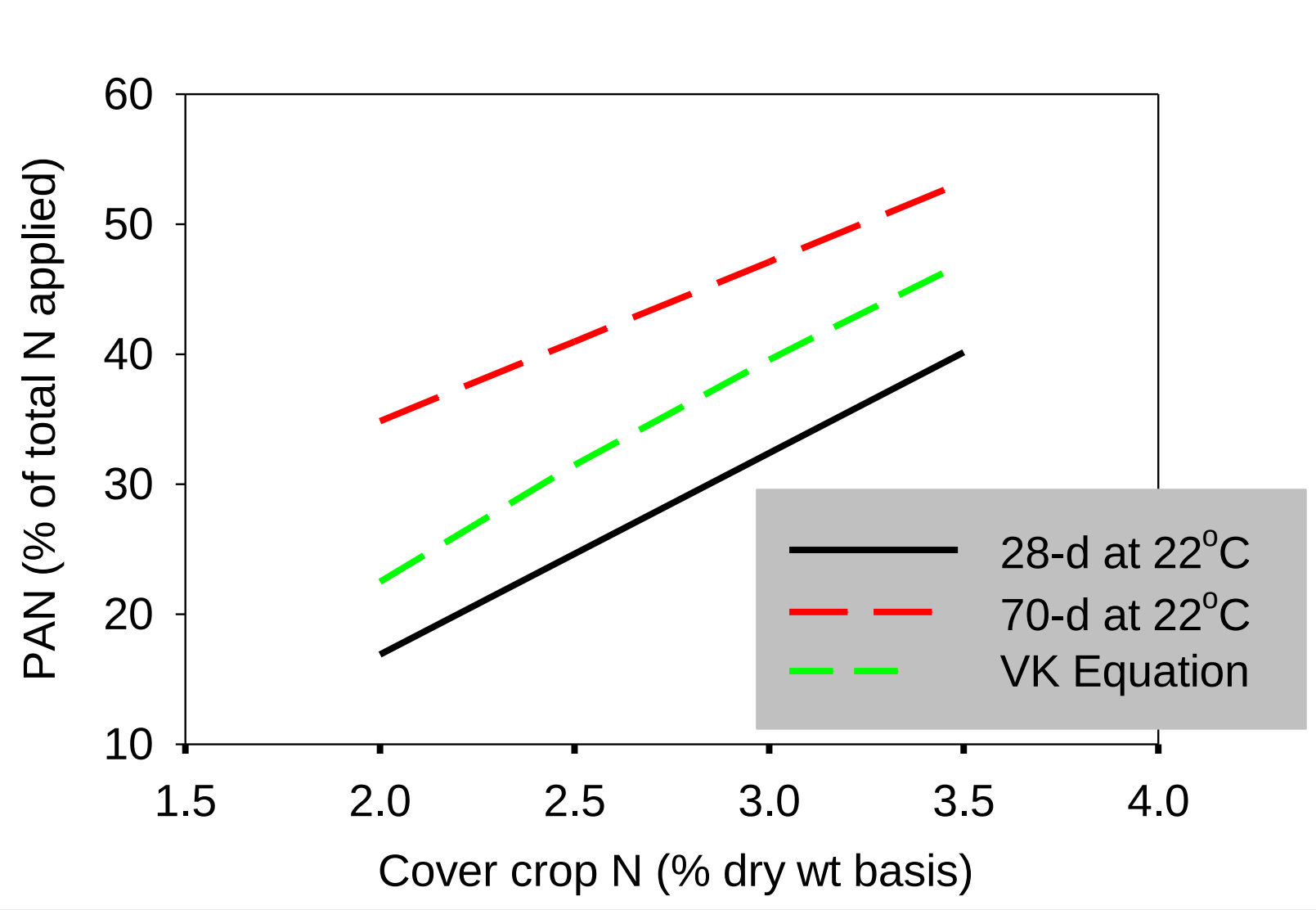
Incubate at room temperature (22 °C); extract soil; measure nitrate-N

PAN for cover crops (OSU Calculator)
cover crop mixes, 2008



Prediction Equation: Vigil and Kissel (1991) SSSAJ 55:757

Three yr summary:
VK Equation vs. lab incubation (22°C or 72°F)



Sullivan and Andrews, 2011 WNMC proceedings

Cover crop PAN: PNW 636

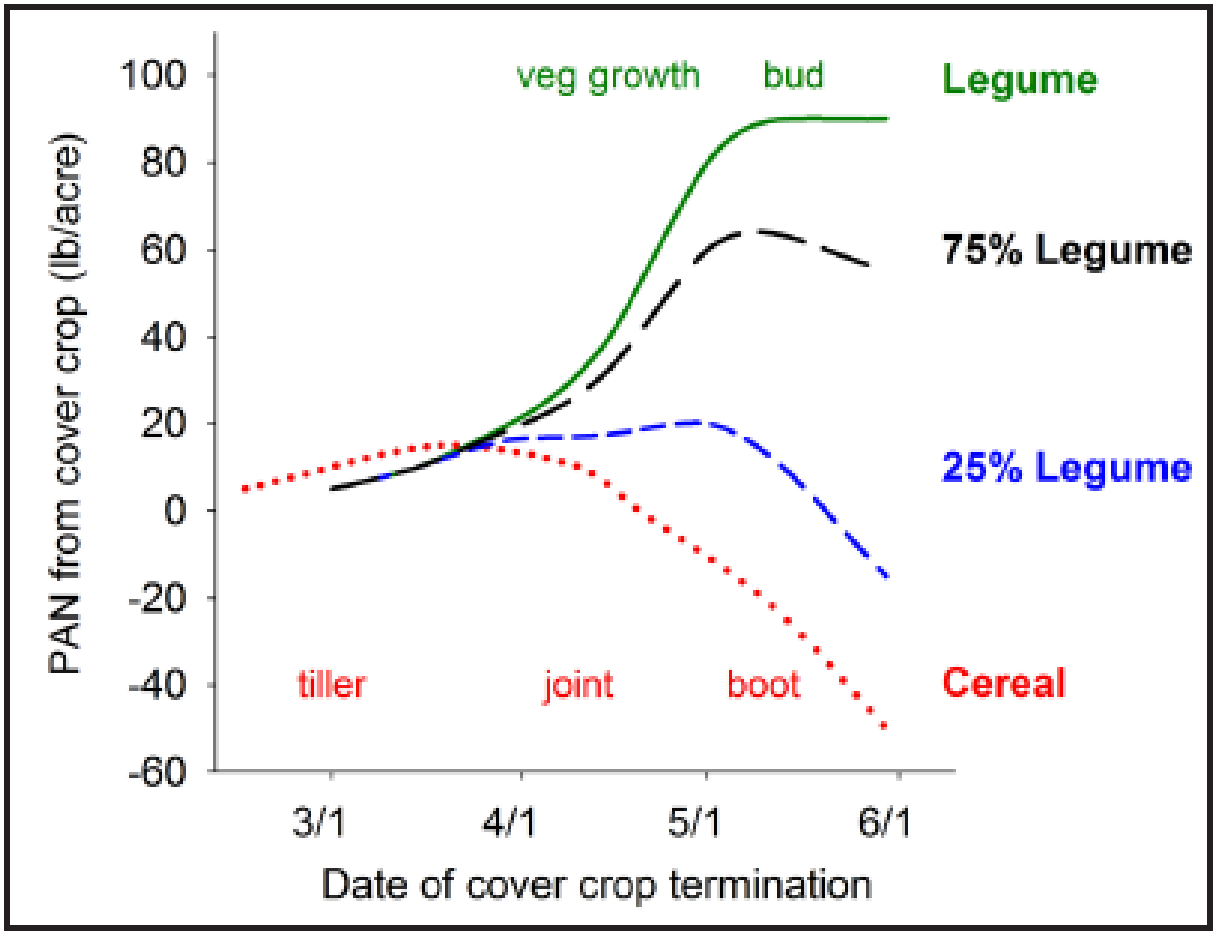


Figure 4. Effect of kill date on typical plant-available N (PAN) release from cereal, legume, or mixed stands. Based on compilation of field data from Willamette Valley cover crop

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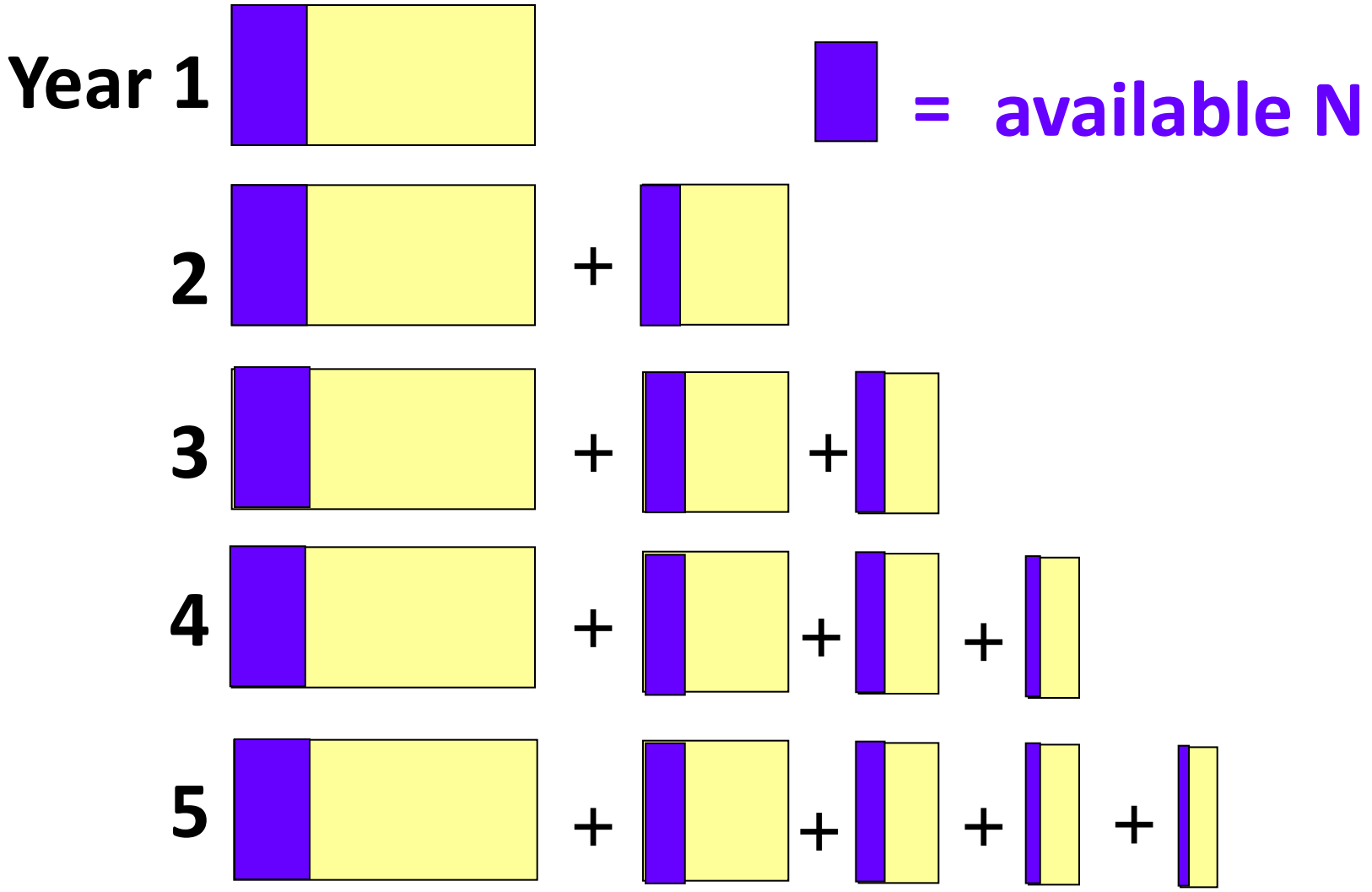
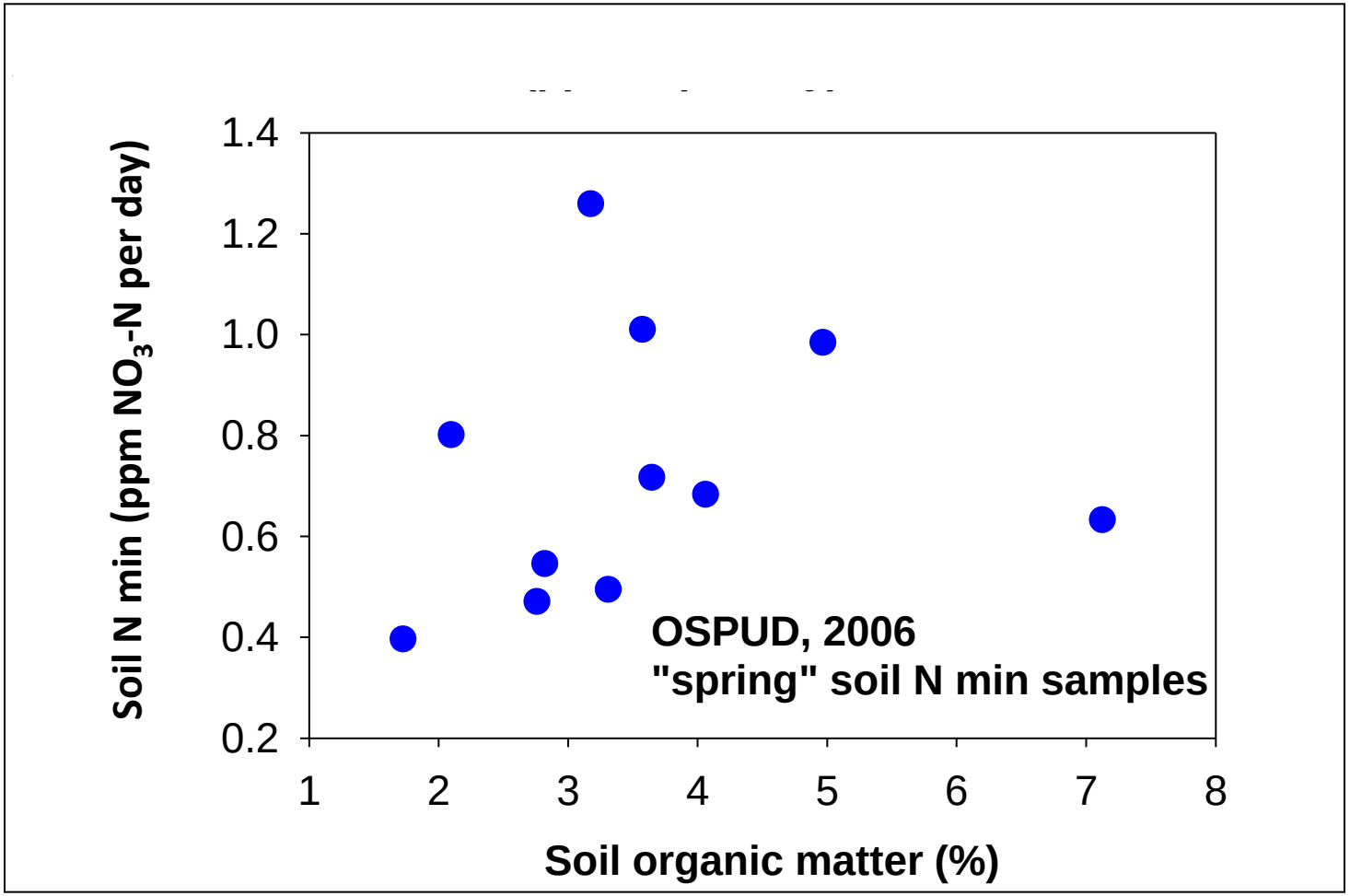
3	**Additional soil organic matter contribution**	**Estimate from previous soil building practices**

Cumulative PAN from an organic source



Courtesy of Dan Sullivan OSU Crop & Soil Science

Does total soil organic matter correlate with N mineralized from soil OM?



PAN from soil organic matter

- Make pre-plant estimate based on field/farm history, rotation, etc.
  - Ballpark estimate: after 3 years of organic management with increased organic inputs, PAN from soil organic matter will increase by at least 50 lb N/acre
- Monitor soil nitrate in growing season (PSNT timing) and crop performance
- Adjust N mineralization credit for future years

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4	**Site specific nitrogen recommendation**	**Line 1 – line 2 – line 3**
5	**Fertilizer PAN**	**OSU Organic Fertilizer & Cover Crop Calculator**

New from Pacific NW Extension: Fertilizing with Manure and other organic amendments (PNW 533)

PAN from uncomposted manure (PNW 533)

Type	C/N ratio	Available N[c]		
		% of total N	lb/ton as-is	lb/cubic yd
Broiler with litter	11	40 to 60	22–34	10–14
Laying hen	8	40 to 60	16–24	11–16
Turkey	9	40 to 60	20–30	10–15
Rabbit	12	20 to 40	4–8	3–6
Sheep	12	20 to 40	3–7	2–5
Goat	14	15 to 30	2–5	2–4
Beef	15	15 to 30	2–4	1.5–3
Llama	15	15 to 30	2–4	1.5–3
Alpaca	15	15 to 30	2–4	1.5–3
Stockpiled dairy manure[f]	15	10 to 20	2–4	1–2
Horse no bedding	20	0 to 15	0–1	0–0.7
Horse with bedding	30	-5[g] to 10	< 1	< 1
Dairy cow separated solids	32	-5 to 10	< 1	< 1

PAN from composted manure (PNW 533)

	Total N	C/N ratio	Available N[c]		
	% dry weight		% of total N	lb/ton as-is	lb/cubic yd
Broiler litter "compost"[e]	3.8	10	30 to 40	12–18	6–9
Rabbit manure compost	1.8	10	15 to 30	2–5	1.5–3
Beef manure compost	1.4	11	0 to 10	2–4	0.8–1.6
Separated dairy solids compost	2.1	18	0 to 10	0–1	0–0.7

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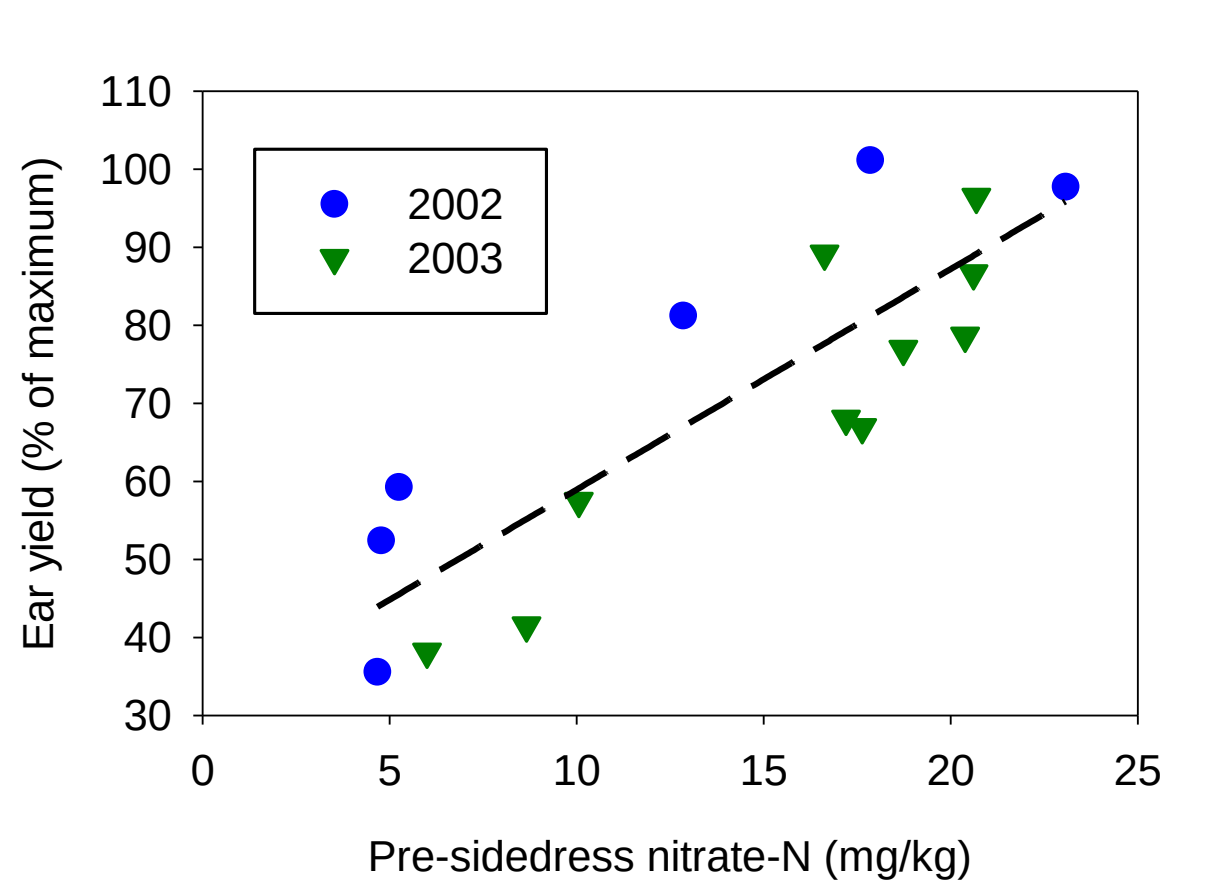
5	Fertilizer PAN estimate and fertilizer application rate	OSU Organic Fertilizer & Cover Crop Calculator
6	**Adjust nitrogen rates based on monitoring**	**Soil tests and observations of crop performance**

Soil nitrate monitoring during growing season

- Integrates all factors related to plant-available N supply
- If soil nitrate-N is 25 ppm in one foot of soil with typical bulk density (1.3 g/cm^3) for silt loam soil
- Then about 90 lb plant-available N present in soil today
- More mineralized tomorrow.

Sweet corn, mid-season soil nitrate-N vs. yield



data point= site-yr for a preplant compost or manure application

David Brown, Mustard Seed Farms

80 ac organic fresh vegetables

“This project helps me evaluate my cover cropping program”

“This year I reduced my fertilizer bill about 60% by working with Nick and Dan and still got great yields”

Scott Latham, Sauvie Island Organics

20 ac organic fresh vegetables, 400 CSA members, 25 restaurants

"We didn’t give our cover crops enough N-credit. The Calculator showed us we were getting twice the N we thought. Now, no N is applied to our head lettuce, we get the same yield and save $275/ac on fertilizer."

“We invest our savings in additional N to our broccoli field and get higher broccoli yields.”

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