

# Soil Nitrates in Idaho: The Basics

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## Dairy Manure Nitrogen



## Manure and Lignin

- Cattle manure contains significantly more lignin than chicken or pig manure.
- Lignin is an extremely stable organic compound and very difficult to decompose, contributing the lower plant availability of N from cattle manure.

Comparing typical lignin contents of various manures to wheat straw.

<b>Substrate</b>	<b>Lignin</b>
Wheat straw	8.9
Cow manure	8.1
Chicken manure	3.4
Pig manure	2.2

Adapted from Cornell University Composting Website:

<http://compost.css.cornell.edu/lignin.table.html>

Accessed on December 3, 2014

Composition of organic N compounds in manures from various animal species. (adapted from Havlin et al., 2005)

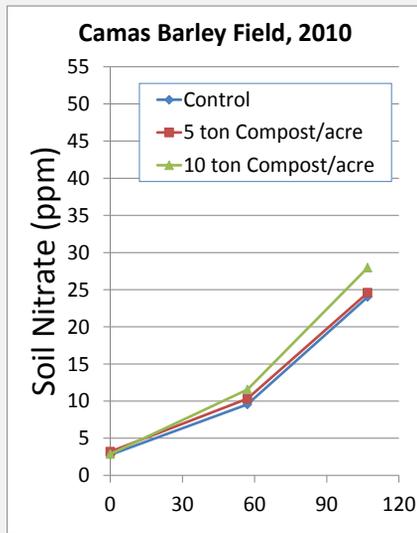
Animal species	Amino acid	Urea	Ammonium	Uric acid	Other (Stable organic N compounds)
Poultry	27	4	8	61	1
Beef	20	35	0.5	0	44
Dairy	23	28	0.5	0	49
Swine	27	51	0.5	0	22

Plant available N from select amendments after 70 day lab incubation

Manure type	% Nitrogen	% Plant Available N in the soil
Dairy Solids	1.4	-6
Dairy Solids Compost	2.0	-2
Broiler Litter	4.2	29

Excerpt from Gale, E.S., D.M. Sullivan, C.G. Cogger, A.I. Bary, D.D. Hephill and E.A. Myhre. 2006. Journal of Environmental Quality. 35:2321-2332.

Nitrogen mineralization after one fall application to an organic dryland barley field in Camas County, Idaho. (unpublished data: Falen, Hunter, Kinder, and Moore)



Days of Incubation

(Day 0 = mid-May, Day 120 = mid-September)

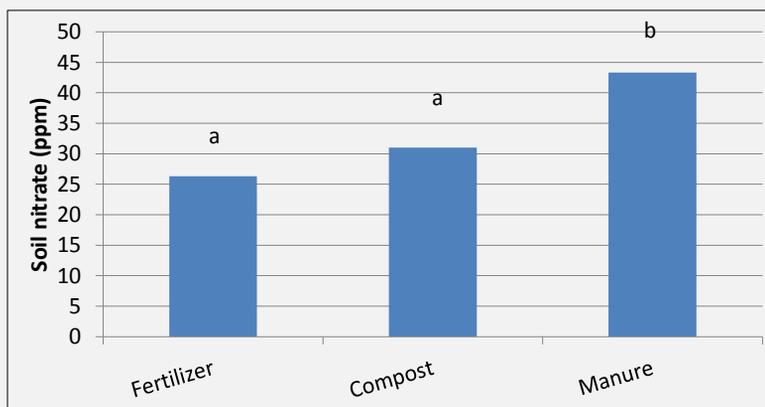
Estimated plant available N from manure, based on a 120-day lab incubation study of soils retrieved from treated plots in late March, 2013. Kimberly, Idaho

(Graybill and Moore, unpublished)

Dairy Manure rate ton/acre	Total N applied (lb/acre)	Plant available N from manure only (lb/acre)	Amount of plant available N in manure (%)
20	300	29 c	10
40	600	62 b	10
60	900	87 a	10

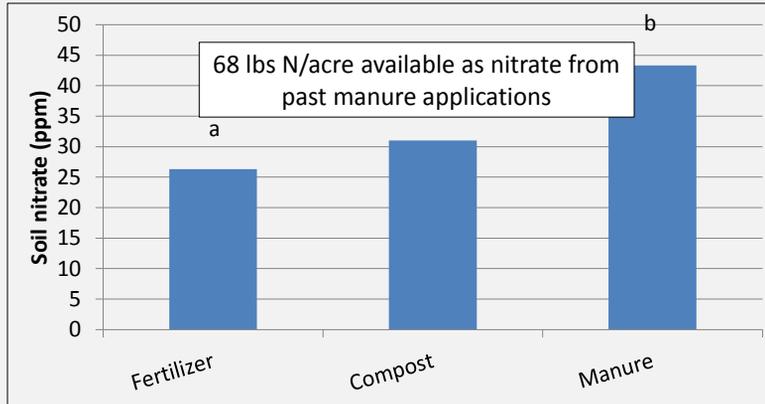
## When does the rest of the N mineralize?

Residual nitrate (0-12 inch depth), three years after last manure or compost application. Kimberly, Idaho.



Moore, A.D., N.L. Olsen, A.M. Carey, and A.B. Leytem. 2011. Residual effects of fresh and composted dairy manure application on potato production. *American Potato Journal of Research*. 88:324-332.

Residual nitrate (0-12 inch depth), three years after last manure or compost application. Kimberly, Idaho.



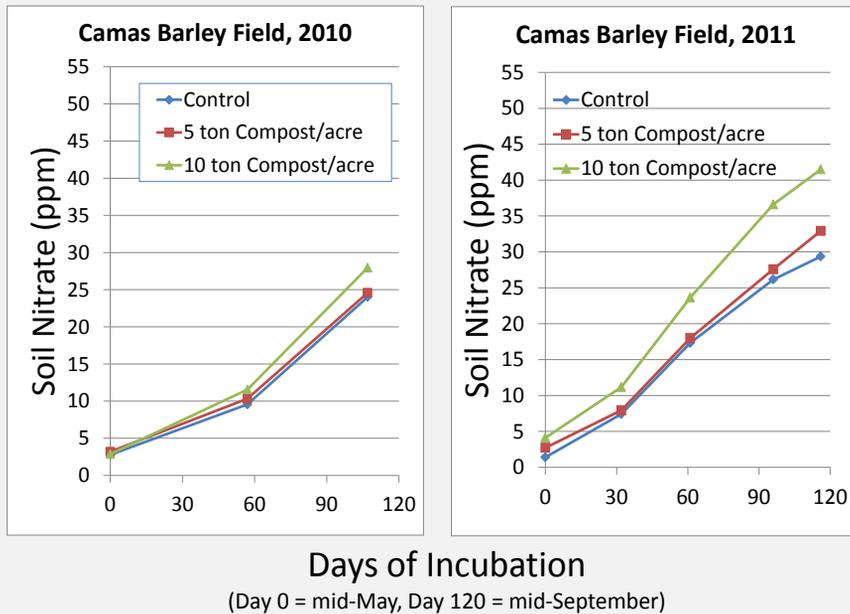
Moore, A.D., N.L. Olsen, A.M. Carey, and A.B. Leytem. 2011. Residual effects of fresh and composted dairy manure application on potato production. *American Potato Journal of Research*. 88:324-332.

Percent of Plant Available Nitrogen following a one-time compost or manure fall application

Year following a 1-time application	Composted dairy manure (12 or 28 dry ton/acre)	Stockpiled dairy manure (10 or 20 dry ton/acre)
First year	-4.2%	17.4%
Second year	4.3%	17.0%
Third year	4.8%	11.4%

Lentz, R.D. and Lehrs, G.A. and Brown, Bradford and Johnson-Maynard, J. and Leytem, A.B. (2011) *Dairy Manure Nitrogen Availability in Eroded and Noneroded Soil for Sugarbeet Followed by Small Grains*. *Agronomy Journal*. 103(3):628-642.

Nitrogen mineralization after 1 and 2 years of dairy  
compost fall applications. *(unpublished data: Falen, Hunter, Kinder, and Moore)*



## Fertilizer Nitrogen

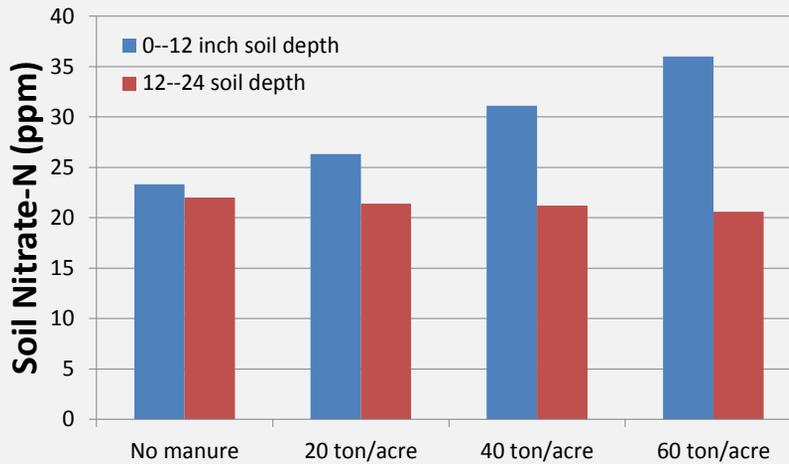
- Urea, Ammonium, and Nitrate
- Urea is technically an organic N compound, but one that is extremely mineralizable
- Lack of stable organic N compounds, very susceptible to nitrate leaching
- The more that fertilizer N can be applied/released when the plant needs it, the less nitrate leaching

## Temperature and Nitrate Leaching

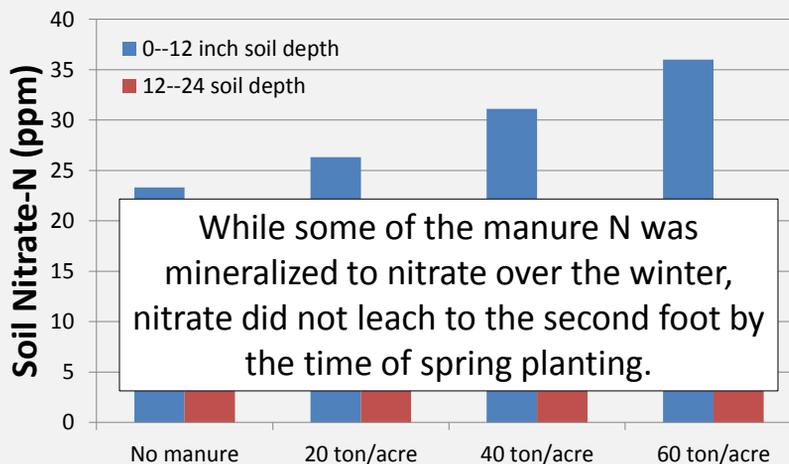
Soil temperature (F)	% nitrification
41	30
59	60
86	100

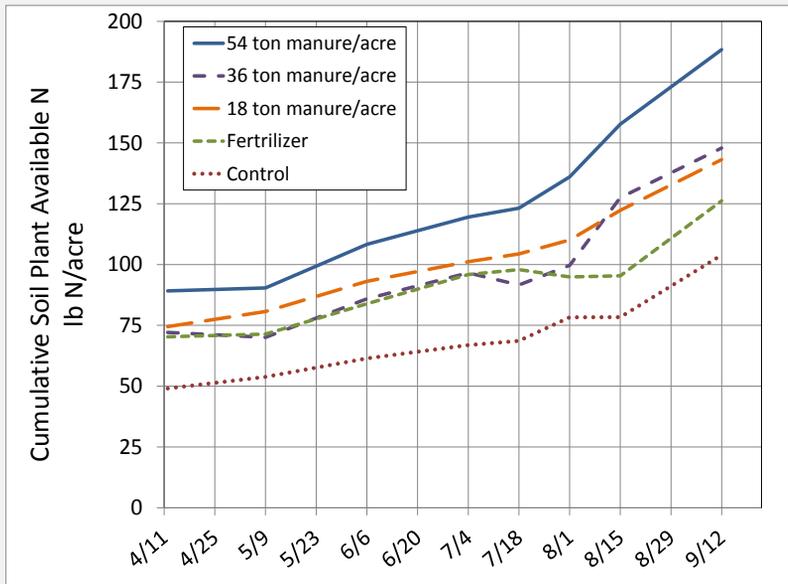
*Chandra, 1962, Canadian Journal of Soil Science 42:314.*

Spring soil nitrate levels, following a November manure application in Kimberly, Idaho (2013).  
Portneuf silt loam. Moore, unpublished.

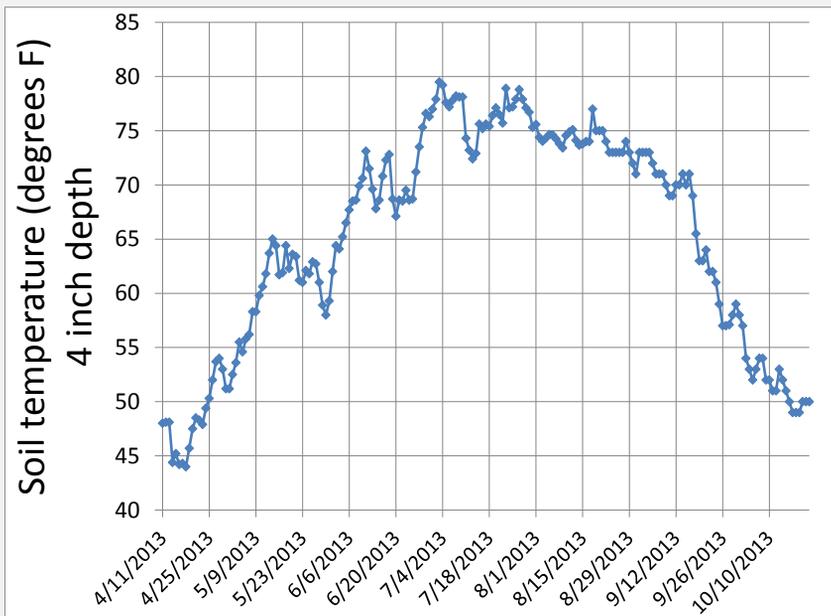


March soil nitrate levels, following a November manure application in Kimberly, Idaho (2013).  
Portneuf silt loam. Moore, unpublished.





Nitrogen mineralization patterns (0-12 inch soil depth) in year 1 of the long-term dairy manure application study. Kimberly, Idaho 2013. Moore, unpublished.



Soil temperature (4 inch depth) in 2012, Kimberly, Idaho. (Data from Agrimet weather database)

Soil temperature (F)	% nitrification
41	30
59	60
86	100

*Chandra, 1962, Canadian Journal of Soil Science 42:314.*

## Dairy Manure Type and Nitrate Leaching



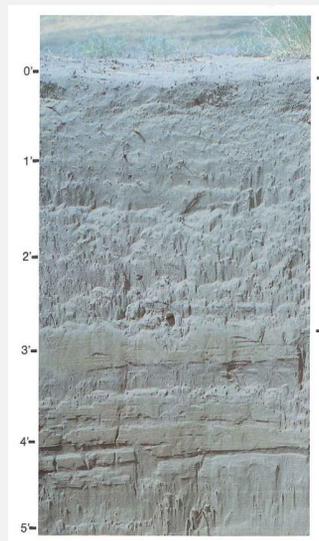
## Dairy Manure Type

- General rules of thumb
  - More liquid usually means more ammonium and readily mineralizable N
  - More turning usually means more stable organic N, less ammonium and readily mineralizable N
- How to account for various forms?
  - Manure testing
  - Analyze for moisture, Total N, ammonium, and nitrate
  - Takes out the guessing

## Soil Type and Nitrate Leaching



Portneuf Silt Loam



Quincy Sand

## Soil type

- Sandy soils
  - Very susceptible to nitrate leaching
  - Prefer spring over fall manure applications for sands
  - Fall applications of compost to sands are fine
  - Liquid manures and N fertilizers are especially susceptible to nitrate leaching on sandy soils
    - Apply when plants need N
    - Apply smaller amounts more often
    - Monitor soil test N level in-season, if possible

## Soil Test N



## Soil test N

- Recommend a yearly preplant soil test (at least to a two foot depth) for ammonium and nitrate
  - A strong indicator of nitrate leaching potential
  - Easier and more accurate than trying to predict N availability based on previous practices
- Can also include a pre-sideress N soil test, especially if there is a history of manure applications

## PSNT (Pre-Sidedress Nitrate Test)

- Pull a second soil sample in mid-June (or when corn is at the 4-6 leaf stage in your area)
- Analyze for ammonium and nitrate
- The idea – Warmer temperatures will allow N mineralization to occur, releasing plant available N into soil. Wait too long, plants will use it up, won't be able to catch it in a soil test.
- PSNT will give you a more accurate idea of how much N is releasing from your soil than the preplant soil test.

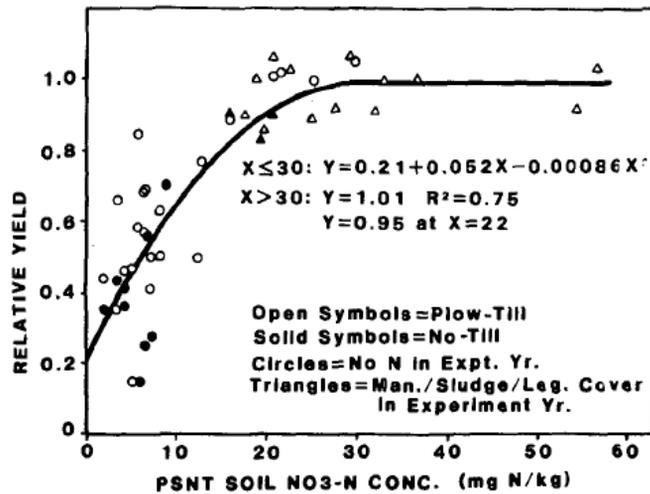


Fig. 1. Relation of corn relative yield to soil NO<sub>3</sub>-N concentration in surface 30 cm of soil.

Meisinger, J.J., V.A. Bandel, J.S. Angle, B.E. O'Keefe, and C.M. Reynolds. 1992. Presidedress Soil Nitrate Test Evaluation in Maryland. Soil Sci. Soc. Am. J. 56:1527-1532.

## Summary

- Dairy manure/compost is predominantly stable organic N compounds that take several years to release as nitrate
  - Repeated loading at intensive rates can lead to nitrate leaching
- Fertilizer N is nitrate and/or readily N mineralizable compounds
  - Conversion to nitrate can occur within days or weeks, depending on soil temperature

## Summary

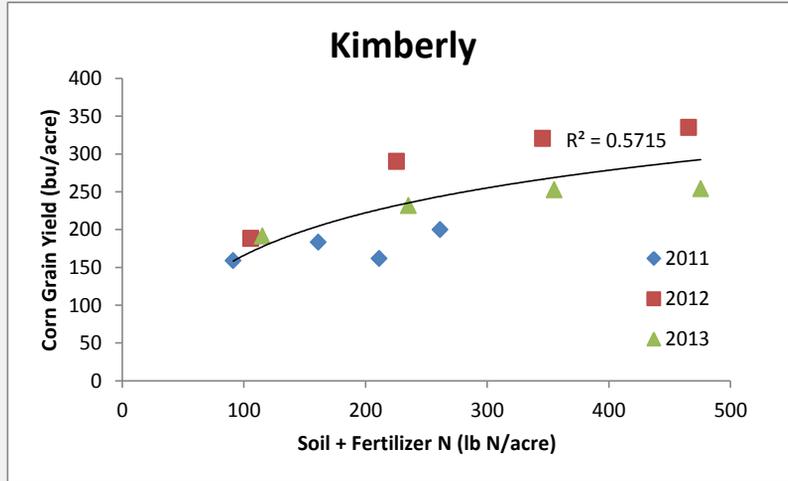
- Soil testing can provide insight on nitrate leaching susceptibility of a field
- Some factors that can contribute to nitrate leaching
  - Sandy soil texture
  - Liquid manure or fertilizer N applications when the plant doesn't need it
  - Applying N (fertilizer or manure form) to soils with high/excessive soil test N levels

Thank you.

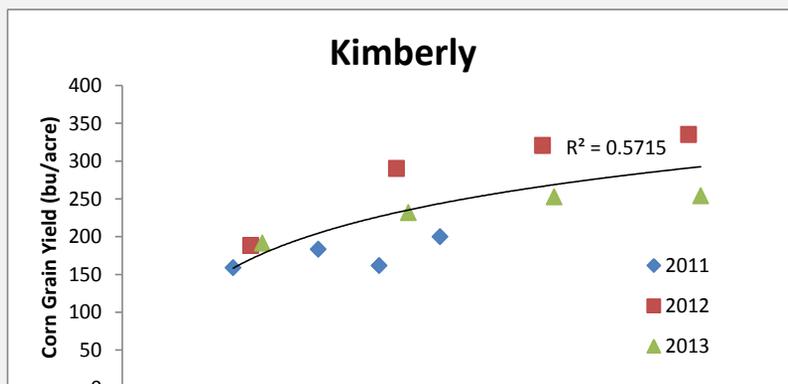
## Soil test N

- If preplant soil test N is above what is recommended by UI for your crop, stop applying N as fertilizer or manure
- What if recommendations are outdated?
- Example - Concerns that we're over-supplementing corn with N fertilizers
- UI and ARS efforts

## UI, Corn response to N

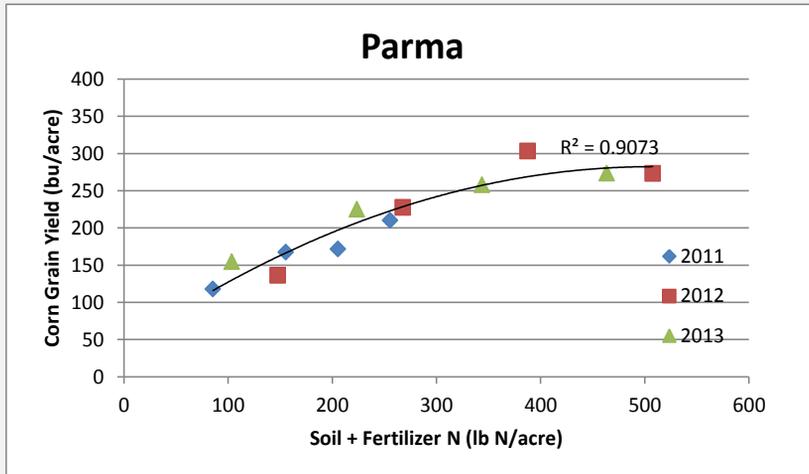


## UI, Corn response to N

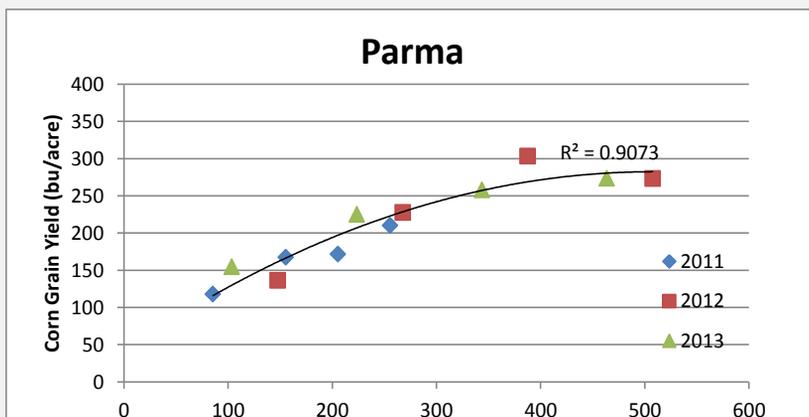


- Minimal N response over 225 lb N/acre
- Equivalent to 56 ppm Nitrate-N (1<sup>st</sup> and 2<sup>nd</sup> foot combined)

## UI, Corn response to N



## UI, Corn response to N



- Minimal N response over 350 lb N/acre
- Equivalent to 87 ppm Nitrate-N (1<sup>st</sup> and 2<sup>nd</sup> foot combined)

Table 2. Recommended fertilizer N rates for field corn harvested for grain in non-manured fields (lb/acre).

Pre-plant soil test N at 0-2 ft (ppm) <sup>1</sup>	Grain yield (bu/acre)						
	100	130	160	190	220	250	280
0	150	195	240	285	315	360	405
10	110	155	200	245	275	320	365
20	70	115	160	205	235	280	325
30	30	75	120	165	195	240	285
40	0	35	80	125	155	200	245
50	0	0	40	85	115	160	205
60	0	0	0	45	75	120	165
70	0	0	0	5	35	80	125
80	0	0	0	0	0	40	85
90						0	45
100							5

Table 2. Recommended fertilizer N rates for field corn harvested for grain in non-manured fields (lb/acre).

Pre-plant soil test N at 0-2 ft (ppm) <sup>1</sup>	Grain yield (bu/acre)						
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Will work with David Tarkalson (ARS) to adjust fertilizer recommendations for corn.

May consider regional instead of statewide recommendations

Reevaluate the use of yield goals.

70	0	0	0	5	35	80	125
80	0	0	0	0	0	40	85
90						0	45
100							5

# Tools

	A	B	C	E	F	G	H	I
1	<b>ENTER FERTILIZER ANALYSES &amp; SEE FERTILIZER, COMPOST AND</b>							
2	<b>Enter your information in yellow cells. Results are in green cells.</b>							
3	<b>MATERIAL</b>			<b>FERTILIZER ANALYSIS (%)</b>				
4		Total % N from label ("as-is" basis; % of product)	Total % dry matter (% of product)	%PAN at 28 days (% of amendment total N, dry wt basis)	%PAN after full season (% of amendment total N, dry wt basis)	PAN at 28 days (lb N per 100lb amendment "as-is" basis)	PAN after full season (lb N per 100lb amendment "as-is" basis)	P <sub>2</sub> O <sub>5</sub> (%)
23	<b>COMPOST</b>							
24	Composted manure (1.5-0.5-0.5)	1.5	60	5	10	0.08	0.15	
25	Amber's Dairy Compost	0.8	74	0	5	0.00	0.04	
26				0	0	0.00	0.00	

- OSU Organic Fertilizer and Cover Crop Calculator
- <http://smallfarms.oregonstate.edu/calculator>

# Estimating plant-available N from manure (OSU publication)

<http://extension.oregonstate.edu/catalog/pdf/em/em8954-e.pdf>