Investing in Your Soil: Plant Available Nitrogen and Nitrogen Management Session 6

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Investing in Your Soil: Plant Available Nitrogen and Nitrogen Management
Today's Topics of Discussion

Review the Nitrogen Cycle

Plant Available Nitrogen concept

How to translate nitrate ppm on soil test reports to applications of various N sources (irrigation water, compost, manures, cover crops, and contributions of N from high organic matter soils).

We'll also be discussing Plant Available Nitrogen (PAN) in the context of all the sources listed above.

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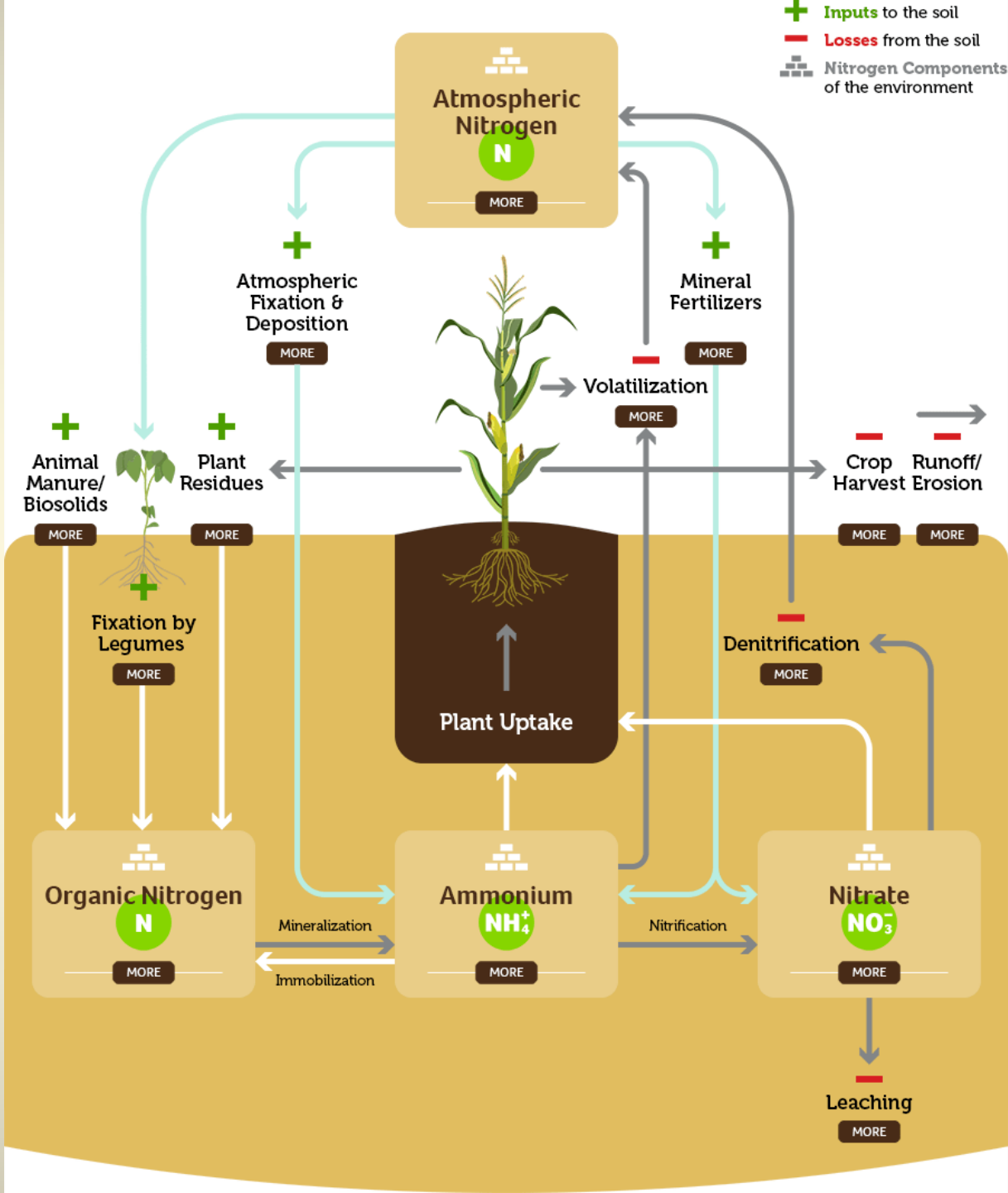
Nitrogen, What It Does

- Nitrogen is an essential constituent of proteins such as chlorophyll, enzymes, and hormones.
- It has a predominant role among the soil nutrients and is needed in substantial amounts, but is also the most likely to be deficient.
- Deficiency limits crop growth and yield. It is rapidly used by crops, can be volatilized into ammonia, and is easily leached as nitrate.
- Nitrogen is most stable when in humus and microbial bodies. Increased active organic matter increases available nitrogen.



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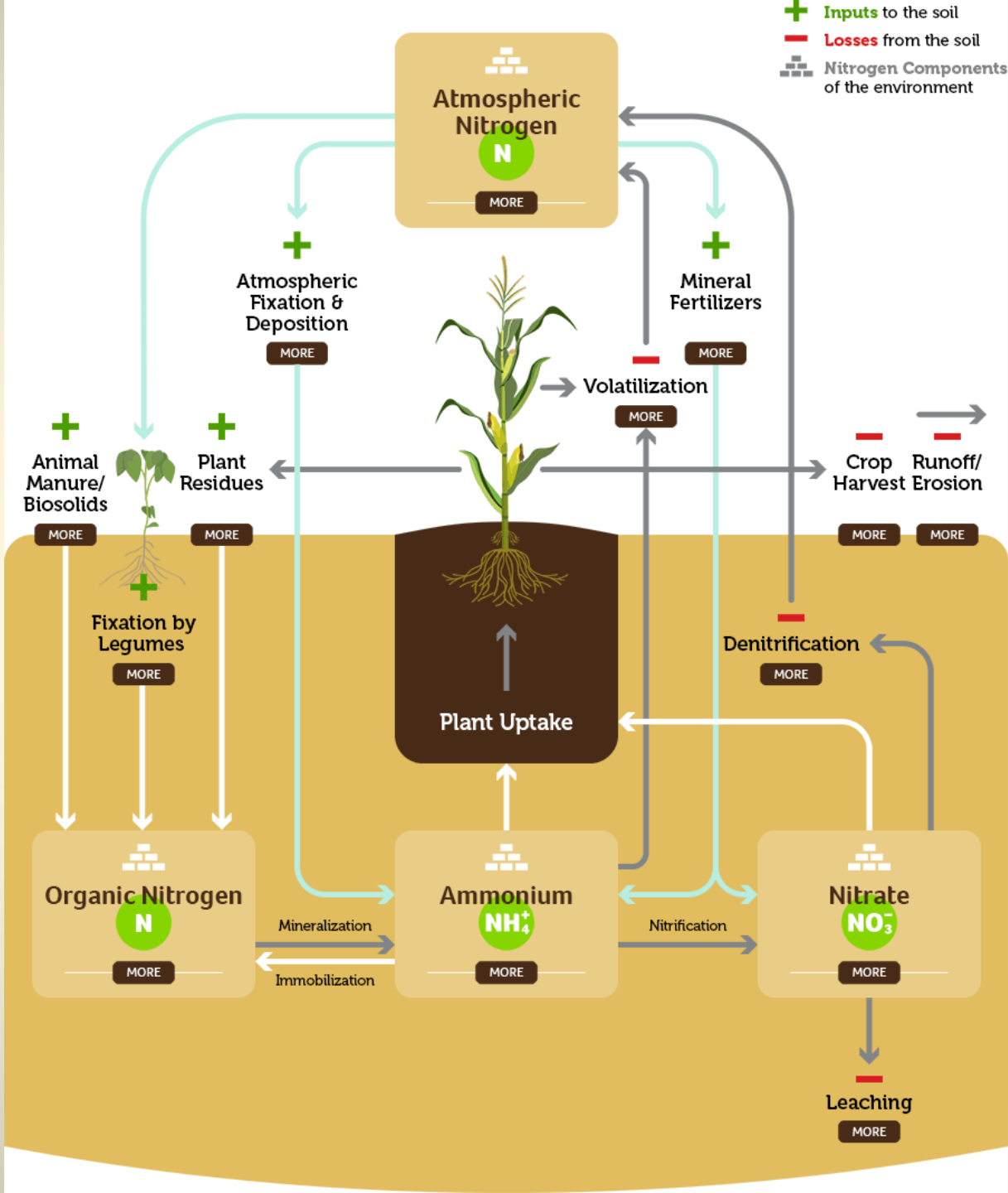
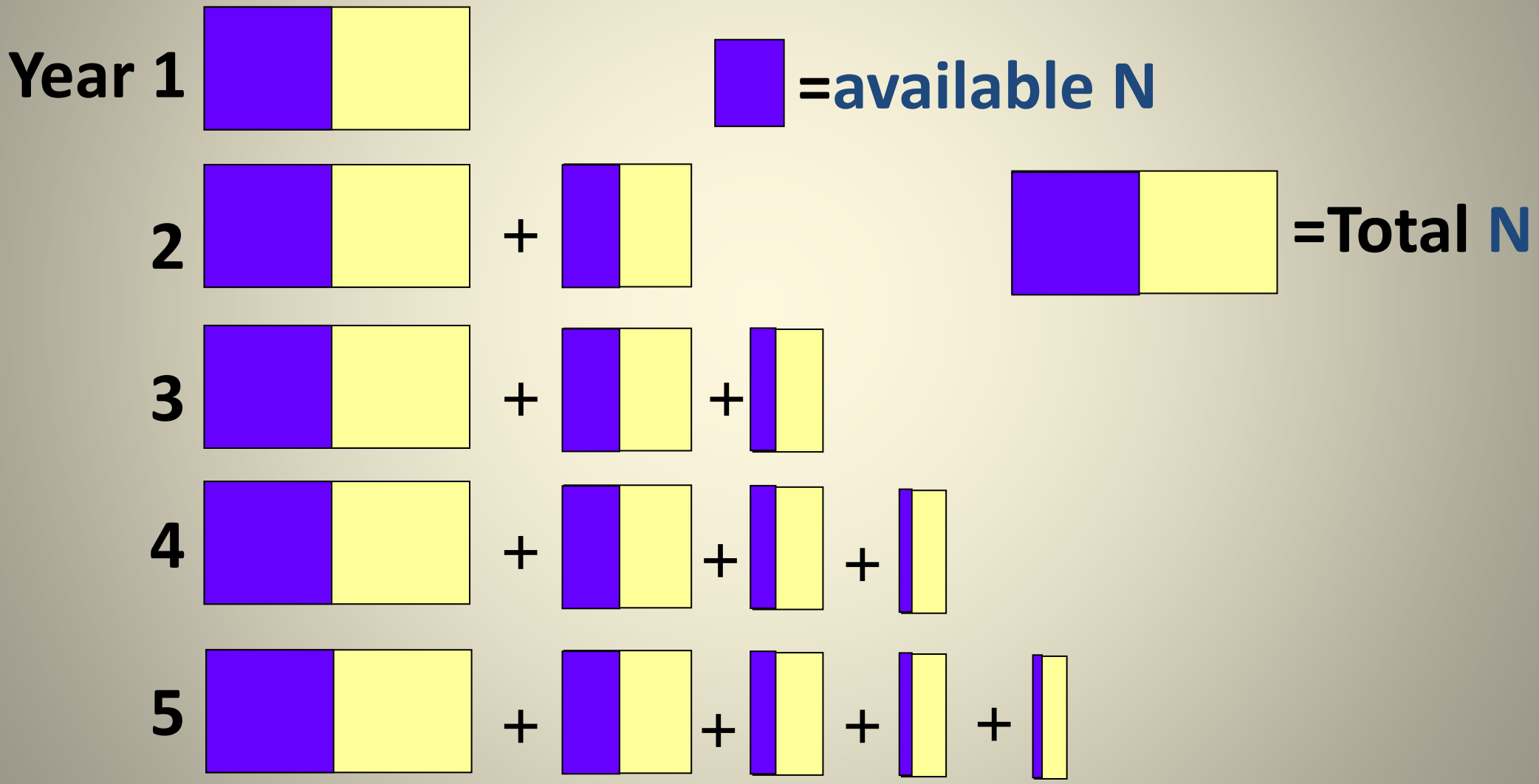
The Nitrogen Cycle

- N comes from biological sources (until humans and the Haber-Bosch process came along).
- Microbial decomposition (mineralization) is what make NO^-_3(nitrate, an anion) available to the plant. Most N taken up by plants is via nitrate uptake.
- NH_4^+ Ammonium, a cation is held by negatively charged soil particles, so doesn't leach, and can also be taken up by plants, but quickly turns into NO^-_3, in warm, moist soils
- There is no N in the mineral component (sand, silt and clay) of the soil



Cumulative Plant Available N (PAN) from any organic source



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Courtesy of Dan Sullivan OSU Crop & Soil Science

N Cost/lb Plant Available N (PAN)

Product	$/ton	Total % N	Est'd % PAN	$/lb PAN	$/100lbs PAN
Urea (now over $859/ton) (not organic)	$500	46%	100%	$0.54	$54
	$1000	46%	100%	$1.09	$109
Processed chicken manure	$200	4%	50%	$5.00	$500
	$250	4%	50%	$6.25	$625
Legume cover crops	$?	~3%	~50%	$1-$3	$100-$300
Legume cover crops	**$1-3.00/lb PAN** All costs attributed to PAN		**$0.50-$1.50/lb PAN** Seed and inoculum only		

Question for Class: What else is added along with N in the processed chicken manure?

Question for Class: What other benefits might come with "growing your own N"?

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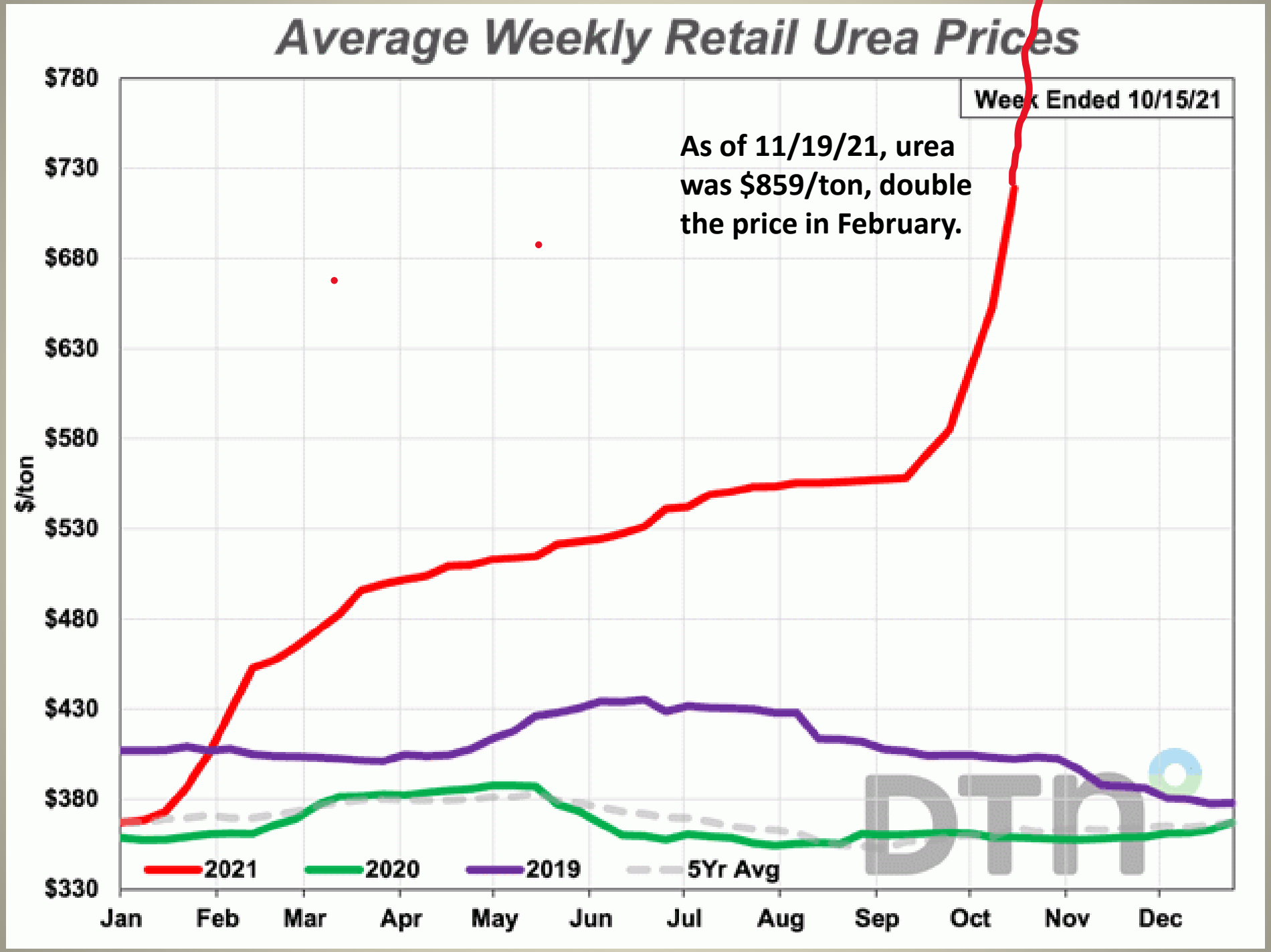
Table 2. Example of PAN Credits.

If you applied 2,000 lbs/acre of broiler litter this year, and this litter is 4% N, then a total of 2,000 x .04 = 80 lbs N/acre was applied. This year, after ten weeks, the PAN from the 80 lbs applied will only be 45% or 36 lbs N (see Table 7). Next year, a year after application, 8% of the total N applied would be available; 80 lbs/acre x .08 = 6.4 lbs/acre. Two years after application, 5% of the N applied would be available (80 x .05 = 4lbs/acre and in year three, 3% would be available (80 x .03 = 2.4/lbs/acre).

PAN, Percent of Total N (general rule)	Years After Application	lbs PAN per acre
45% x 80 lbs/acre	current year	36
8% x 80 lbs/acre	1	6.4
5% x 80 lbs/acre	2	4
3% x 80 lbs/acre	3	2.4

Average Weekly Retail Urea Prices



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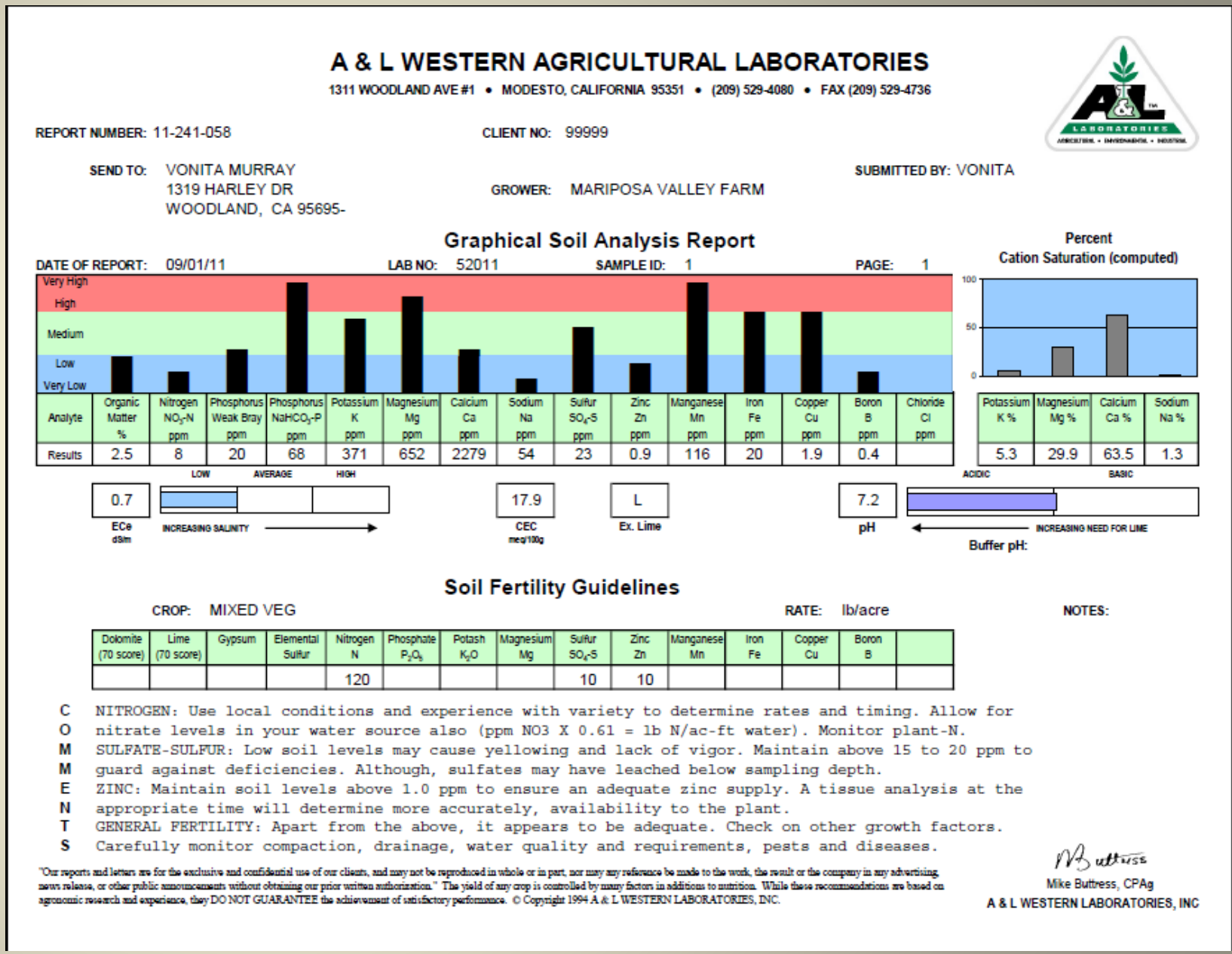
This soil analysis shows a nitrate level of 8 ppm in the soil.

Say we're going to grow broccoli, which requires 20 ppm nitrate nitrogen

It requires 4 lbs of N to increase the ppm of nitrate nitrogen by 1 unit.

How much compost would you need to apply to provide N required by the crop?



A & L WESTERN AGRICULTURAL LABORATORIES

1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209) 529-4080 • FAX (209) 529-4736

REPORT NUMBER: 11-241-058 CLIENT NO: 99999

SEND TO: VONITA MURRAY
1319 HARLEY DR
WOODLAND, CA 95695-

GROWER: MARIPOSA VALLEY FARM

SUBMITTED BY: VONITA

Graphical Soil Analysis Report

DATE OF REPORT: 09/01/11 LAB NO: 52011 SAMPLE ID: 1 PAGE: 1

Very High / High / Medium / Low / Very Low

Analyte	Organic Matter %	Nitrogen NO_3-N ppm	Phosphorus Weak Bray ppm	Phosphorus $NaHCO_3$-P ppm	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Chloride Cl ppm
Results	2.5	8	20	68	371	652	2279	54	23	0.9	116	20	1.9	0.4	
			LOW	AVERAGE	HIGH										

Percent Cation Saturation (computed)

Potassium K %	Magnesium Mg %	Calcium Ca %	Sodium Na %
5.3	29.9	63.5	1.3

ACIDIC BASIC

ECe dS/m	CEC meq/100g	Ex. Lime	pH
0.7	17.9	L	7.2

INCREASING SALINITY → INCREASING NEED FOR LIME

Buffer pH:

Soil Fertility Guidelines

CROP: MIXED VEG RATE: lb/acre NOTES:

Dolomite (70 score)	Lime (70 score)	Gypsum	Elemental Sulfur	Nitrogen N	Phosphate P_2O_5	Potash K_2O	Magnesium Mg	Sulfur SO_4-S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B	
				120				10	10					

COMMENTS

NITROGEN: Use local conditions and experience with variety to determine rates and timing. Allow for nitrate levels in your water source also (ppm NO3 X 0.61 = lb N/ac-ft water). Monitor plant-N.
SULFATE-SULFUR: Low soil levels may cause yellowing and lack of vigor. Maintain above 15 to 20 ppm to guard against deficiencies. Although, sulfates may have leached below sampling depth.
ZINC: Maintain soil levels above 1.0 ppm to ensure an adequate zinc supply. A tissue analysis at the appropriate time will determine more accurately, availability to the plant.
GENERAL FERTILITY: Apart from the above, it appears to be adequate. Check on other growth factors. Carefully monitor compaction, drainage, water quality and requirements, pests and diseases.

Mike Buttress, CPAg
A & L WESTERN LABORATORIES, INC

Soil Test: 8 ppm N/acre in the soil; broccoli requires 20 ppm; there are 4 lbs N per acre required to have a 1 ppm increase in N

Compost has about 1% N

1. How many lbs of N/acre will be needed to meet broccoli needs?

2. How many lbs/acre of compost will be needed to supply broccoli N requirements?

1. 20 ppm-8 ppm = 12 ppm N needed per acre, 12 ppm/acre x 4 lbs N per 1ppm = 48 lbs N/acre needed
2. 48 lbs N per acre ÷.01 lbs N per lb of compost = 4,800 lbs of compost (**To provide total N** = 48 lbs)

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Soil Test: 8 ppm N; broccoli requires 20 ppm; there are 4 lbs N per acre required to have a 1 ppm increase in N

Compost has about 1% N

We know: 48 lbs N/acre is needed from compost, and we've calculated the ***Total N*** in 4,800 lbs/acre of compost is ~48 lbs/acre.... **BUT,** consider the PAN of compost, which we'll say is 20% (or one fifth) of total N applied.

3. What is the total amount of compost needed to be applied in order to meet the broccoli N requirements of 48 lbs N per acre for that growing season?

1. 48 lbs/.01 N = 4,800 lbs of compost (total N = 48 lbs), BUT, if the PAN is only 20% of the total applied compost, then we can calculate: 4,800/.2 = 24,000 lbs of compost (12 tons/acre)

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Soil Test: 8 ppm N; broccoli requires 20 ppm; there are 4 lbs N per acre required to have a 1 ppm increase in N

Compost has about 1% N

4. What would be the total applied N if you applied 24,000 lbs/acre of compost?

1. 24,000 lbs compost/acre X .01 lbs N per lb/compost = 240 lbs N/acre—that's the total N in compost application

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A walnut grower expects a nut yield of 2 tons/acre. Because of the high price of N, the grower wants to avoid using chemical fertilizers if possible.

The grower wants to know the contributions from the irrigation water (microsprinklers and can fertigate), from the cover crop, and then will figure out how much compost to apply to make up the rest of the N requirements for the crop if possible.

Note: In the Table, The Fertilizer N required is *either* Split broadcast or Fertigation, not both.

Why do you think the split broadcast is higher than the fertigation?

Also, the type of soil (sandy or clay) and the type of irrigation (flood, drip or microsprinkler) will influence how much of the applied N is taken up by the tree.

Walnut N Budget and Nut Yield

Nut yield (tons/acre)	N removed (lb/acre)	Fertilizer N required (lbs N/acre)	
		Split broadcast	Fertigation
1	48	86	68
1.5	72	129	101
2	96	171	135
2.5	120	214	169

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Your irrigation water has a nitrate-N level of 9 ppm. Your walnut orchard needs 3.5 acre-feet of water over the season (1.14 M gallons).

How much N will you be applying via irrigation water?

Note: mg/L (milligrams per Liter) is the same as parts per million (ppm)

$$\left(\frac{mg}{L}\ Nitrate\ N\right) * \left(3.78\frac{L}{Gal}\right) * \left(27154\frac{Gal}{acreinch}\right) * \left(\frac{1lb}{453{,}592.4mg}\right) = N\ credit\ in\ Lbs/acre$$

So, 9 mg/L nitrate N X 3.78 Liters/Gallon = 34.02 mg N/gal

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So, 9 mg/L nitrate N X 3.78 Liters/Gallon = 34.02 mg N/gal

34.02 mg N/gal X 27,154 gal/acre-inch =

923,779 mg/acre-inch ÷ 453,592.4 mg/lb = **2 lbs N/acre-inch**

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923,779 mg/acre-inch /453,592.4 mg/lb = **2 lbs N/acre-inch**

How many inches in 3.5 feet?

2 lbs N/acre-inch X 42 inches =

84 lbs N/acre applied via irrigation water

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Walnut N Budget so far..

N Source	PAN	Total N applied
Irrigation water	84 lbs/acre	84 lbs/acre
Cover crops	?	?
Compost	?	?
Total	84 lbs/acre	84 lbs/acre

This is a lot of “ballpark estimation. We don’t have any information about how efficient his irrigation system is. It’s always a good idea to be conservative in these kinds of calculations.

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		Split broadcast	Fertigation
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1.5	72	129	101
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Cover Crop PAN Varies

Rye, vetch, peas, and mustard
~20” canopy

~155 lbs total N/acre & 60 lbs PAN

~110 lbs total N/acre & 10 lbs PAN

Oats and vetch
~26” canopy

Cover crop PAN

	Typical analysis		PAN released from cover crop following incorporation			
	Total %N (dry wt)	C:N	% of residue total N		lb N/dry ton	
Typical residue			**4 wk**	**10 wk**	**4 wk**	**10 wk**
Cereals after head emergence	1	40	-40	<0	-8	<0
Cereals tillering/jointing	2	20	5	20	2	8
50/50 Cereal/legume mix or flowering legumes	3	13	35	40	21	24
Legumes, vegetative	4	10	50	55	40	44

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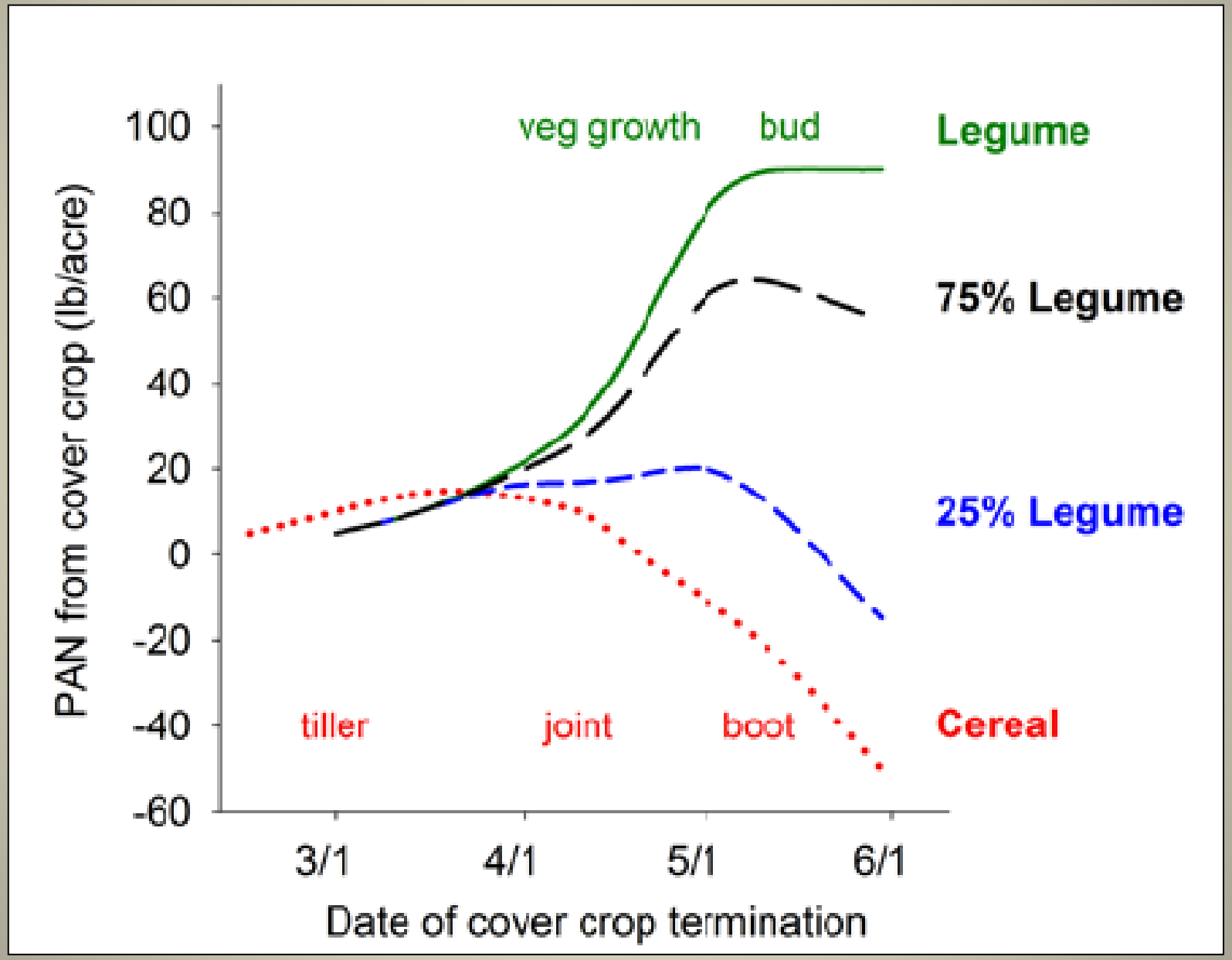
When to terminate covers for maximum PAN



Break

Break

A walnut grower has a cover crop of mustards, oats, and bell bean, each about 1/3 of the cover crop.

3 samplings of 4 sq feet provide an average wet weight of 3.5 lbs/4 sq feet. The grower will chop and incorporate the cover crop when it's still green and lush.

Calculating Cover Crop N

3.5 lbs cover crop/4 sq ft =.88 lbs “wet covercrop”/sq ft

One acre has 43,560 square feet, so the wet biomass per acre = 43,560 sq ft/acre X .88 lbs wet biomass/sq ft = 38,333 lbs wet biomass/acre

Calculating Cover Crop (CC) N

	Percent dry matter	Total %N
Common vetch and other legumes	12-18%	3-4%
Cereals	15-20%	1.5-2.5%
50/50 vetch/cereal mix	15%	2.5-3%

The mix of mustards, oats and bellbean doesn't exactly match any of these, but what do you think is the closest?

Using the % dry matter from the bottom row--85% of the cover crop is "water weight", so in order to get dry weight, or the weight of the dry matter portion of the cover crop, we'll multiply the weight of the cover crop by .15, so .15 (% dry matter) x 38,333 lbs wet cc/acre =

5,750 lbs/acre dry wt.

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Calculating Cover Crop N

	Percent dry matter	Total %N
Common vetch and other legumes	12-18%	3-4%
Cereals	15-20%	1.5-2.5%
50/50 vetch/cereal mix	15%	2.5-3%

A guestimate of the %N of the cover crop (see picture) is 2% (only 1/3 of the cc is a legume, 2/3 is oats+mustard),

So 5,750 lbs/acre dry wt of cc x .02 (%N) = **115 lbs N/acre** from the cover crop.

The PAN will be roughly 50% for this cover crop. So, only about half of the 115 lbsN/acre will be available to the walnut crop this year, so the **PAN will be 57 lbs N/acre**

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Walnut N Budget so far..

N Source	PAN	Total N applied
Irrigation water	84 lbs/acre	84 lbs/acre
Cover crops	57 lbs/acre	115 lbs/.acre
Compost		
Total	141 lbs/acre	199 lbs/acre

This is a lot of “ballpark estimation, and what if we added another 14 lbs/acre “N-surance” (above the PAN rates were calculating. The compost and cover crop N aren’t being fertigated.—using 155 lbsPAN/acre instead of 135 under “fertigation).

Nut yield (tons/acre)	N removed (lb/acre)	Fertilizer N required (lbs N/acre)	
		Split broadcast	Fertigation
1	48	86	68
1.5	72	129	101
2	96	171	135
2.5	120	214	169

Needed: 14 lbs/acre PAN from compost

Compost has about 1% N

1. How many lbs of compost will be needed to supply the 14 lbs?
2. 14 lbs N/acre ÷ .01 (%N per lb of compost) = 1,400 lbs of compost (total N = 14 lbs, but PAN is only a fraction of that),
3. **BUT,** what is the PAN? We'll say it's 20% of total N applied
4. 14 lbs total N X .2 (%PAN in compost) = **2.8 lbs PAN per 1,400 lbs of compost.**
5. 2.8 lbs is one fifth of 14 lbs. So, we need 5 times as much compost (1,400 lbs X 5= 7,000 lbs compost/acre) to provide the 14 lbs of PAN
6. 7,000 lbs of compost (3.5 tons/acre) needed to provide 14 lbs PAN/acre
7. **What is the total N applied per acre?**
8. 70 lbsN/acre

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Walnut N Budget so far..

This is a lot of “ballpark estimation. You can see

N Source	PAN	Total N applied
Irrigation water	84 lbs/acre	84 lbs/acre
Cover crops	57 lbs/acre	115 lbs/acre
Compost	14 lbs/acre	70 lbs/acre
Total	155 lbs/acre	269 lbs/acre

Nut yield (tons/acre)	N removed (lb/acre)	Fertilizer N required (lbs N/acre)	
		Split broadcast	Fertigation
1	48	86	68
1.5	72	129	101
2	96	171	135
2.5	120	214	169

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Calculating N in Irrigation Water

Table 1. Nitrogen credit from irrigation water

Nitrate-N in irrigation water	1 in. (of irrigation water)	2 in.	3 in.	4 in.	5 in.	6 in.	7 in.	8 in.
10 ppm	2 lbs. N/ac	5 lbs. N/ac	7 lbs. N/ac	9 lbs. N/ac	11 lbs. N/ac	14 lbs. N/ac	16 lbs. N/ac	18 lbs. N/ac
15	3	7	10	14	17	20	24	27
20	5	9	14	18	23	27	32	36
25	6	11	17	23	28	34	40	45
30	7	14	20	27	34	41	48	54
35	8	16	24	32	40	48	55	63
40	9	18	27	36	45	54	63	72
45	10	20	31	41	51	61	71	81
50	11	23	34	45	57	68	79	91

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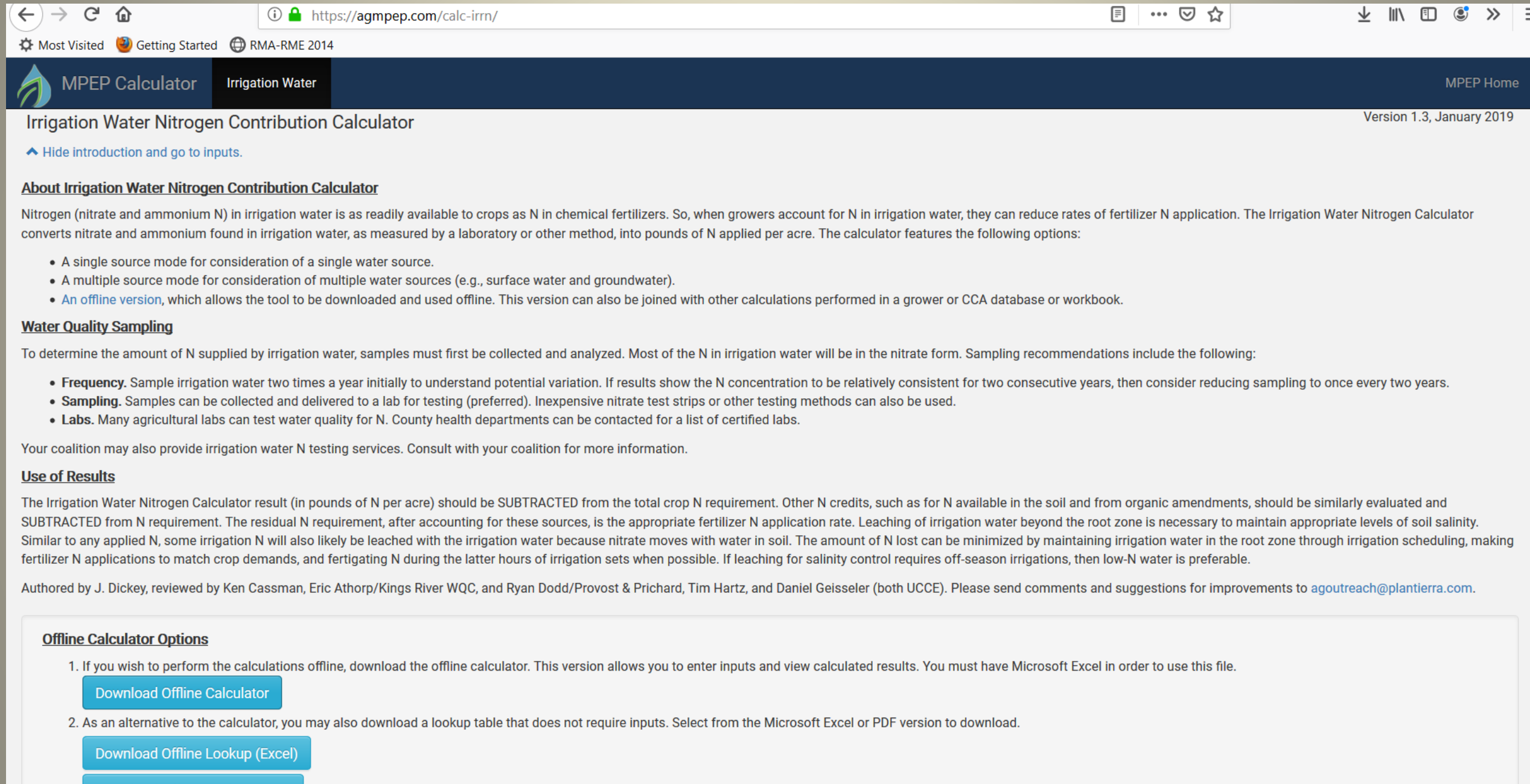
https://agmpep.com/calc-irrn/ This site has an N calculator for irrigation water



https://agmpep.com/calc-irrn/

Most Visited Getting Started RMA-RME 2014

MPEP Calculator | Irrigation Water | MPEP Home

Irrigation Water Nitrogen Contribution Calculator

Version 1.3, January 2019

Hide introduction and go to inputs.

About Irrigation Water Nitrogen Contribution Calculator

Nitrogen (nitrate and ammonium N) in irrigation water is as readily available to crops as N in chemical fertilizers. So, when growers account for N in irrigation water, they can reduce rates of fertilizer N application. The Irrigation Water Nitrogen Calculator converts nitrate and ammonium found in irrigation water, as measured by a laboratory or other method, into pounds of N applied per acre. The calculator features the following options:

- A single source mode for consideration of a single water source.
- A multiple source mode for consideration of multiple water sources (e.g., surface water and groundwater).
- An offline version, which allows the tool to be downloaded and used offline. This version can also be joined with other calculations performed in a grower or CCA database or workbook.

Water Quality Sampling

To determine the amount of N supplied by irrigation water, samples must first be collected and analyzed. Most of the N in irrigation water will be in the nitrate form. Sampling recommendations include the following:

- **Frequency.** Sample irrigation water two times a year initially to understand potential variation. If results show the N concentration to be relatively consistent for two consecutive years, then consider reducing sampling to once every two years.
- **Sampling.** Samples can be collected and delivered to a lab for testing (preferred). Inexpensive nitrate test strips or other testing methods can also be used.
- **Labs.** Many agricultural labs can test water quality for N. County health departments can be contacted for a list of certified labs.

Your coalition may also provide irrigation water N testing services. Consult with your coalition for more information.

Use of Results

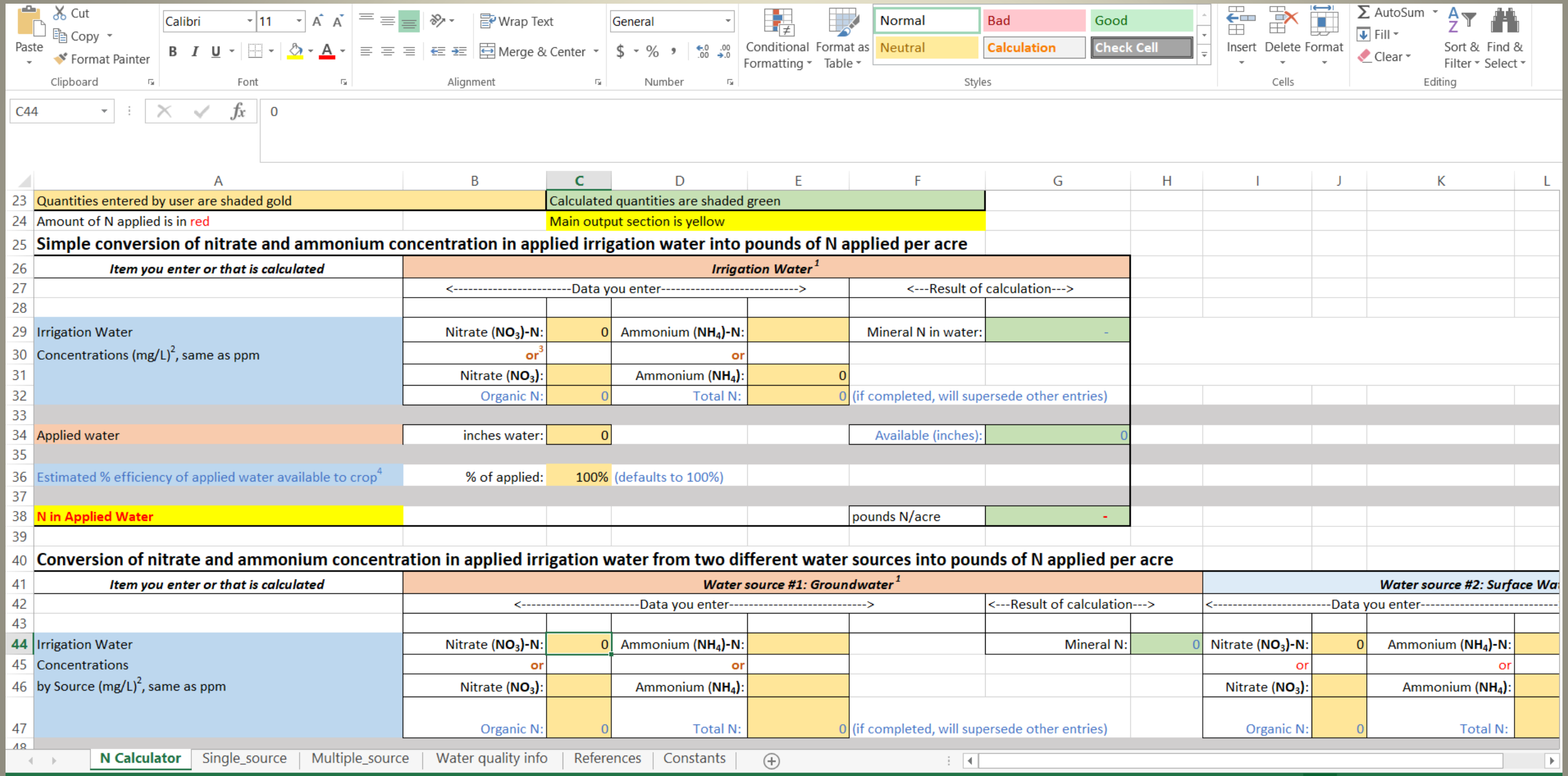
The Irrigation Water Nitrogen Calculator result (in pounds of N per acre) should be SUBTRACTED from the total crop N requirement. Other N credits, such as for N available in the soil and from organic amendments, should be similarly evaluated and SUBTRACTED from N requirement. The residual N requirement, after accounting for these sources, is the appropriate fertilizer N application rate. Leaching of irrigation water beyond the root zone is necessary to maintain appropriate levels of soil salinity. Similar to any applied N, some irrigation N will also likely be leached with the irrigation water because nitrate moves with water in soil. The amount of N lost can be minimized by maintaining irrigation water in the root zone through irrigation scheduling, making fertilizer N applications to match crop demands, and fertigating N during the latter hours of irrigation sets when possible. If leaching for salinity control requires off-season irrigations, then low-N water is preferable.

Authored by J. Dickey, reviewed by Ken Cassman, Eric Athorp/Kings River WQC, and Ryan Dodd/Provost & Prichard, Tim Hartz, and Daniel Geisseler (both UCCE). Please send comments and suggestions for improvements to agoutreach@plantierra.com.

Offline Calculator Options

1. If you wish to perform the calculations offline, download the offline calculator. This version allows you to enter inputs and view calculated results. You must have Microsoft Excel in order to use this file.
   Download Offline Calculator
2. As an alternative to the calculator, you may also download a lookup table that does not require inputs. Select from the Microsoft Excel or PDF version to download.
   Download Offline Lookup (Excel)

https://agmpep.com/calc-irrn/ This is the N calculator for irrigation water



	A	B	C	D	E	F	G
23	Quantities entered by user are shaded gold		Calculated quantities are shaded green				
24	Amount of N applied is in red		Main output section is yellow				
25	**Simple conversion of nitrate and ammonium concentration in applied irrigation water into pounds of N applied per acre**						
26	***Item you enter or that is calculated***	***Irrigation Water*** [1]					
27		<----------Data you enter---------->				<---Result of calculation--->	
28							
29	Irrigation Water	Nitrate (NO_3)-N:	0	Ammonium (NH_4)-N:		Mineral N in water:	-
30	Concentrations (mg/L)[2], same as ppm	or[3]		or			
31		Nitrate (NO_3):		Ammonium (NH_4):	0		
32		Organic N:	0	Total N:	0	(if completed, will supersede other entries)	
33							
34	Applied water	inches water:	0			Available (inches):	0
35							
36	Estimated % efficiency of applied water available to crop[4]	% of applied:	100%	(defaults to 100%)			
37							
38	**N in Applied Water**					pounds N/acre	-
39							
40	**Conversion of nitrate and ammonium concentration in applied irrigation water from two different water sources into pounds of N applied per acre**						
41	***Item you enter or that is calculated***	***Water source #1: Groundwater*** [1]					
42		<----------Data you enter---------->				<---Result of calculation--->	
43							
44	Irrigation Water	Nitrate (NO_3)-N:	0	Ammonium (NH_4)-N:		Mineral N:	0
45	Concentrations	or		or			
46	by Source (mg/L)[2], same as ppm	Nitrate (NO_3):		Ammonium (NH_4):			
47		Organic N:	0	Total N:	0	(if completed, will supersede other entries)	

	H	I	J	K	L
41				***Water source #2: Surface Wa***	
42				<----------Data you enter----------	
43					
44		Nitrate (NO_3)-N:	0	Ammonium (NH_4)-N:	
45		or		or	
46		Nitrate (NO_3):		Ammonium (NH_4):	
47		Organic N:	0	Total N:	

N Calculator | Single_source | Multiple_source | Water quality info | References | Constants

Questions?

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