UW Nutrient Management Farmer Education

Nitrogen

Nitrogen Management

Disclaimer: Any use of trade names is for descriptive purposes and does not represent an endorsement by the author.

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Division of Extension

@agronomybadger

NPM

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Nitrogen Function in Plants

Atmosphere contains 78% nitrogen (N_2)
Plants cannot use this N directly
Nitrogen from air must be converted for plant use

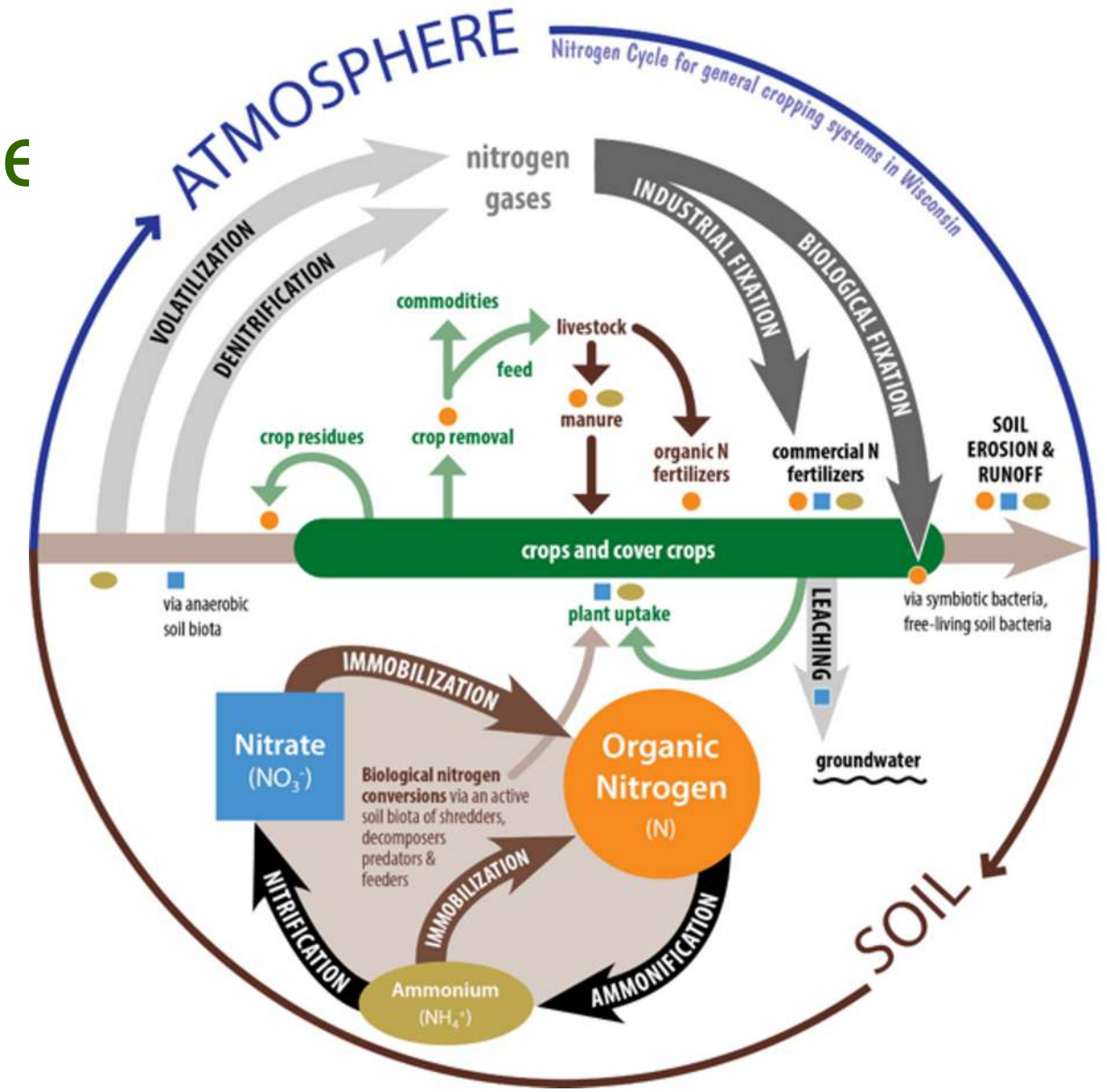
Biological fixation (*Rhizobia* and legumes)
Chemical fixation (fertilizers)

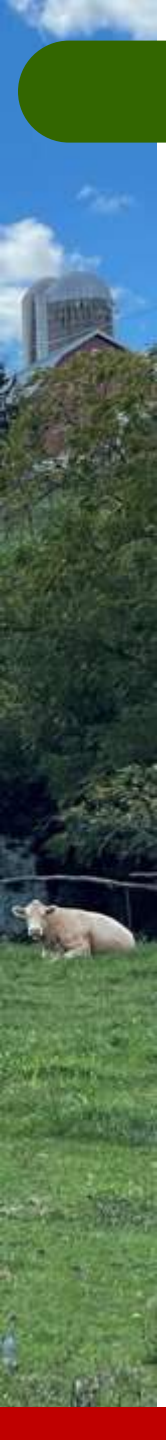
- **Plants absorb more nitrogen than any other element. It is essential for structural, genetic and metabolic compounds in plant cells.**
  Nitrogen is mobile in the plant
- **Nitrogen deficiency symptoms (yellowing) occur in older leaves.**

Nitrogen Function in Plants

- Excessively green plants at the end of summer can indicate too much nitrogen was available to the plant.
- Plants use nitrogen in the ammonium (NH_4^+) and nitrate (NO_3^-) forms.

The nitrogen cycle



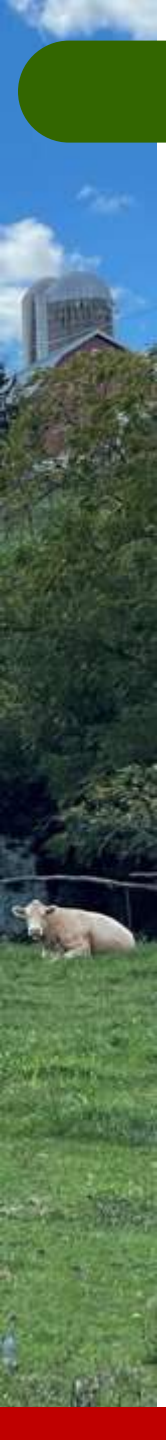


Nitrogen Reactions

- Biological fixation (symbiotic)

$$\text{Atmospheric } N_2 \xrightarrow[\textit{(Rhizobia)}]{} \text{Legume Plant N}$$

(Soil Temp. > 50 degrees F)

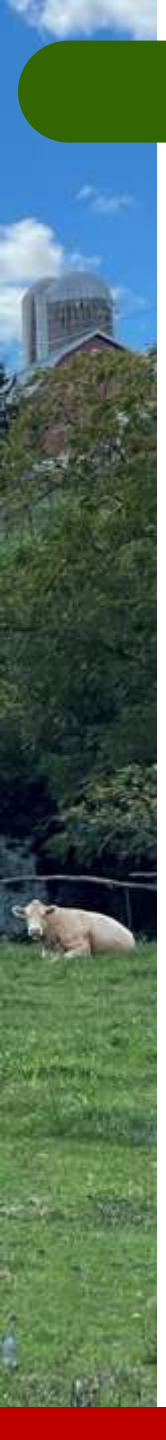


Nitrogen Reactions

- Biological fixation (symbiotic)
- Chemical / industrial fixation

$$\underset{\textit{natural gas}}{\text{Atmospheric } N_2 + CH_4} \longrightarrow \underset{\textit{ammonia}}{NH_3}$$

$$\underset{\textit{ammonia}}{NH_3} \longrightarrow \text{N fertilizers}$$



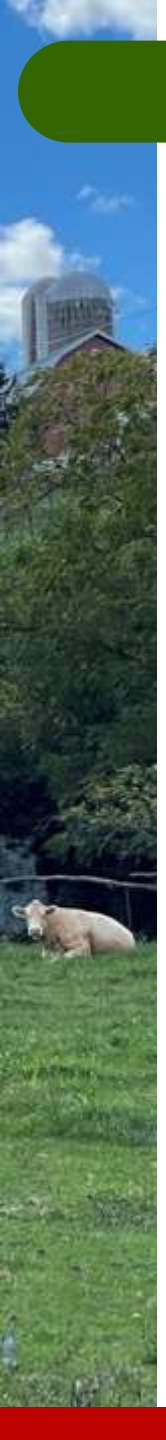
Nitrogen Reactions

- Biological fixation (symbiotic)
- Chemical / industrial fixation
- Mineralization (ammonification)

Soil Organic N → NH4+ - N

ammonium

(Soil Temp. > 50 degrees F)



Nitrogen Reactions

- Biological fixation (symbiotic)
- Chemical / industrial fixation
- Mineralization (ammonification)
- Nitrification

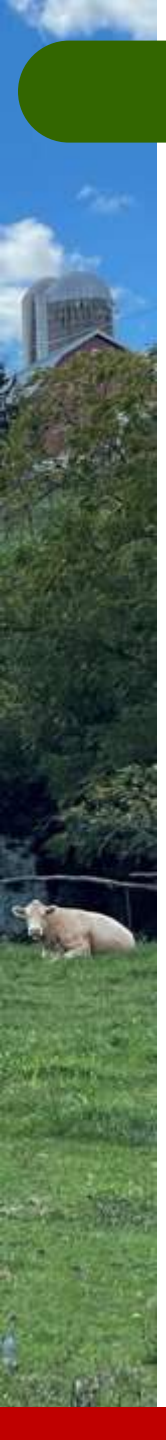
$$NH_4^+ \xrightarrow[\text{soil bacteria}]{} NO_2^- + H^+$$

ammonium → *nitrite*

$$NO_2^- \longrightarrow NO_3^-$$

nitrite → *nitrate*

(Soil Temp. > 50 degrees F)



Nitrogen Reactions

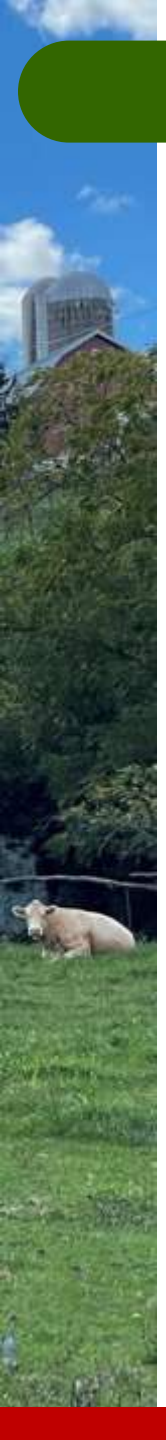
- Biological fixation (symbiotic)
- Chemical / industrial fixation
- Mineralization (ammonification)
- Nitrification
- Immobilization

NO3- or NH4+ → Organic N

soil bacteria

inorganic N

(Soil Temp. > 50 degrees F)

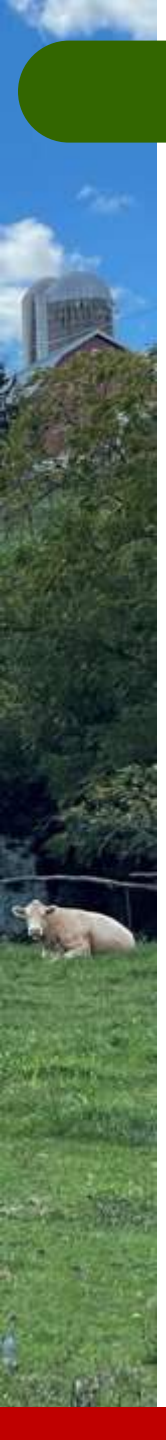


Carbon:Nitrogen Ratio Effects on N Release

Expected N Effect	C:N Range
Release N	< 20
Variable (depends on composition)	20 - 50
Immobilize (tie-up) N	> 50

Carbon:Nitrogen Ratios of Organic Materials

Material	C:N Ratio	
Soil microorganisms	8	
Soil organic matter	10	Release N
Alfalfa	12	
Rotted manure	20	
Corn residue	60	Tie-up N
Grain straw	80	
Sawdust	300	



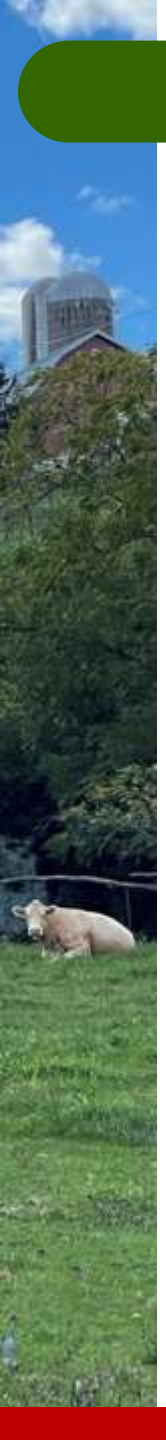
Nitrogen Reactions

- Biological fixation (symbiotic)
- Chemical / industrial fixation
- Mineralization (ammonification)
- Nitrification
- Immobilization
- Denitrification

$$NO_3^- \xrightarrow[\text{wet soils, low oxygen}]{\text{soil bacteria}} N_2 + N_2O$$

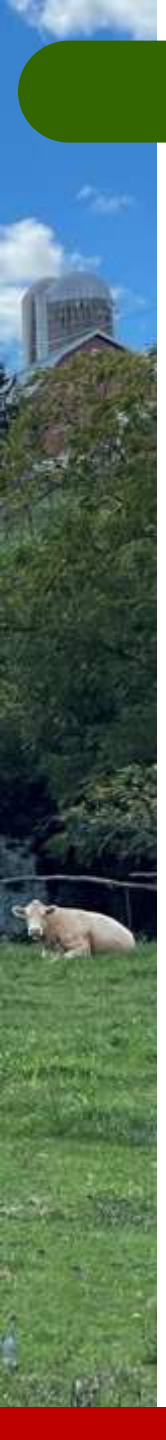
nitrate → *gases lost to air*

(Soil Temp. > 50 degrees F)



Nitrogen Loss: Denitrification

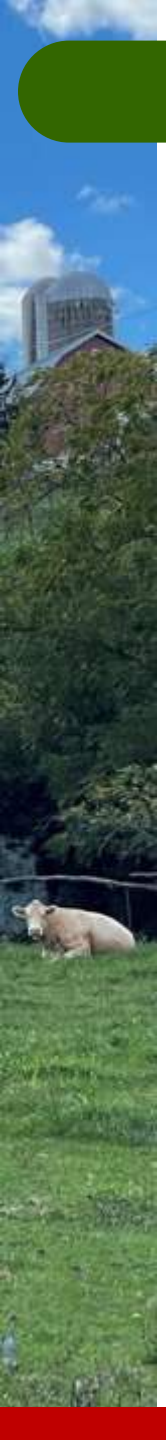
- Factors favoring denitrification losses
  - Poorly drained, poorly aerated soils
  - Ponded, waterlogged soils
  - 2-3 days of standing water can cause most of the nitrate-N to be lost.
- Practices for minimizing denitrification losses
  - Sidedress N applications on soils that are often wet
  - Use a nitrification inhibitor with preplant N applications to soils that are often wet.



Nitrogen Loss: Leaching

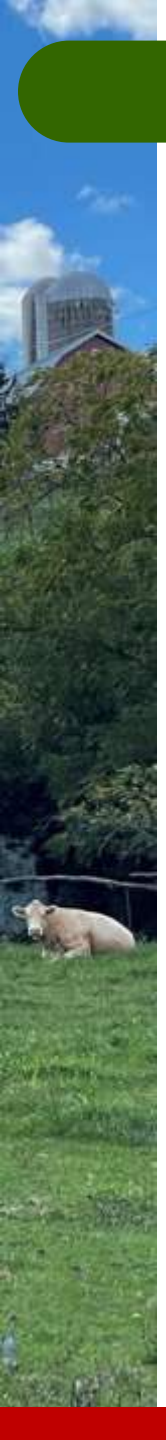
- Factors favoring leaching losses
  - Coarse-textured soils (sands)
  - Nitrate-N fertilizers (UAN, ammonium nitrate)
  - Significant rainfall after application

- Practices for minimizing leaching losses
  - Use ammonium fertilizers (anhydrous, urea, ammonium sulfate)
  - Delay applications (split, sidedress)



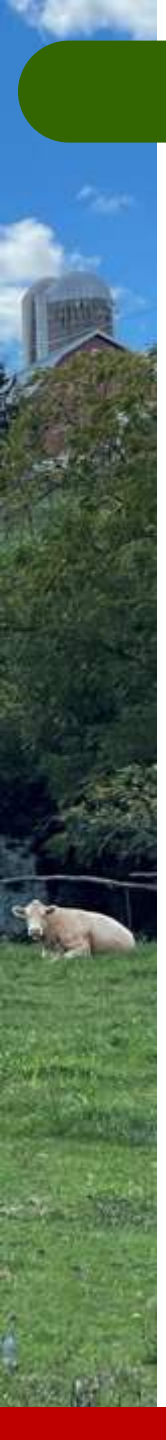
Nitrogen Loss: Ammonia Volatilization

- Factors favoring ammonia loss:
  - No rain or irrigation after application
  - Crop residue on the soil surface
  - High temperatures
  - High soil pH
  - Low clay & organic matter (low CEC)
  - Initially moist soil followed by drying

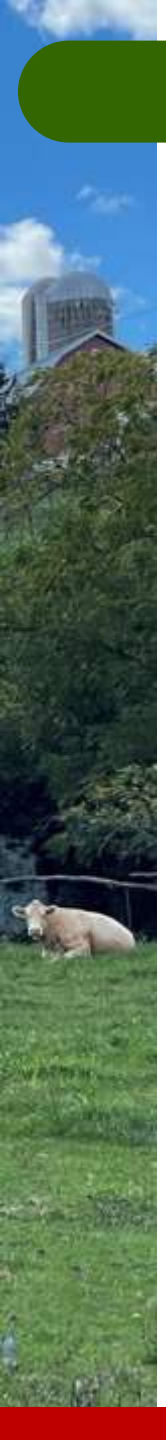


Nitrogen Loss: Ammonia Volatilization

- Practices for minimizing ammonia loss:
  - Incorporate/inject or rainfall/irrigation after application
  - Maintain soil pH
  - Urease inhibitors (ex. Agrotain) to reduce loss from urea fertilizers
    - Economic benefit from inhibitors is uncertain
  - Winter applications of urea susceptible to loss
  - Preplant applications of urea on sands should be avoided



Nitrogen Fertilizers

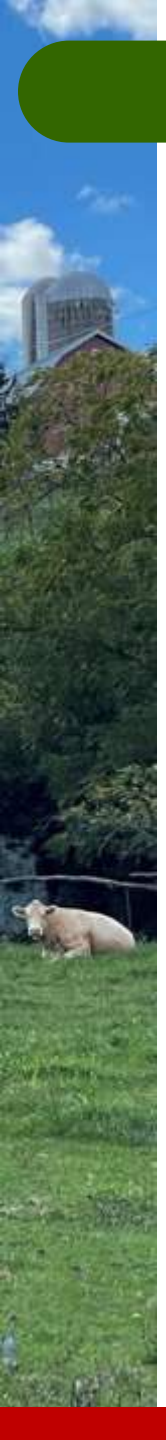


Nitrogen Fertilizers

Fertilizer	Chemical formula	Fertilizer analysis (%) $N\text{-}P_2O_5\text{-}K_2O$	% of N	
			NH_4^+	NO_3^-
Anhydrous ammonia	NH_3	82-0-0	100	0
UAN solutions	NH_4NO_3 + urea + H_2O	28-0-0 32-0-0	75	25
Urea	$NH_2\text{-}CO\text{-}NH_2$	46-0-0	100	0
Ammonium nitrate	NH_4NO_3	33-0-0	50	50
Ammonium sulfate	$(NH_4)_2SO_4$	21-0-0	100	0

Nitrogen Fertilizers: Differences in Effectiveness?

- All equally effective if losses are minimized
  - Flexibility in rates based on economics
- Different susceptibility to loss processes
- Leaching
  - Denitrification
  - Ammonia volatilization
- Timing may heavily influence fertilizer purchased due to application method available.

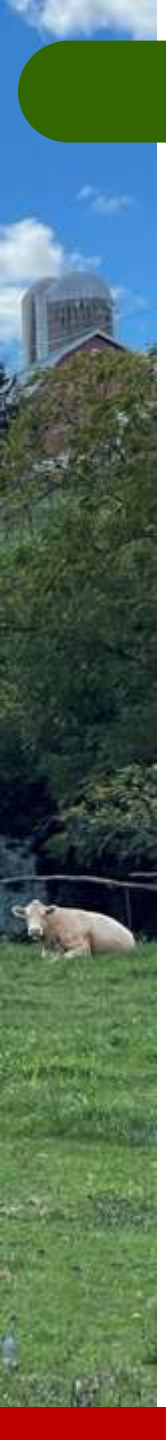


Nitrogen Application Rate

	Nitrogen	Phosphorus (P_2O_5)	Potassium (K_2O)
Base Recommendations	180	60	60
Dairy manure application (12 tons/ac) 3-3-6 book value	36	36	72
Proceeding Crop= Alfalfa Poor stand (0-30% alfalfa, <8" regrowth)	90	0	0
Commercial Fertilizer that could be applied	54	24	0

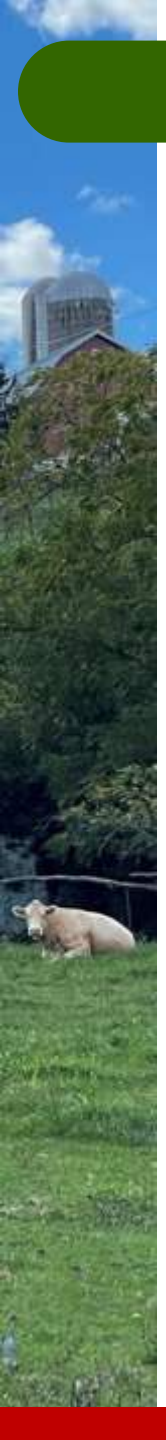
Fertilizer Blends

- Fertilizer blends commonly used to meet field crop needs.
- Fertilizer blends are calculated based on data from soil test values, application rate, crop need, and fertilizer product purchased.



Fertilizer Blends

- Example- MRTN recommends 180 lb./ac N and the soil test values indicate a need for 60 lb./ac P2O5.
- Products available: DAP- 18-46-0 and Urea- 46-0-0
  - 24 lb./ac P2O5 (36 lb. manure credit) / .46= 52 lb./ac DAP application
  - 52 DAP x .18 (N in DAP)= 9 lb. N
  - Legume and Manure Credits= 129 lb. N
  - 180-129=51 lb. N (MRTN Rate) – 9 lb. (DAP) = 42 lb. N still needed
  - 42 / .46 (N in Urea) = 91 lb./ac urea application
  - 91 lb. urea/ac and 52 lb./ac DAP



Fertilizer Additives Used to Reduce Potential N Losses

Additive	Common Name(s)	N Content	N Process	Inhibition Duration
		%		weeks
Nitrification Inhibitors				
Nitrapyrin	N-Serve Stay-N 2000	-	Nitrification Denitrification	2-6
DCD	DCD Ensan	1.6	-	4-8
DMPP	DMPP ENTEC	- 12-26	-	6-8
Urease Inhibitors				
NBPT	Agrotain Super U	- 46	Volatilization	2-3
Thiosulfate	ATS CaTS	12	Volatilization Nitrification	2-3
Combination Products				
DCD + NBPT	Agrotain Plus HYDREXX	-	Volatilization Nitrification Denitrification	6-8
DCD + NBPT + urea	UMAXX UFLEXX Super U	47 46	-	8-12 6-8
Polymer	Nutrisphere	-	-	6-12
Polymer + urea	SSN	46	-	6-12

Source: Soil Fertility and Fertilizers 8th ed. Havlin et al.

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University of Wisconsin Nitrogen Recommendations

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Goals of Nitrogen Management

- Maximize economic return with optimum N rates.
- Avoid environmental risks due to above-optimum N use.

Price Adjusted N Guidelines for Corn

- Maximum Return to N (MRTN)
  - Flexibility in rates based on economics
    - Cost of N
    - Price of corn
- Cropping systems approach
  - Corn after soybeans, small grains
  - Corn after corn, forage legumes, green manures, etc.
- Multi-state, regional approach
  - WI, IA, IL, MN, OH, IN, MI

Wisconsin Nitrogen Recommendations for Corn are based on:

- Corn & nitrogen prices
- Soil yield potential
- Soil texture (sands vs. others)
- Previous crop
- Irrigation (sands & loamy sands)

- NOT CORN YIELD GOAL -

Example

Urea $552/ Ton (46-0-0)

2000 lbs. X .46= 920 lbs. N

$552/920 lbs. = $0.60/lb.

Grain Price $4.50

$0.60 lb./ N $4.50 bu = N:Corn Price Ratio = 0.10

Price Adjusted N Guidelines for Corn - Loamy (medium & fine-textured) Soils -

Soil Yield Potential	Previous Crop	- - - N:Corn Price Ratio ($/lb N:$/bu) - - -							
		0.05		0.10		0.15		0.20	
		Rate[1]	Range[2]	Rate[1]	Range[2]	Rate[1]	Range[2]	Rate[1]	Range[2]
		- - - - - - - - - - lb N/a to apply[3] - - - - - - - - - -							
High	**Corn**, legumes[4]	**190**	170-210	**165**	155-180	**150**	140-160	**135**	125-150
	Soybean, small grain[5]	**140**	125-160	**120**	105-130	**105**	95-115	**90**	80-105
Medium	**Corn**, legumes[4]	**145**	130-160	**125**	115-140	**115**	105-125	**105**	95-110
	Soybean, small grain[5]	**130**	110-150	**100**	85-120	**85**	70-95	**70**	60-80

[1] Maximum return to N (MRTN) rate.

[2] Within $1/a of MRTN rate.

[3] Total N to apply, includes N in starter, herbicides, etc.

[4] Subtract N credits for forage legumes, legume vegetables, animal manures, green manures.

[5] Subtract N credits for animal manures and second year forage legumes.

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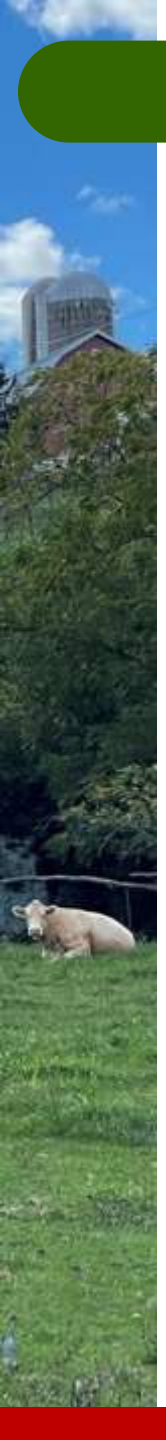


Price Adjusted N Guidelines for Corn - Sands & Loamy Sands -

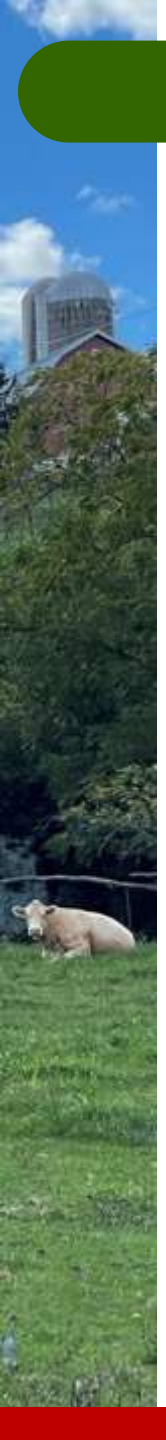
Sands & Loamy Sands	Previous Crop	- - - N:Corn Price Ratio ($/lb N:$/bu) - - -							
		0.05		0.10		0.15		0.20	
		Rate[1]	Range[2]	Rate[1]	Range[2]	Rate[1]	Range[2]	Rate[1]	Range[2]
		- - - - - - - - - - lb N/a to apply[3] - - - - - - - - - -							
Irrigated	All Crops[4]	**215**	200-230	**200**	185-210	**185**	175-195	**175**	165-185
Non-irrigated	All Crops[4]	**140**	130-150	**130**	120-140	**120**	110-130	**110**	100-120

[1] Maximum return to N (MRTN) rate.

[2] Within $1/a of MRTN rate.

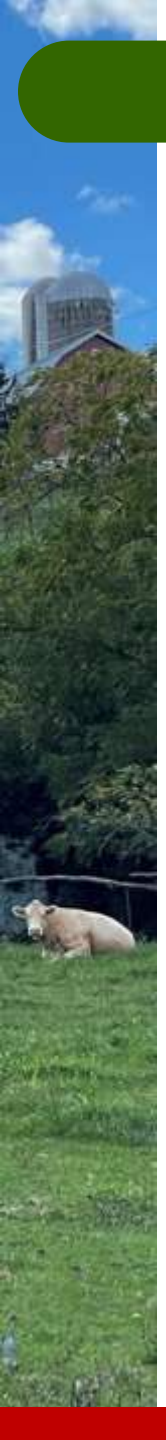
[3] Total N to apply, includes N in starter, herbicides, etc.

[4] Subtract N credits for forage legumes, legume vegetables, animal manures, green manures.



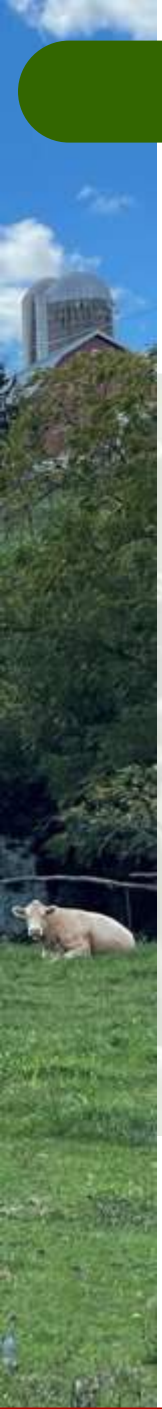
N Guidelines for Corn- Additional Guidelines

- For maximum silage yield, use N rate for the 0.05 price ratio. To adjust rates for silage, use price ratio that reflects typical prices for N and grain.
- If >50% residue at planting, use upper end of range.
- If all N is from organic sources, use top end of range. Plus, up to 20 lb N/a as starter.
- For loamy (medium & fine-textured) soils with >10% soil organic matter, use low end of range.
- For all soils with <2% OM, use high end of range.



N Guidelines for Corn - Additional Guidelines

- For sands with <2% OM, use high end of range; 2-10% OM, use mid- to low-end of range; 10-20% OM, use non-irrigated guidelines – regardless of irrigation status; >20% OM, apply 80 lb N/a.
- When corn follows small grains on loamy soils, use the mid- to low-end of range.
- For loamy irrigated or drained soils, use rates for high yield potential soils.
- If potential for carry-over (residual) N, use low end of range or use the high end and subtract preplant soil nitrate test (PPNT) credits.



Corn

The University of Wisconsin's nitrogen (N) fertilizer guidelines for corn allow growers to determine N application rates that provide maximum economic returns based on the cost of N and an anticipated corn price. These guidelines also provide a range of profitable N rates that are within $1/acre of the maximum return rate. See UWEX publication A2809 *Nutrient Application Guidelines for Field, Vegetable, and Fruit Crops in Wisconsin.*

ADDITIONAL GUIDELINES

- For maximum silage yield, use N rate for 0.05 price ratio. To adjust rates for silage, use price ratio that reflects typical prices for N and grain.
- If >50% residue at planting, use upper end of range.
- If all N is from organic sources, use top end of range. Plus, up to 20 lb N/acre as starter may be used.
- For loamy (medium & fine-textured) soils with >10% soil organic matter (OM), use low end of range.
- For all soils with <2% soil OM, use high end of range.
- For sandy (coarse-textured) soils with <2% OM, use high end of range; 2-10% OM, use mid to low end of range; 10-20% OM, use non-irrigated guidelines–regardless of irrigation status; >20% OM, apply 80 lb N/acre.
- When corn follows small grains on loamy soils, use the mid to low end of range.
- For loamy irrigated or drained soils, use rates for high yield potential soils.
- If potential for carry-over (residual) N, use low end of range or use the high end and subtract preplant soil nitrate test (PPNT) credits.

This publication is available from the Nutrient and Pest Management (NPM) Program. web (ipcm.wisc.edu); phone (608) 265-2660; email (npm@hort.wisc.edu).

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Funding provided by the Wisconsin Dept. of Agriculture, Trade & Consumer Protection.

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N:Corn Price Ratio Table*

Color Key for ratio (see other side): 0.05, 0.10, 0.15, 0.20

Price of Corn ($/bu corn)

Price of N ($/lb N) — Price of N = [$/ton fertilizer N x (100 / % N in fertilizer)] / 2000	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50
0.25	0.10	0.09	0.08	0.08	0.07	0.07	0.06	0.06	0.06	0.05	0.05	0.05	0.05
0.30	0.12	0.11	0.10	0.09	0.09	0.08	0.08	0.07	0.07	0.06	0.06	0.06	0.05
0.35	0.14	0.13	0.12	0.11	0.10	0.09	0.09	0.08	0.08	0.07	0.07	0.07	0.06
0.40	0.16	0.15	0.13	0.12	0.11	0.11	0.10	0.09	0.09	0.08	0.08	0.08	0.07
0.45	0.18	0.16	0.15	0.14	0.13	0.12	0.11	0.11	0.10	0.10	0.09	0.09	0.08
0.50	0.20	0.18	0.17	0.15	0.14	0.13	0.13	0.12	0.11	0.11	0.10	0.10	0.09
0.55	0.22	0.20	0.18	0.17	0.16	0.15	0.13	0.13	0.12	0.12	0.11	0.11	0.10
0.60	0.24	0.22	0.20	0.18	0.17	0.16	0.14	0.14	0.13	0.13	0.12	0.11	0.11
0.65	0.26	0.24	0.22	0.20	0.19	0.17	0.16	0.15	0.14	0.14	0.13	0.12	0.12
0.70	0.28	0.25	0.23	0.22	0.20	0.19	0.18	0.16	0.16	0.15	0.14	0.13	0.13
0.75	0.30	0.27	0.25	0.23	0.21	0.20	0.19	0.18	0.17	0.16	0.15	0.14	0.14
0.80	0.32	0.29	0.27	0.25	0.23	0.21	0.20	0.19	0.18	0.17	0.16	0.15	0.15

* to use an online calculator go to http://www.soils.wisc.edu/extension/cropprod.php

Corn

University of Wisconsin Nitrogen Guidelines for Corn

N:Corn Price Ratio (see table on other side)

Soil[1]	Previous Crop	0.05	0.10	0.15	0.20
		lbs N/acre (total to apply)[2]			
loamy: high yield potential soils	**Corn**, Forage legumes, Legume vegetables, Green manures[5]	**190**[3] 170-------210[4]	**165** 155----180	**150** 140---160	**135** 125----150
	Soybean, Small grains[6]	**140** 125------160	**120** 105----130	**105** 95--115	**90** 80----105
loamy: medium yield potential soils	**Corn**, Forage legumes, Legume vegetables, Green manures[5]	**145** 130-----160	**125** 115----140	**115** 105---125	**105** 95--110
	Soybean, Small grains[6]	**130** 110-------150	**100** 85------120	**85** 70---95	**70** 60---80
sands/ loamy sands	Irrigated—**All crops**[5]	**215** 200-----230	**200** 185----210	**185** 175---195	**175** 165---185
	Non-irrigated—**All crops**[5]	**140** 130---150	**130** 120---140	**120** 110---130	**110** 100---120

[1] To determine soil yield potential, consult UWEX publication A2809 or contact your county agent or agronomist.

[2] Includes N in starter.

[3] Maximum return to N (MRTN) rate.

[4] Profitability range within $1/acre of MRTN rate.

[5] Subtract N credits for forage legumes, legume vegetables, animal manures, green manures.

[6] Subtract N credits for animal manures and second year forage legumes.

R-01-2015-2M

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Wheat

The University of Wisconsin Nitrogen Fertilizer Guidelines for Wheat allows growers to determine nitrogen application rates that provide maximum economic return based on the cost of nitrogen and an anticipated wheat price. By first determining the ratio in the **LOOKUP TABLE** on right, then using the corresponding column in the table on other side of card along with the field's soil group and previous crop, a profitable N rate range is identified; rates can be further refined to within $1/acre of the maximum return rate by consulting the guidelines below and those on the other side of the card. For wheat following corn on loamy soils, results from the preplant soil nitrate test (PPNT) can also help refine nitrogen rates. *To learn more, see University of Wisconsin-Madison, Division of Extension publication A2809 Nutrient Application Guidelines for Field, Vegetable, and Fruit Crops in Wisconsin.*

ADDITIONAL GUIDELINES (SEE OTHER SIDE FOR MORE GUIDELINES):

- When wheat follows a forage legume or leguminous vegetable, use the N rate for wheat following corn with a PPNT less than or equal to 50 lb N/a and take the legume credit.
- Manure N credits must be subtracted from the N rates.
- No N is required on organic soils.
- If 100% of the N will come from organic sources, use the top end of the range.
- Reduce N rates by 10 lb N/a for spring wheat on all soils.

NPM 02-2020-2M

Funding provided by the Wisconsin Department of Agriculture, Trade & Consumer Protection.

NITROGEN: WHEAT PRICE RATIO **LOOKUP TABLE**

Anticipated wheat price ($/bu wheat)

Cost of nitrogen ($/lb N) = [$/ton fertilizer N x (100 / % N in fertilizer)] / 2000	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00
0.25										0.050			
0.30													
0.35													
0.40							0.075						
0.45													
0.50					0.100								
0.55													
0.60													
0.65				0.125									
0.70													
0.75													
0.80													

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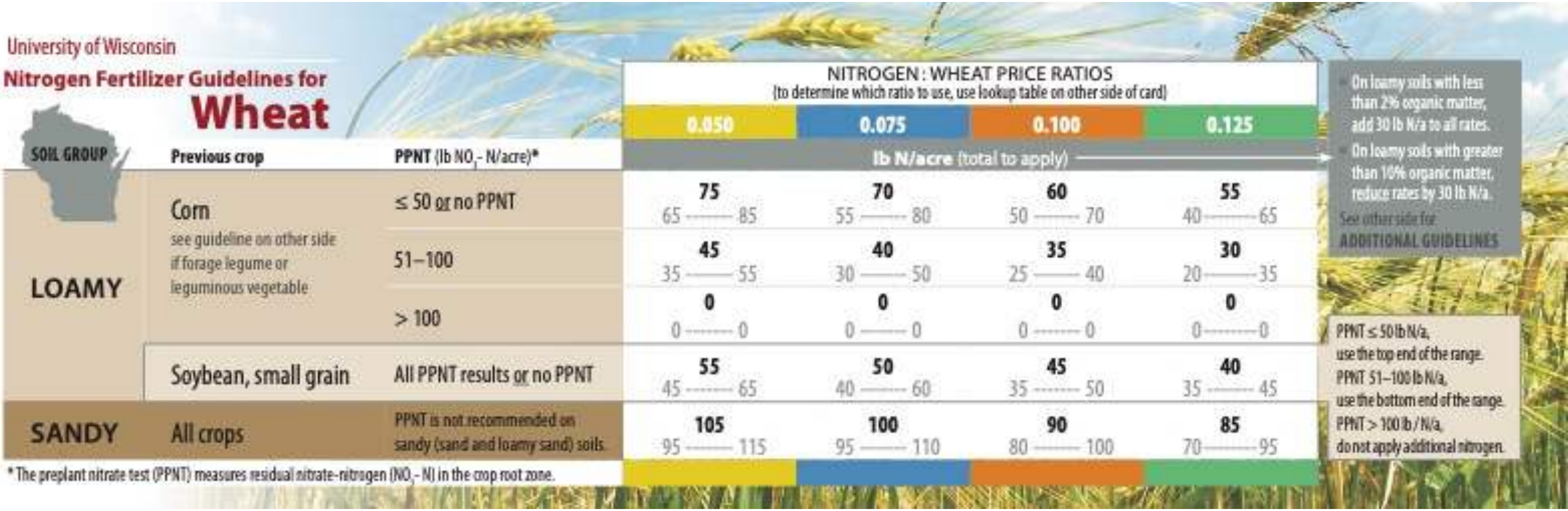
Wheat



University of Wisconsin

Nitrogen Fertilizer Guidelines for Wheat

SOIL GROUP	Previous crop	PPNT (lb NO_3- N/acre)*	NITROGEN : WHEAT PRICE RATIOS (to determine which ratio to use, use lookup table on other side of card)			
			0.050	0.075	0.100	0.125
			lb N/acre (total to apply) →			
LOAMY	Corn see guideline on other side if forage legume or leguminous vegetable	≤ 50 or no PPNT	**75** 65 — 85	**70** 55 — 80	**60** 50 — 70	**55** 40 — 65
		51–100	**45** 35 — 55	**40** 30 — 50	**35** 25 — 40	**30** 20 — 35
		> 100	**0** 0 — 0	**0** 0 — 0	**0** 0 — 0	**0** 0 — 0
	Soybean, small grain	All PPNT results or no PPNT	**55** 45 — 65	**50** 40 — 60	**45** 35 — 50	**40** 35 — 45
SANDY	All crops	PPNT is not recommended on sandy (sand and loamy sand) soils.	**105** 95 — 115	**100** 95 — 110	**90** 80 — 100	**85** 70 — 95

* On loamy soils with less than 2% organic matter, add 30 lb N/a to all rates.
* On loamy soils with greater than 10% organic matter, reduce rates by 30 lb N/a.

See other side for ADDITIONAL GUIDELINES

PPNT ≤ 50 lb N/a, use the top end of the range.
PPNT 51–100 lb N/a, use the bottom end of the range.
PPNT > 100 lb / N/a, do not apply additional nitrogen.

* The preplant nitrate test (PPNT) measures residual nitrate-nitrogen (NO_3- N) in the crop root zone.

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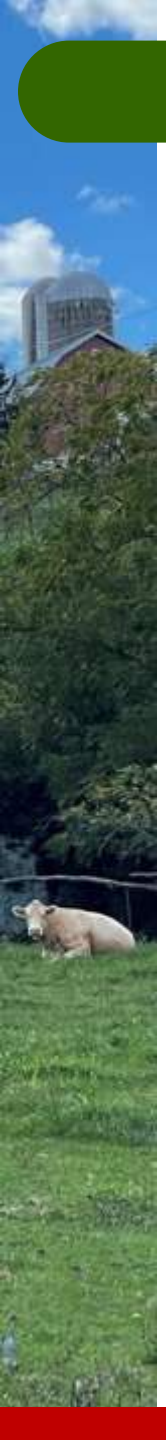
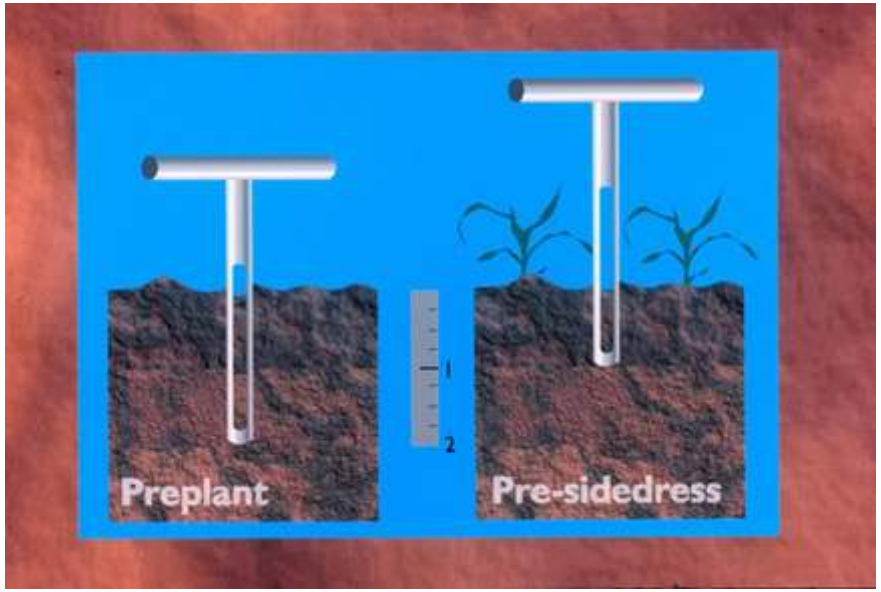
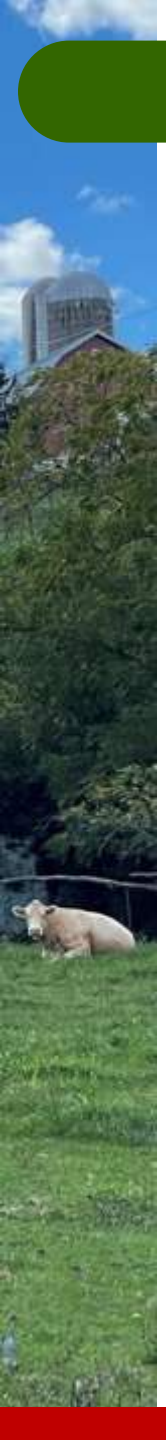


Adjusting Base N Recs in Corn

Soil Nitrate Tests for Corn

- Two options:
  - Preplant soil nitrate test (PPNT)
  - Pre-sidedress soil nitrate test (PSNT)
- Agronomic & environmental benefits
- Predicts corn N needs
  - Site- and year-specific

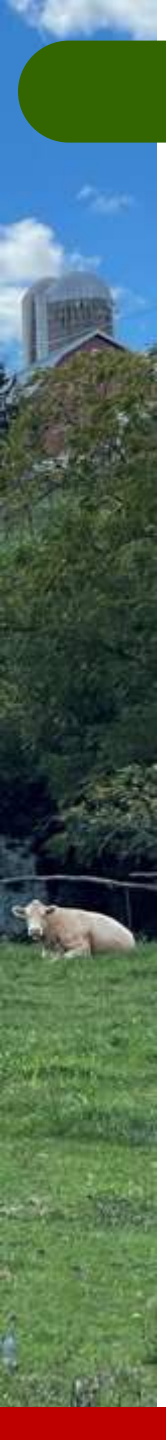




Preplant Soil Nitrate Test (PPNT)

- Measures residual (carry-over) nitrate
  - Corn after corn
  - Medium- and fine-textured soils
  - Normal or below normal rainfall
  - Available N exceeds crop need

- Not applicable on sands, loamy sands

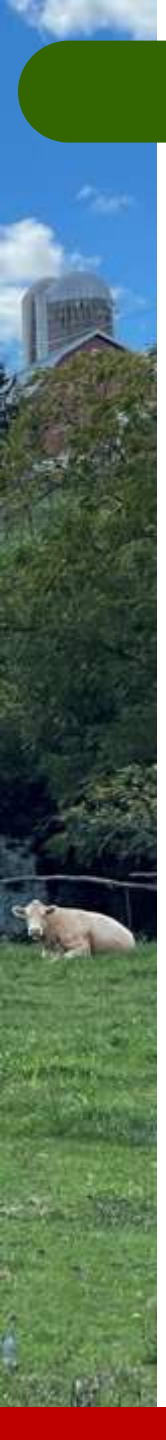


Pre-sidedress Soil Nitrate Test (PSNT)

- Estimates N availability from organic sources
  - Measures N credits from manure
  - Useful when manure & legume history is unknown
- Partial accounting for carry-over nitrate
- Short sampling & analysis time
- Sidedress N – if needed

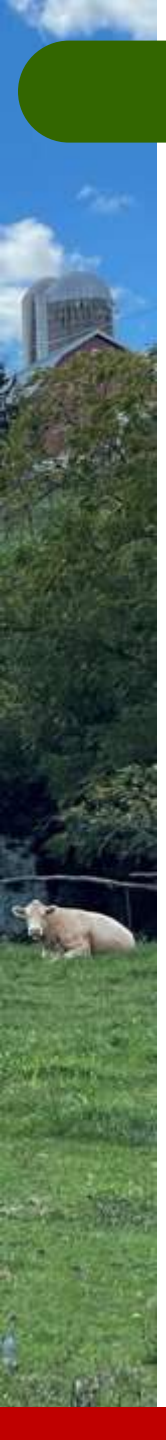
Using Soil Nitrate Tests: Corn after Corn

- Preplant Test (PPNT)
  - Highest potential for carryover N
  - Adjust for N credits separately
    - Second year N credits
    - Manured sites
- Pre-sidedress Test (PSNT)
  - Direct adjustment for N credits
  - Partial carryover measurement



Using Soil Nitrate Tests: Corn after Alfalfa

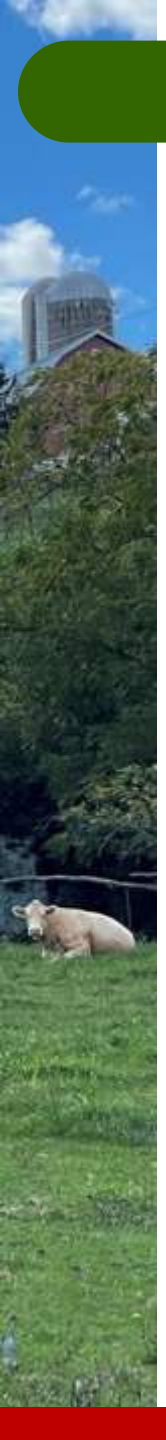
- Use standard legume-N credit
- Pre-sidedress Test (PSNT)
  - Confirms legume credit
  - For PSNT value < 21 ppm N, apply no more than 40 lb N/acre
- Do not use preplant test (PPNT)



Using Soil Nitrate Tests: Manured Sites

- Pre-sidedress Test (PSNT)
  - Direct adjustment for N credit
  - Confirms N credit
  - Useful for unknown manure application rates

- Preplant Test (PPNT)
  - Accounts for carry-over nitrate from previous years
  - Separate N credit needed for current or second-year manure-N applications

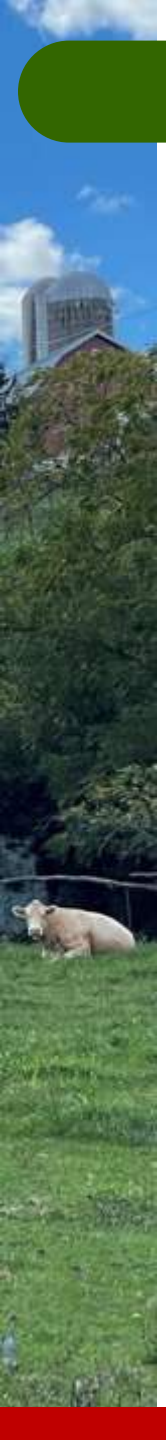


Using Soil Nitrate Tests: Corn after Soybean

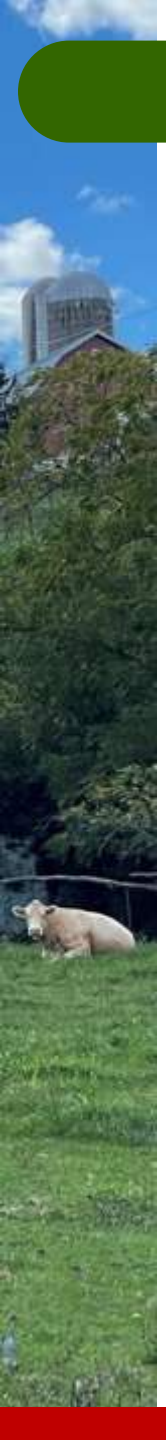
- Preplant Test (PPNT)
  - Accounts for carry-over nitrate from previous years
- Pre-sidedress Test (PSNT)
  - Do not use

Additional Nitrogen Tests

- The end of season stalk nitrate test can help evaluate current N management strategies for a field.
- Plant tissue analysis provides the concentration of N, P, K, Ca, Mg, S, Zn, Mn, B, Cu, and Fe in the plant sample. A soil sample should be collected at the same time as the tissue test.
- Normalized Difference Vegetation Index (NDVI) and Normalized Difference RedEdge (NDRE) are measures of the state of plant health based on how the plant reflects light at certain frequencies. The correlation between plant color and nitrogen need are being evaluated in Wisconsin and should be researched further before using for nitrogen applications.



Nitrogen uptake and loss potential



When apply Nitrogen in Wisconsin?

Soil	Fall	Preplant	Sidedress
Medium/Fine Texture Well-Drained	OK*	BEST	OK
Medium/Fine Texture Poorly Drained	NO	OK	BEST
Coarse Texture	NO	NO	BEST

* Includes use of BMPs for fall-applied N.

When to apply Nitrogen via Manure?

- Spring- prior to planting
- Fall- after soil temperatures have dropped below 50 °F

Nitrogen Application Restrictions

- Environmental and Landscape restrictions
  - Soil temperature
  - Soil Type (sands, etc)
  - Depth to bedrock
  - Depth to water table

Nitrogen Application Restrictions: SnapPlus

Nitrogen (N) restricted soils (gold lines or squares)

Soils identified as having a high risk for allowing contaminates to leach through to groundwater have restrictions on N rates and timing.

- ✓ Fall applications of commercial nitrogen are not allowed on these soils except for up to 36 lb N per acre on fall-seeded crops or in blends with other fertilizers.
- ✓ Each soil type has additional restrictions as described below:

P (high permeability) Water moves through these soils relatively quickly.

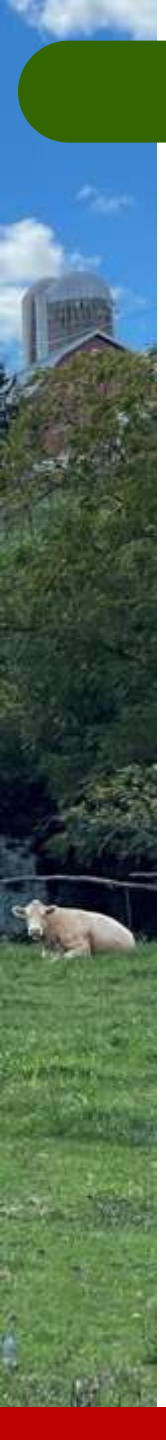
- ✓ Fertilizer N in the spring and summer has to be applied in split applications with the majority post-planting or else applied with a nitrification inhibitor or in slow-release form.
- ✓ Late summer or fall manure N is limited to 90 lb N/a for spring-planted crops (i.e. corn, soybean) and 120 lb per acre for all other crops. Fall applications before spring-planted crops should be delayed until soil temperatures are less than 50°F or October 1, whichever comes first. If the manure has 4% dry matter or less, applications must be surface-applied or use a nitrification inhibitor.

R (bedrock likely to be within 20 inches of the soil surface)

- ✓ These soils have the same late summer and fall manure N guidelines as outlined above for P soils but do not have restrictions on spring or summer commercial fertilizer.

W (water table within 12 inches of the surface)

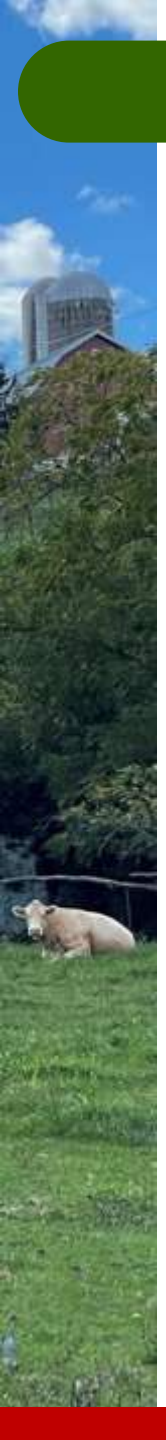
- ✓ Late summer or fall manure N is limited to 120 lb per acre.
- ✓ For fall-applied manure with 4% or less dry matter, the application is limited to 90 lb N unless one of the following is used: surface application; nitrification inhibitor; application to growing crop; cover crop established within 14 days; or application delayed until soil temperatures are less than 50° F or October 1, whichever comes first.



Placement of Nitrogen Applications

Nitrogen Placement: Surface and Foliar

- Economic and Environmental Considerations
  - Spring preplant applications- medium/fine texture well drained soils
  - Sidedress applications- medium/fine textured poorly drained and course texture soils
  - Wheat and other crop applications where incorporation is not an option
  - Urea and urea-containing fertilizers subject to ammonia volatilization without incorporation or rain within 2-3 days of applications
  - Maximum loss= 20-30% of nitrogen



Injection/Subsurface

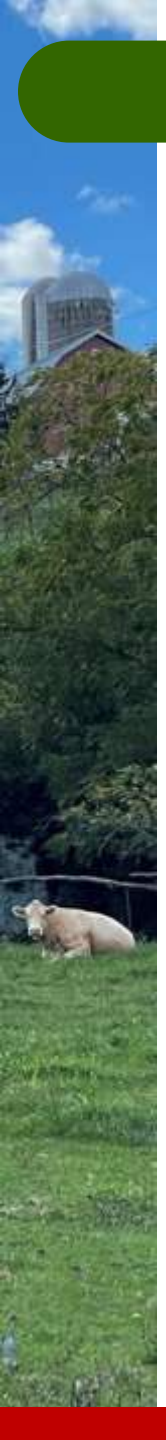
- Economic and Environmental Considerations
  - Starter fertilizer- subsurface applications
    - Always based on crop need and soil test values
    - Starter fertilizers usually increase corn yields when soils are in the responsive range.
    - Factors influencing response include soil test values, soil compaction, fertilizer rate, placement, planting date, and tillage
- Broadcasted starter fertilizer applications are not likely have same effect.
  - Injection: Anhydrous ammonia- necessary application technique
    - Avoid using on sites prone to soil erosion
    - Fall applications only ok on well drained medium/fine texture soils using best management practices (apply when soil temperatures are below 50 °F and use a nitrification inhibitor)

Nitrogen Placement: Broadcast and Band

- Economic and Environmental Considerations
  - Urea, UAN solutions, Ammonium sulfate, and Ammonium nitrate
  - Will cause crop injury if nitrogen comes in contact with plant
  - Urea and urea-containing fertilizers subject to ammonia volatilization without incorporation or rain within 2-3 days of applications
  - Maximum loss= 20-30% of nitrogen
  - Recommended for sandy and poorly drained soils

Nitrogen Placement: Incorporation

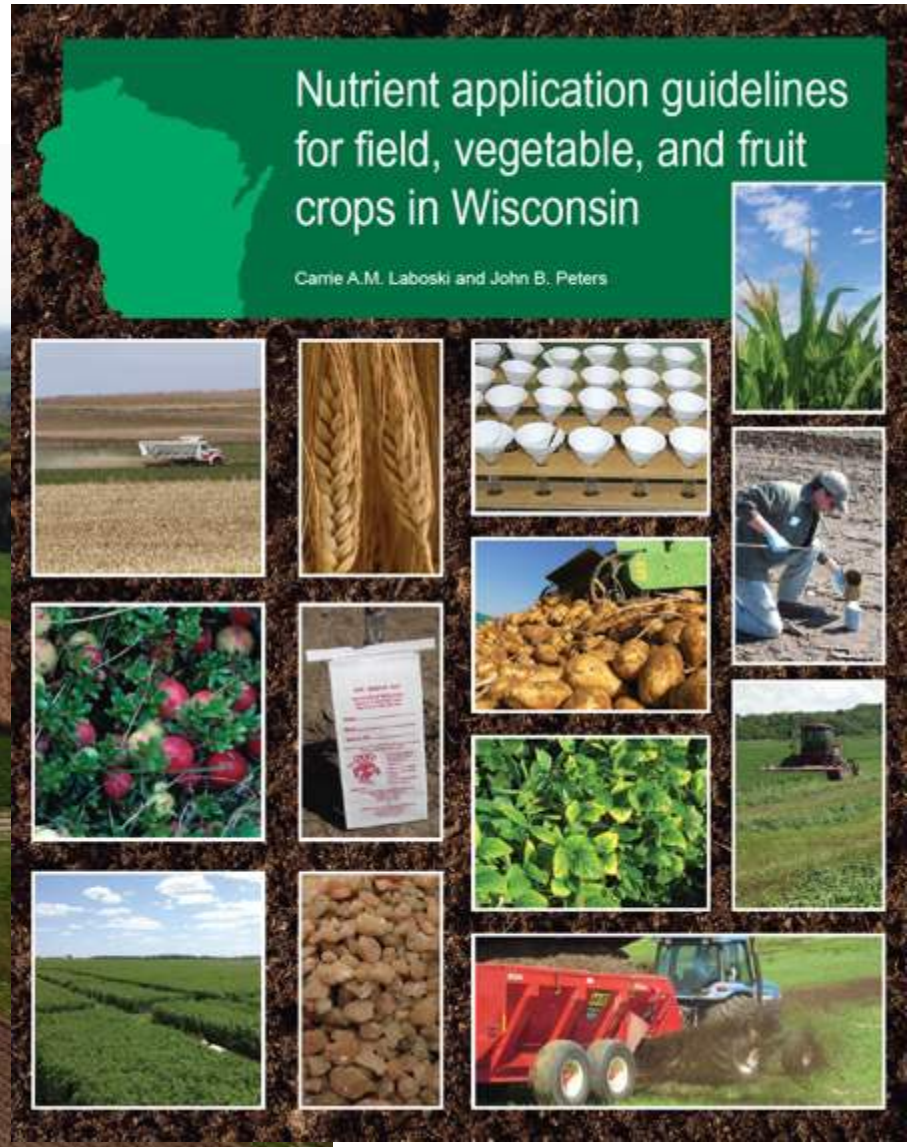
- Economic and Environmental Considerations
  - Urea and UAN solutions
  - Ammonia volatilization occurs without incorporation or rain within 2-3 days of applications
  - Maximum loss= 20-30% of nitrogen



Nitrogen Placement: Multiple Applications

- Economic and Environmental Considerations
  - MRTN based rate
  - Subtract manure and legume credits
  - Yield increases are not necessarily seen on medium/fine texture soils when compared to spring applied nitrogen
  - Reduces risk of nitrogen losses

For more information



Thank you!

Questions?

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