Precision Nitrogen Management of Corn

Adaptive N management:
Fine-tuning Nitrogen Management for Corn
Field by field, year by year

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http://nmsp.cals.cornell.edu

Nitrogen

Nitrogen availability limits the productivity of most ecosystems in the US.

Nitrogen

Deficiency:

- Little new growth.
- Yellowing (chlorosis) of older leaves.
- Earlier fall leaf drop.
- Low protein content.

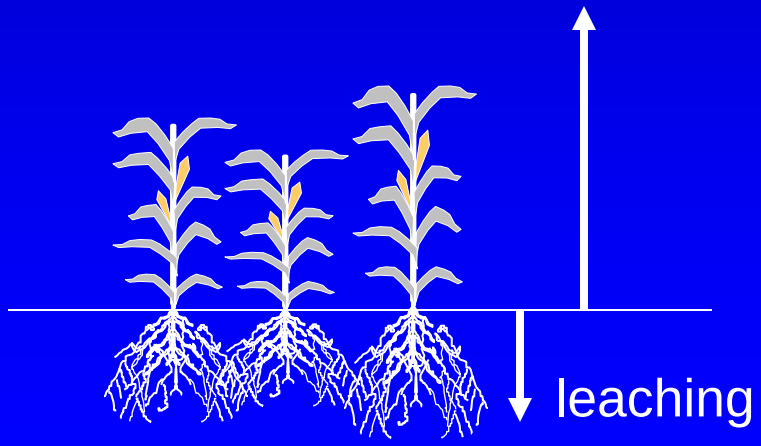
Excess:

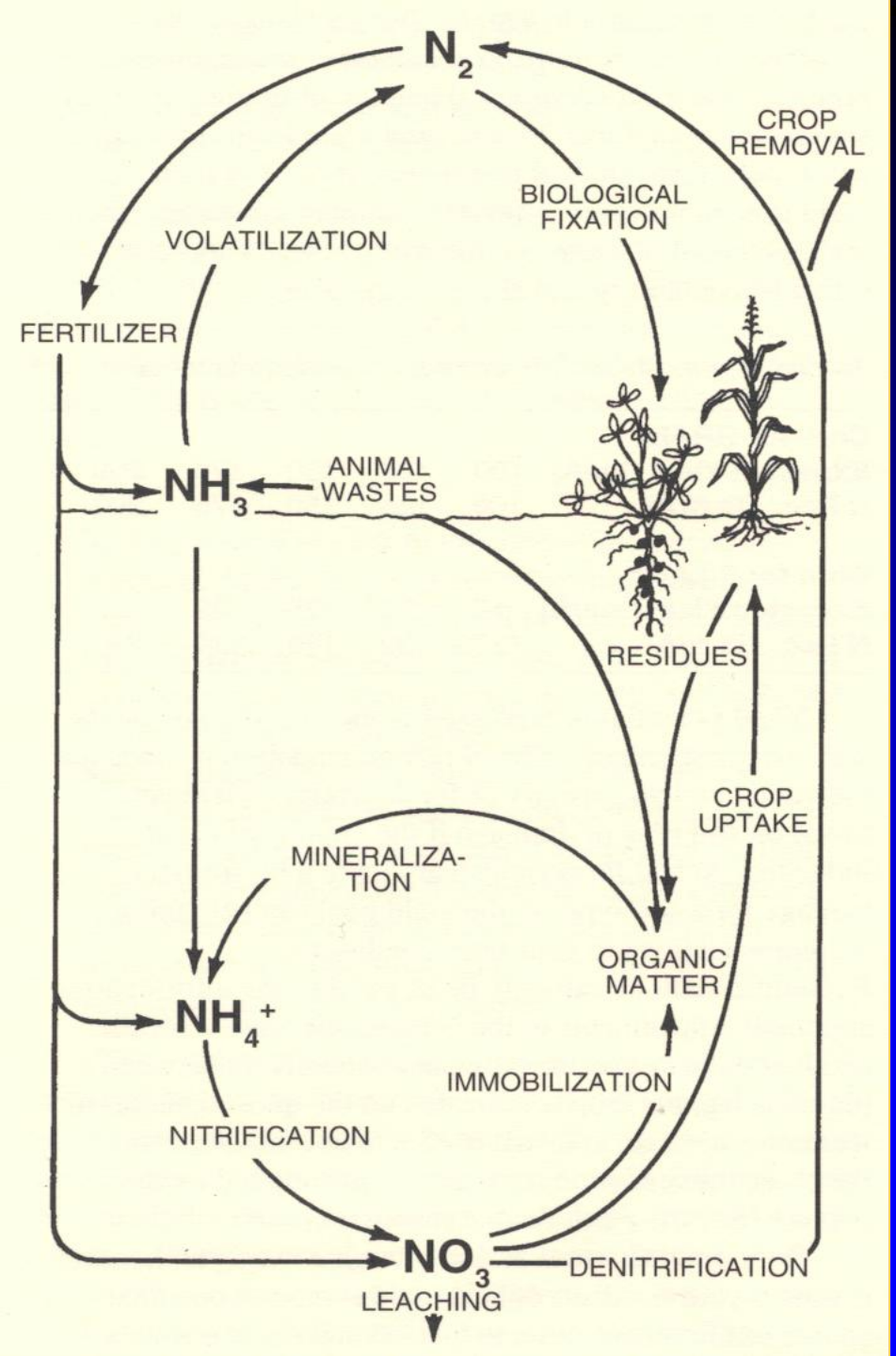
- Very dark green leaves.
- Excessive vegetative growth.
- Lodging and delayed maturity.
- High nitrate content of some crops.

Nitrogen loss to the environment

Nitrogen can be lost from dairy farms to:

- The atmosphere.
- Groundwater and surface waters.





Conversion processes:

1. N fixation
2. Mineralization
3. Nitrification
4. Denitrification
5. Ammonia volatilization
6. Immobilization

+ Nitrate leaching

From Penn State Agronomy Facts 12

Nitrogen Guidelines for Corn – the Basics

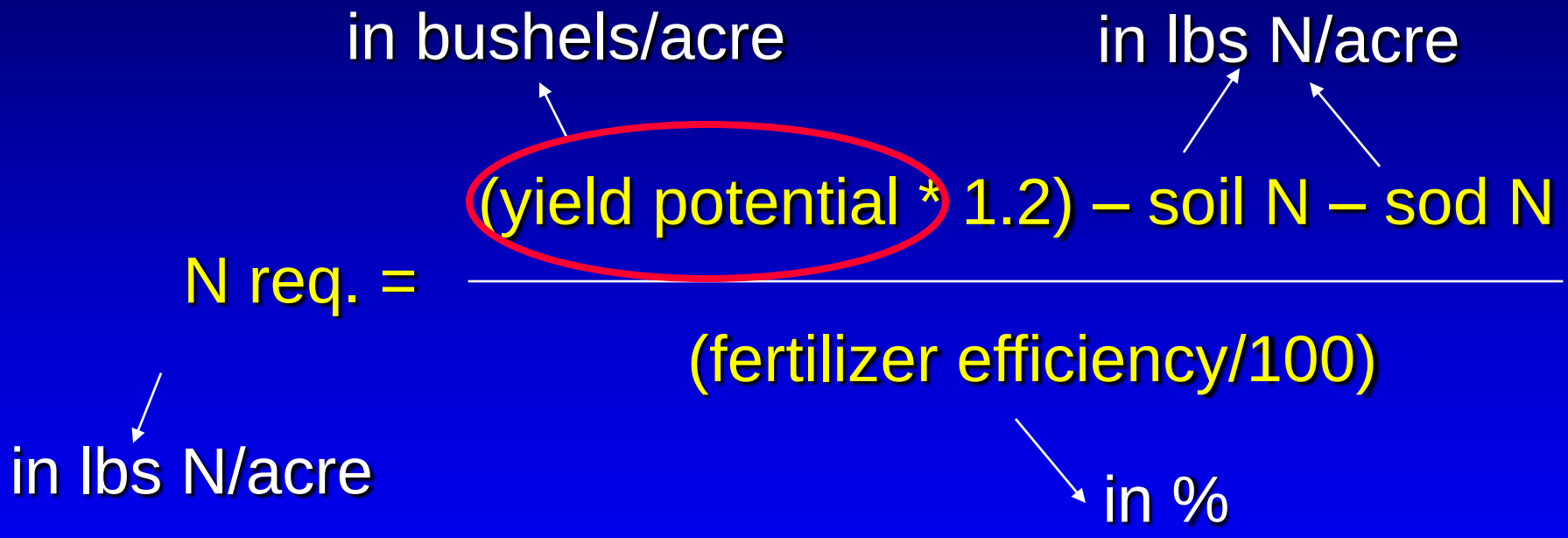
- Take into account all nitrogen sources
  - Soil N supply (soil organic matter)
  - Sod and other rotation credits
  - Past and current manure applications
- Use fertilizer only to supplement
- Fine-tune over time and field by field using N management tools:
  - Illinois Soil Nitrogen Test (ISNT)
  - Pre-sidedress Nitrate Test (PSNT)
  - Corn Stalk Nitrate Test (CSNT)

Corn N Recommendations (NY)

How to find out how much N is needed?

- Yield potential
  - soil type and drainage
- Soil N supply
  - soil type and drainage
- N fertilizer uptake efficiency
  - soil type and drainage
- N credits from sods
  - % legume/grass in the sod
- N credits from manure
  - manure source & application method

Corn N Recommendations



Cornell Nitrogen Recommendations

Corn Yield Potential

To get yield potentials:

- ✓ Use the Cornell database to obtain yield potentials.
- ✓ Use higher yield potentials only when you have 3 years worth of proof of higher yields.

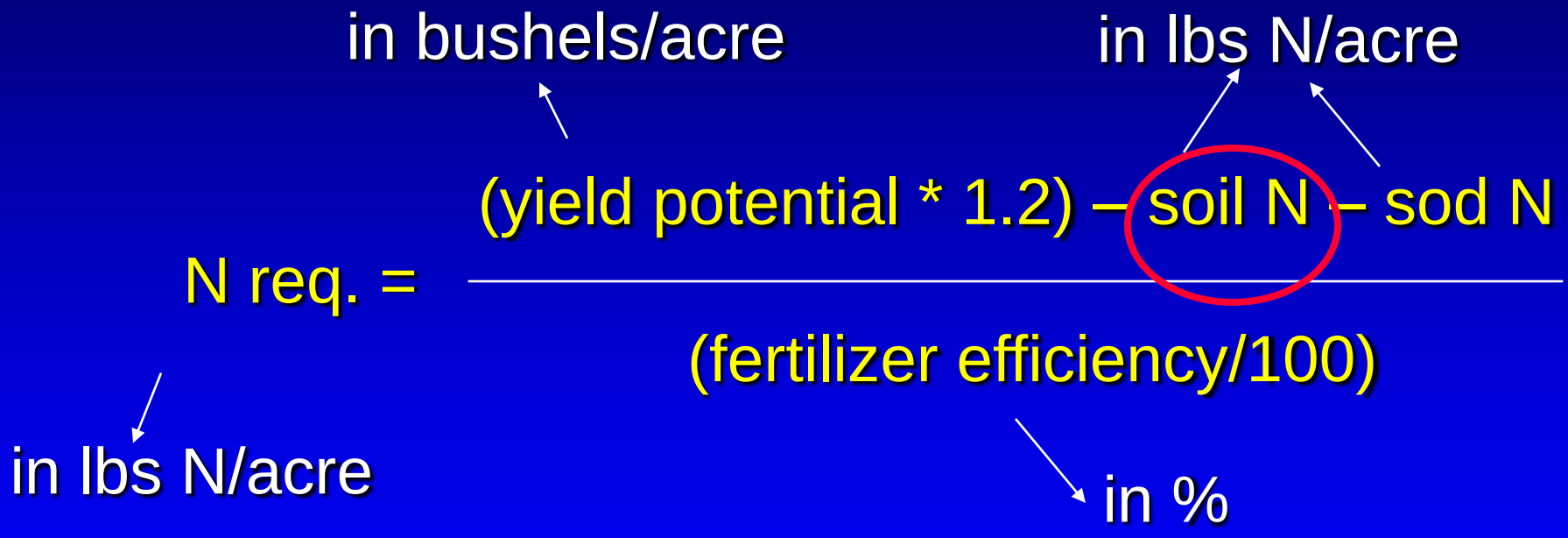
Corn Yield Potential

Expected yield 3 to 4 years out of 5 under good management:

	Undrained bu/acre	Drained bu/acre
Hamlin	155	155
Bath	125	125
Volusia	95	105
Fremont	100	110
Howard	135	135

1 tons of silage (35% dry matter) equals about **5.9** bushels of grain (85% DM)

Corn N Recommendations



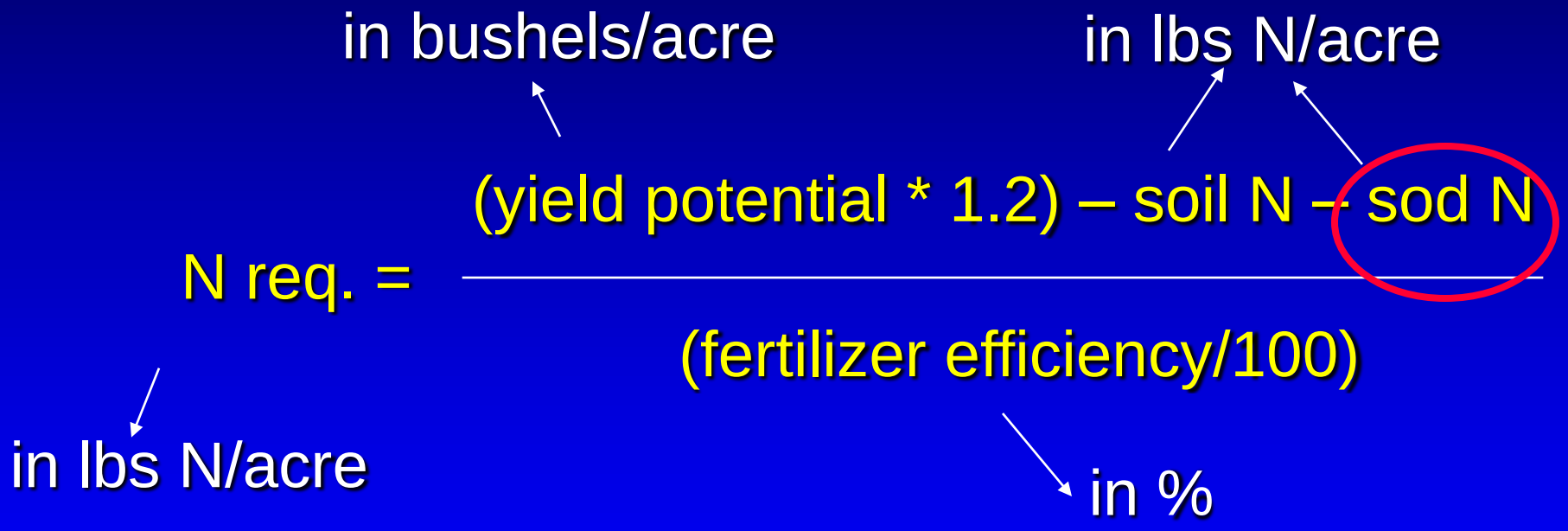
Cornell Nitrogen Recommendations

N from Soil Organic Matter

Soil N: soils database

	Undrained	Drained
	--------lbs/acre--------	
Honeoye	75	75
Palmyra	70	70
Volusia	60	70
Wayland	60	75
Howard	70	70

Corn N Recommendations

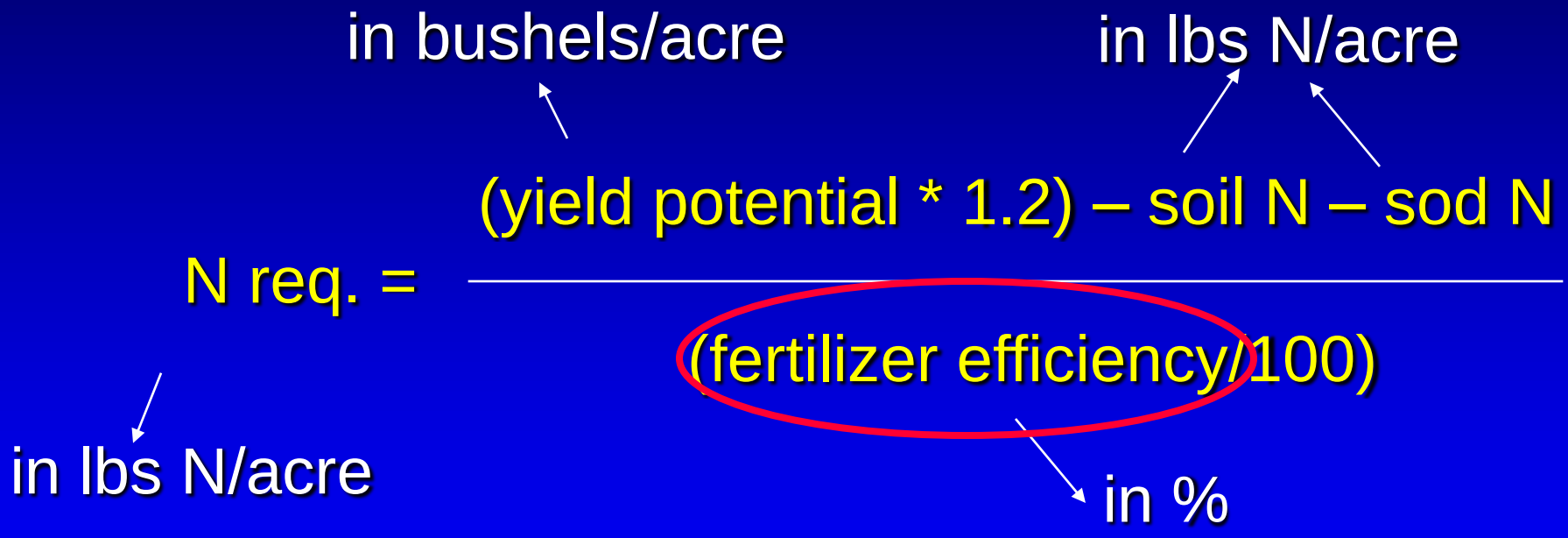


Cornell Nitrogen Recommendations

Nitrogen from Sods

Legume (%)	N (lbs/acre)	Year 1 (lbs/acre)	Year 2 (lbs/acre)	Year 3 (lbs/acre)
0	150	83	18	8
1-25	200	110	24	10
25-50	250	138	30	13
50+	300	165	36	15
		(55%)	(12%)	(5%)

Corn N Recommendations



Cornell Nitrogen Recommendations

Fertilizer N Uptake Efficiency

- Reflects the observation that <100% of the applied inorganic N will be taken up by the corn (losses to the environment will occur).

- N uptake efficiency depends on:

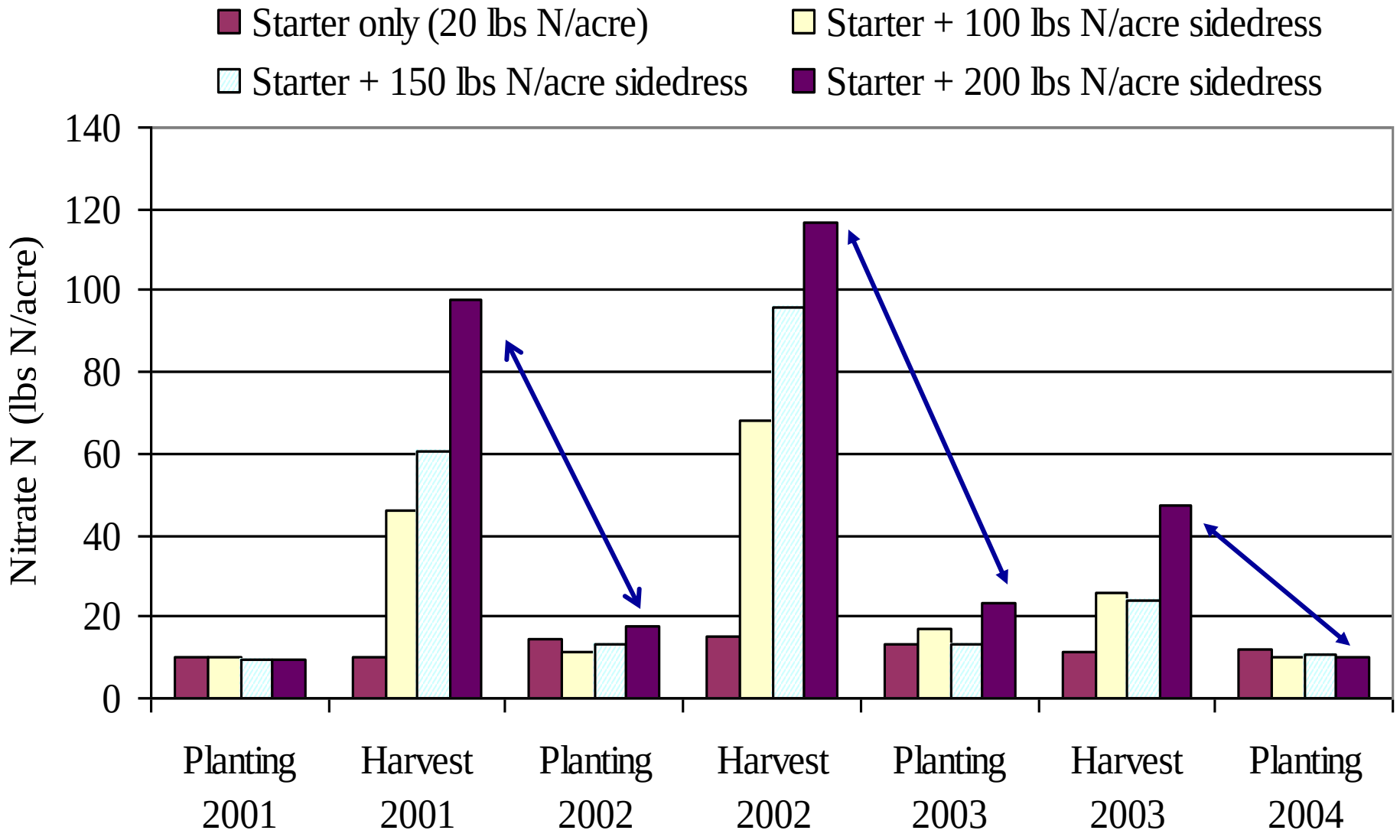
  - ✓ Soil type
  - ✓ Artificial drainage (drained/undrained)

Fertilizer N Uptake Efficiency

Examples

Soil type	N efficiency (%)	
	undrained	drained
Angola	60	65
Bath	75	75
Niagara	60	65
Honeoye	75	75
Swanton	60	65
Volusia	60	65
Howard	75	75

Most of what is left after harvest is lost in Northeast climates!!



N Recommendations for Corn

Sample calculation

N Recommendations for Corn

Question:

- Corn will be planted on an Angola soil. How much inorganic N should we add at side-dressing time?

Given:

- The soil is artificially drained.
- This is the third year that corn is planted.
- A 15% legume containing sod was plowed down prior to the first corn year.
- 100 lbs of 17-20-0 starter was applied.

N Recommendations for Corn

Answer:

What is the corn yield potential of a drained Angola soil? **110 bu/a**

How much N will a drained Angola soil supply? **80 lbs/a**

How much N will a 15% legume sod supply in the 3rd year? **10 lbs/a**

What is the N uptake efficiency for a drained Angola soil? **65 %**

What is the total N requirement?

$$\text{N req.} = \frac{(\text{yp} * 1.2) - \text{soil N} - \text{sod N}}{(\text{fertilizer efficiency}/100)} = \frac{(110*1.2) - 80 - 10}{(65/100)} = 65 \text{ lbs N/a}$$

N Recommendations for Corn

How much N was added with the starter? 17 lbs/acre

100 lbs of 17-20-0 gives …..lbs N/acre total.

Note: Target starter N to 10-30 lbs, up to 50 lbs

Actual N + K_2O should not exceed 80-100 lbs/acre

Limit actual N from urea in starter to <30 lbs/acre

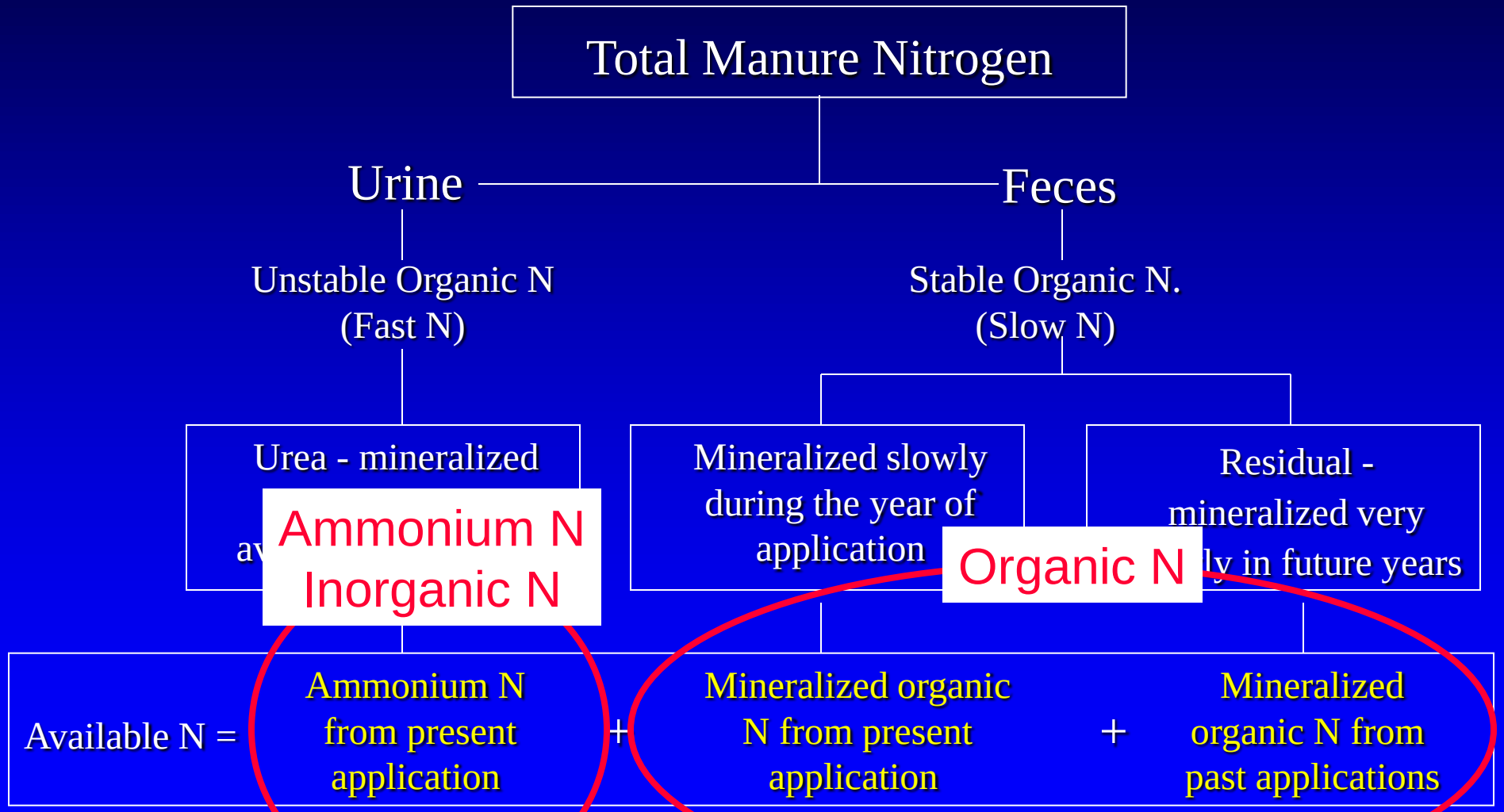
How much N still needs to be applied? ~48 lbs/acre

Check results with Pre Sidedress Nitrogen Test (PSNT).

Corn N Recommendations

Can I meet N needs with manure?
How much should I apply?

N Credits From Manure



N Credits From Manure

An example of a manure analysis:

	%	lbs/ton	lbs/1000 gallons
Total Nitrogen (N)	0.41	8	34
Ammonium Nitrogen	0.19	4	16
Organic Nitrogen	0.22	4	18
Phosphorus (P)	0.08	2	7
Phosphate Equivalent (P_2O_5)	0.18	4	15
Potassium (K)	0.26	5	22
Potash Equivalent (K_2O)	0.32	6	27

Ammonium N in Manure

- If incorporated in the fall, assume 100% loss.
- If applied as sidedress injection for row crops, assume 100% fertilizer equivalent.
- For spring application:

Incorporation within:

1	2	3	4	5	>5 d after spreading
65	**53**	**41**	**29**	**17**	0 % available

Organic N in Manure

	Current year	Last year	2 years ago
Cow manure <18% DM	0.35	0.12	0.05
Cow manure ≥18% DM	0.25	0.12	0.05
Poultry manure <18% DM	0.55	0.12	0.05
Poultry manure ≥18% DM	0.55	0.12	0.05
Swine manure <18% DM	0.35	0.12	0.05
Swine manure ≥ 18% DM	0.25	0.12	0.05
Horse manure <18% DM	0.30	0.12	0.05
Horse manure ≥ 18% DM	0.25	0.12	0.05

N Recommendations for Corn

Question:

- How much manure do we need to apply to meet corn N requirements given the following scenario?
  - ✓ N requirement: 50 lbs N/acre.
  - ✓ Manure is applied in this year only (i.e. no past manure applications).
  - ✓ *Manure was surface applied, no incorporation.*
  - ✓ Manure contains 5 lbs organic N and 4 lbs ammonium N per ton.
  - ✓ Dry matter content of the manure is 8%.

N Recommendations for Corn

Answer:

- Manure is surface spread without incorporation so all ammonium N is lost as ammonia.
- Per ton of manure, there are 5 lbs of organic N.
- In the first year 35% of the organic N will be available for manure with less than 18% dry matter.
- Thus, per ton of manure there is 0.35 * 5 = 1.75 lbs N.
- To obtain 50 lbs of N, we need to apply 50 / 1.75 = 29 tons/acre of this manure.

N Recommendations for Corn

Additional question:

- How much P_2O_5 and K_2O are supplied with the 29 tons of manure?

Given: 5 lbs of P_2O_5 per ton of manure.
6 lbs of K_2O per ton of manure.

Answer:

5 * 29 = 145 lbs P_2O_5 /acre!!!

6 * 29 = 174 lbs of K_2O/acre

N Recommendations for Corn

Another scenario:

- How much manure do we need to apply to meet corn N requirements given the following scenario?

  - ✓ N requirement: 50 lbs N/acre.
  - ✓ Manure is surface applied in the spring and incorporated within one day.
  - ✓ Manure contains 5 lbs organic N and 4 lbs ammonium N per ton.
  - ✓ Dry matter content of the manure is 8%.
  - ✓ Manure is applied in this year only.

N Recommendations for Corn

- Manure is incorporated within one day in the spring so 65% of the ammonium N is conserved and available is 0.65 * 4 = 2.6 lbs/ton.
- Per ton of manure, there are 5 lbs of organic N.
- In the first year 35% of the organic N will be available for manure with less than 18% dry matter.
- Thus, per ton of manure there is 0.35 * 5 = 1.75 lbs N from the organic fraction.
- Total N supply by the manure is 2.6 + 1.75 = 4.35 lbs/ton.
- To obtain 50 lbs of N, we need to apply 50 / 4.35 = 11 tons/acre.

N Recommendations for Corn

Additional question:

- How much P_2O_5 and K_2O are supplied with the 11 tons of manure?

Given: 5 lbs of P_2O_5 per ton of manure.
6 lbs of K_2O per ton of manure.

Answer:

- 5 * 11 = **55** lbs P_2O_5/acre
  (compare to 145 lbs when NH_4^+ is not conserved!!!)
- 6 * 11 = **66** lbs of K_2O/acre
  (compare to 174 lbs when NH_4^+ is not conserved!!!)

N Recommendations for Corn

Another scenario:

- How much manure do we need to apply to meet corn N requirements given the following scenario?
  - ✓ N requirement: 50 lbs N/acre.
  - ✓ Manure is injected in the spring.
  - ✓ Manure contains 5 lbs organic N and 4 lbs ammonia N per ton.
  - ✓ Dry matter content of the manure is 8%.
  - ✓ 32 tons of the same manure were applied in each of the two previous years.

N Recommendations for Corn

Answer:

- From the organic N in the 32 tons of manure applied two years earlier, 5% will be mineralized this year: 32*5*0.05=8 lbs of N.
- From the organic N in the 32 tons of manure applied last year, 12% will be mineralized this year: 32*5*0.12=19 lbs N.
- Total requirement for this year is: 50-8-19=23 lbs N/acre.
- Manure is injected in the spring so 65% of the ammonia N is conserved and available is 0.65 * 4 = 2.6 lbs/ton.
- Per ton of manure, there are 5 lbs of organic N.
- In the first year 35% of the organic N will be available: 0.35 * 5 = 1.75 lbs N per ton of manure.
- Total N supply by the manure is 2.6 + 1.75 = 4.35 lbs/ton.
- To obtain 23 lbs of N, we need to apply 23 / 4.35 = 5 tons/acre.

Tools for N Management

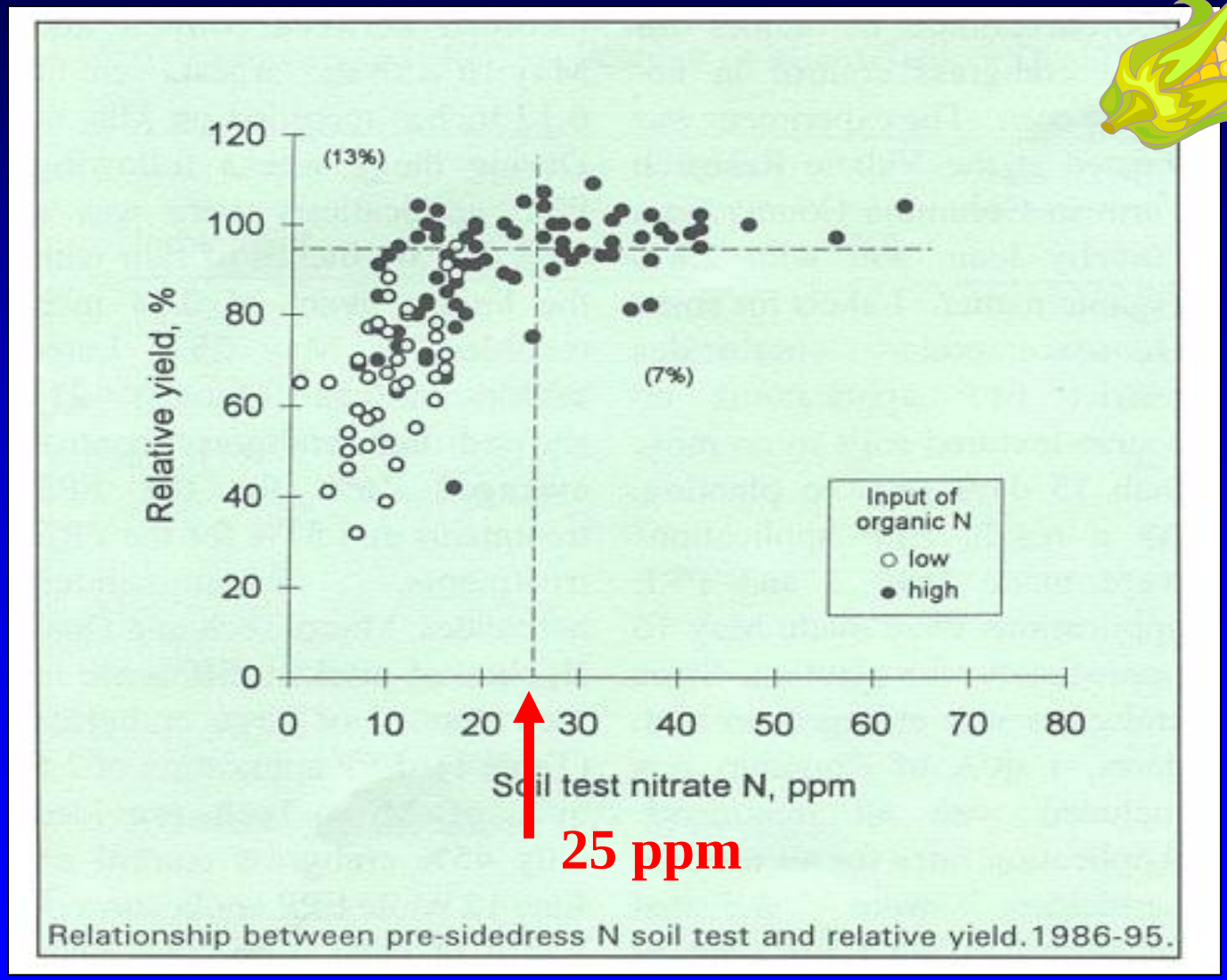
- Presidedress nitrate test (PSNT)
- Illinois soil N test (ISNT) and LOI
- Stalk nitrate test

Pre-Sidedress NO_3^- Test (PSNT)

Measures the amount of nitrate.
Predicts if there is enough N from organic sources for optimum yield without further fertilizer addition.

12 inch cores taken when the corn is 6-12 inches tall

Pre-Sidedress NO_3^- Test (PSNT)



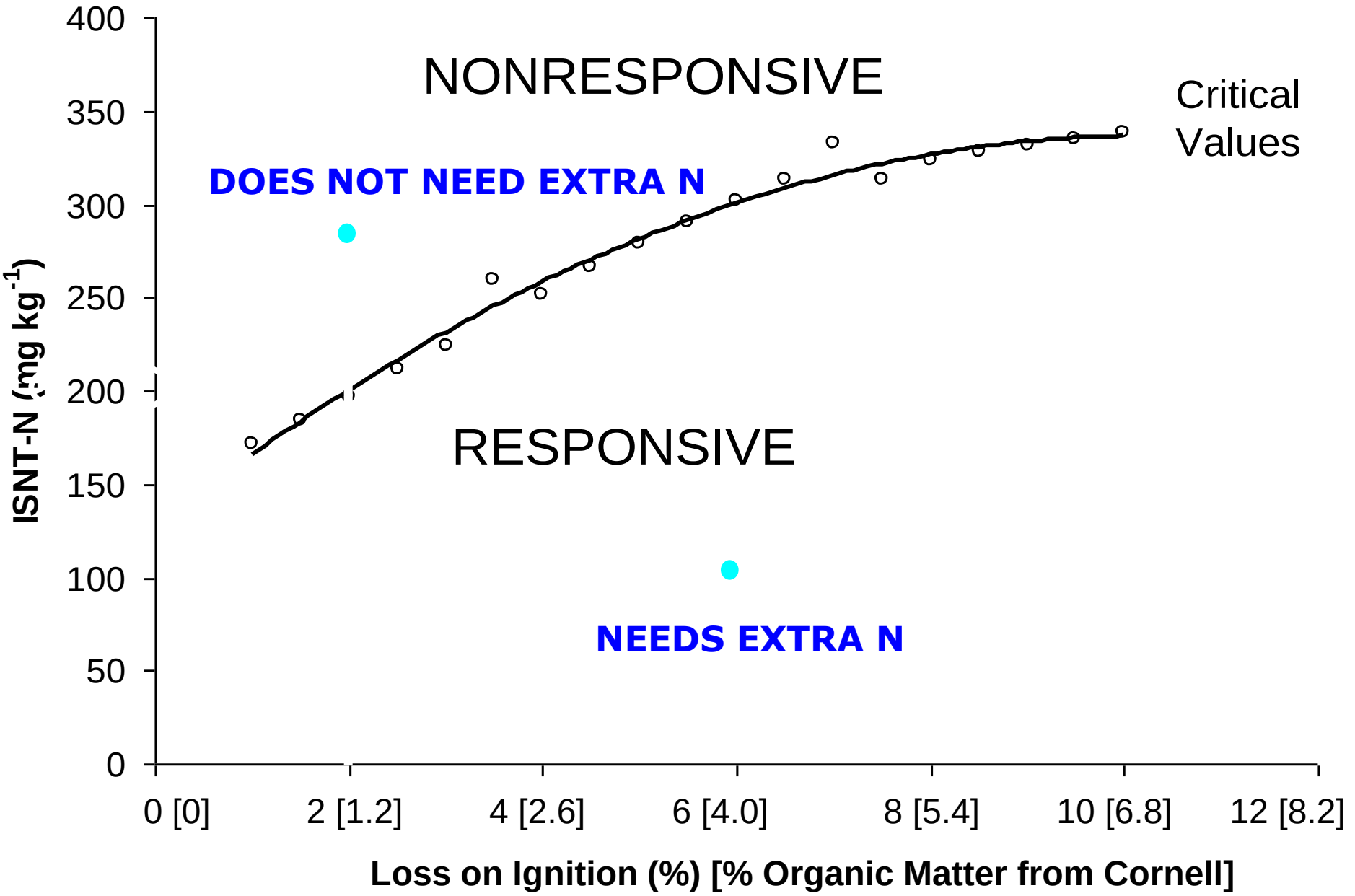
Relationship between pre-sidedress N soil test and relative yield. 1986-95.

Pre-Sidedress NO_3^- Test (PSNT)

PSNT interpretations:

PSNT (ppm)	Economic response to N?	Recommendation
<21	highly likely	add N as recommended
21-24	10% chance	consider 25-50 lbs N
≥25	unlikely	do not add extra N

Illinois Soil N Test (ISNT)


NONRESPONSIVE
Critical Values
DOES NOT NEED EXTRA N
RESPONSIVE
NEEDS EXTRA N
ISNT-N (mg kg-1)
400
350
300
250
200
150
100
50
0
0 [0]
2 [1.2]
4 [2.6]
6 [4.0]
8 [5.4]
10 [6.8]
12 [8.2]
Loss on Ignition (%) [% Organic Matter from Cornell]

Late Season Stalk Nitrate Test

Low:

= less than 250 ppm N

Optimal:

= 250 to 2000 ppm N

Excess:

= more than 2000 ppm N

Nitrogen Guidelines

- Pre-Sidedress Nitrogen Test (PSNT) Refresher
- Agronomy Fact Sheet #2: Nitrogen Basics
- Agronomy Fact Sheet #3: Pre-Sidedress Nitrate Test
- Agronomy Fact Sheet #4: Nitrogen Credits from Manure
- Agronomy Fact Sheet #21: Nitrogen Needs of 1st Year Corn
- Agronomy Fact Sheet #22: Cation Exchange Capacity (CEC)
- Agronomy Fact Sheet #30: Soybean N Credits
- Agronomy Fact Sheet #31: Late Season Stalk Nitrate Test
- Agronomy Fact Sheet #35: N Guidelines for Corn
- Agronomy Fact Sheet #36: Illinois Soil Nitrogen Test
- Agronomy Fact Sheet #39: Nitrogen Fixation
- Agronomy Fact Sheet #41: Soil Organic Matter
- Agronomy Fact Sheet #44: Nitrogen Fertilizers for Field Crops
- Agronomy Fact Sheet #45: Enhanced-Efficiency Nitrogen Sources

Cornell University
Nutrient Management Spear Program

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The vision of the Cornell University's Nutrient Management Spear Program is to assess current knowledge, identify research and educational needs, conduct applied, field and laboratory-based research, facilitate technology and knowledge transfer, and aid in the on-farm implementation of strategies for field crop nutrient management, including timely application of organic and inorganic nutrient sources to improve profitability and competitiveness of New York State farms while protecting the environment. For more information see our latest (2/15/2011) Program Report.

News RSS

- 12/17/10: New Student Intern Impact Story: Joseph Foster.
- 12/03/10: New value of manure calculator and tutorials added to the: Nutrient Management Curriculum.
- 11/17/10: New whole farm mass nutrient balance software: MNB_1.0.
- 10/28/10: Latest Additions to the Agronomy Fact Sheets Series: #55: Tissue Testing for Corn, Alfalfa and Soybeans, and #56: Winter Triticale Forage.
- 10/2/10: New Story: Manure Expo Highlights (Manure Manager Magazine).
- 9/21/10: Webcast: Novel Approaches to Manure Application in No-Till (Livestock and Poultry Environmental Learning Center).
- 5/16/10: New York Corn Systems Cover Crop Survey: For Farmers with Experience *with* Cover Crops or For Farmers *without* Experience with Cover Crops (Print, Complete and Mail).

Featured Links

- Cornell Nutrient Guidelines for Field Crops
- Agronomy Factsheets
- Impact Statements
- Nutrient Management Tutorials
- Nitrogen Management on Dairy Farms

Events

2011 Northeast Region CCA Conference
November 29-December 1, 2011. Register by November 5 for an early registration discount.

Photo Gallery

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