

NITROGEN EFFICIENCY AND FALL N APPLICATIONS

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NITROGEN FERTILIZER EFFICIENCY

$$\% \text{ NFE} = \frac{\text{Crop uptake of fertilizer N}}{\text{Amount of N fertilizer applied}} \times 100$$

Improved N Management



Higher Crop Recovery
of Available N



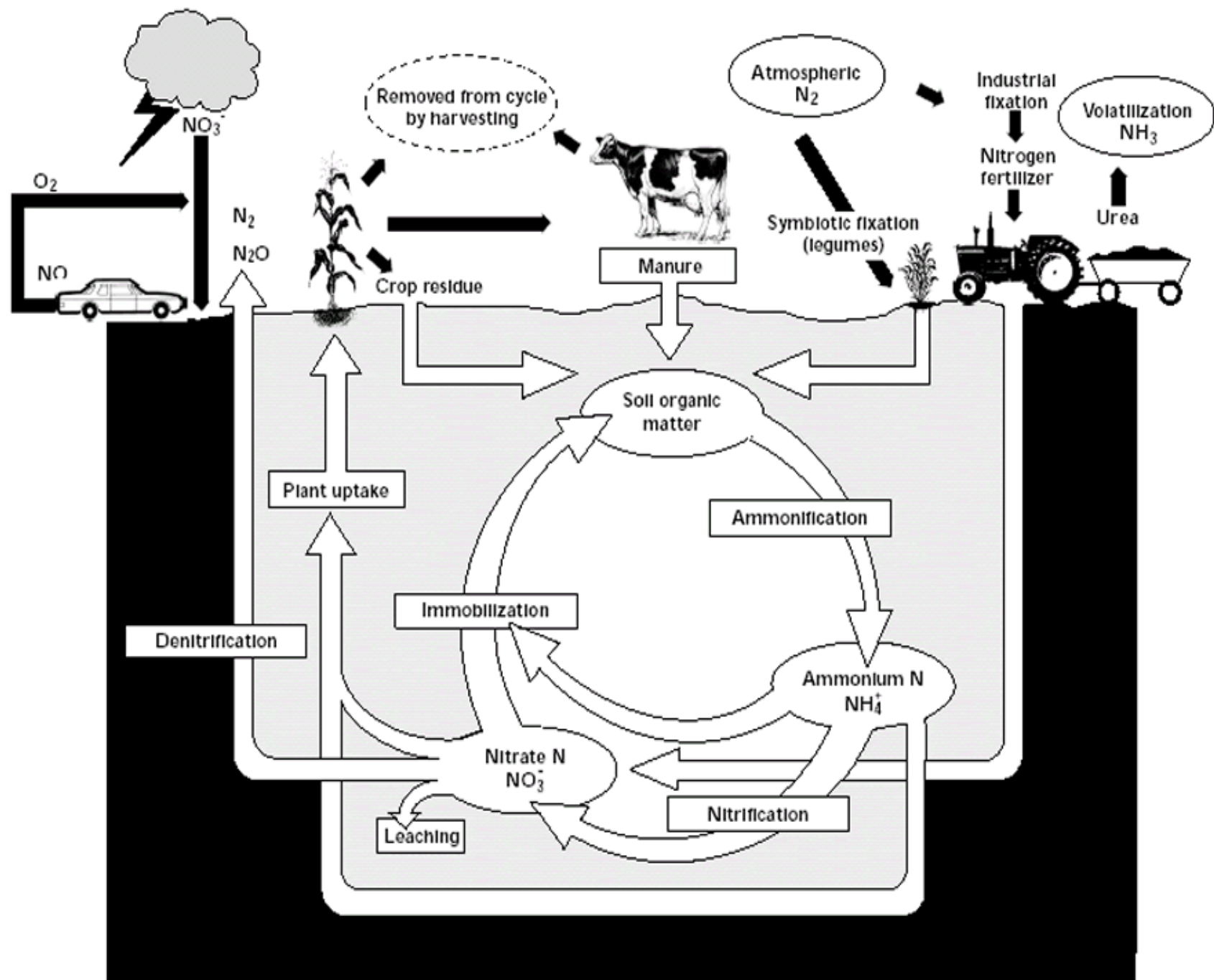
Reduced Risk of N
Loss

Nitrogen Management Decisions

- **Rate**
- **Source**
- **Timing**
- **Nitrification inhibitors**

Nitrogen Loss Processes

- Leaching
 - Denitrification
 - Ammonia volatilization
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Nitrogen Reactions

Mineralization (Ammonification):



Soil Organic Matter

- Most Midwest soils = 1-5%
- Organic soils = 20-50+ %
- Nitrogen Content (O.M.) = 5% N
- About 2-3% of O.M. decomposes annually

Nitrogen Reactions

Nitrification:



Nitrogen Reactions

Immobilization:



Inorganic
Nitrogen

Carbon : Nitrogen ratio effects on N release

Expected N Effect

C : N range

Release N

< 20

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
Alfalfa	12
Rotted manure	20
Corn residue	60
Grain straw	80
Sawdust	300

Nitrogen Reactions

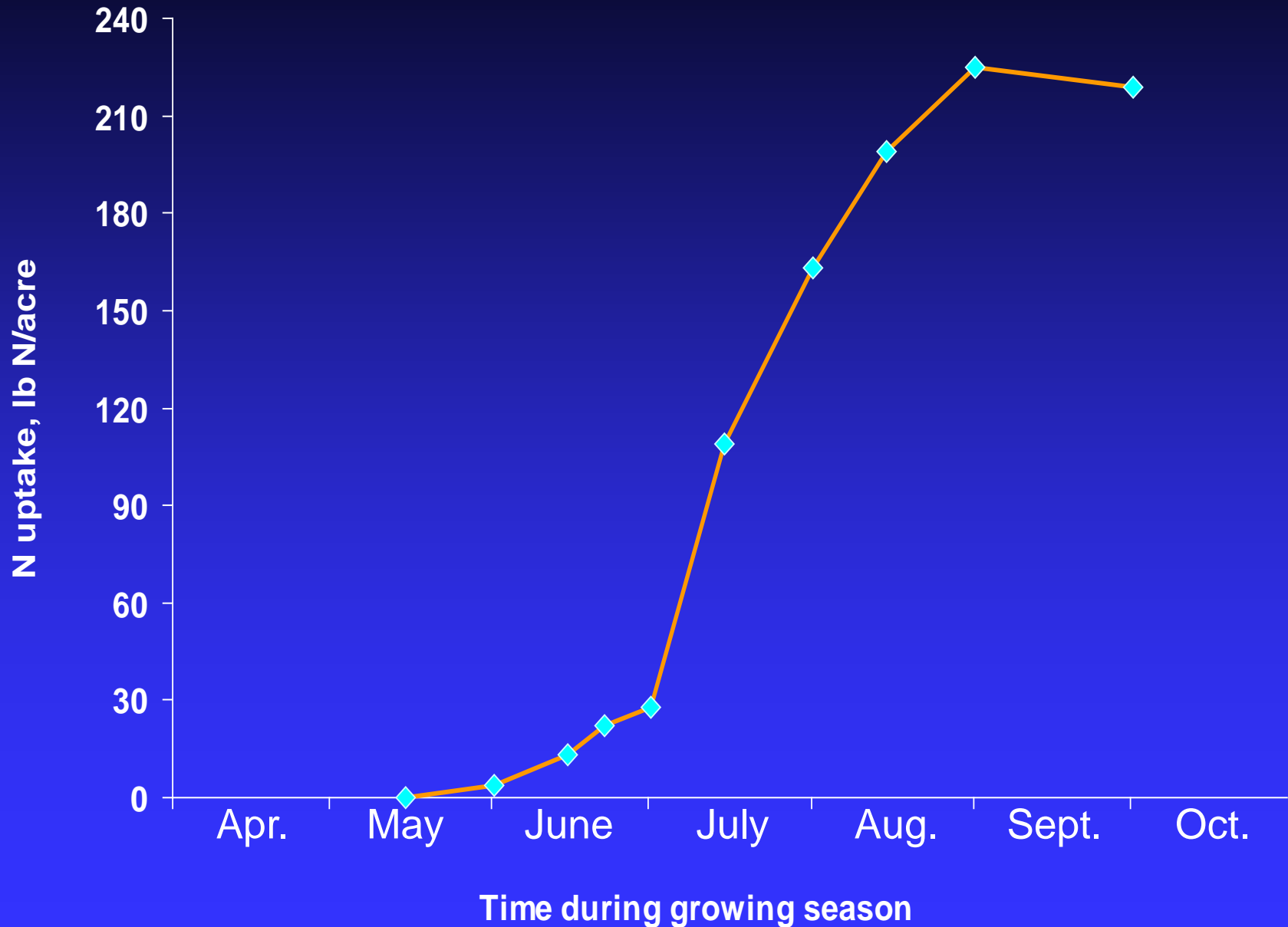
Denitrification:



Nitrogen Timing Options

- Fall
- Preplant
- Sidedress
- Post-emergence
- Split

Timing of Nitrogen Uptake by Corn



FALL N APPLICATIONS AND RESIDUE DECOMPOSITION



2x Residue
ON

Objectives

- Determine the influence of pre-season (fall) N fertilization at low rates (30 and 100 lb N/acre) on corn residue decomposition in no-till corn production.
- Monitor the effects of pre-season (fall) N treatments and residue chopping on residue quantity, carbon and nitrogen composition, and soil temperature.

Treatments

- Times and rates of N (UAN and ammonium sulfate)
 - Sulfur as gypsum applied to equalize sulfur
 - Residue fall chopped or not chopped.
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Measurements

- Soil nitrate (Fall, PPNT, PSNT)
 - Residue quantity and composition
 - Soil temperature, 4 in. depth
 - Corn silage and grain yield
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Treatments

N timing, source, & rate (lb N/a)

Fall	Spring	Total
0	0	0
30 UAN	0	30
30 AS	0	30
100 AS	0	100
0	100 AS	100
30 UAN	160 UAN	190
30 AS	160 AS	190
0	190 UAN	190
0	190 AS	190
100 AS	90 UAN	190

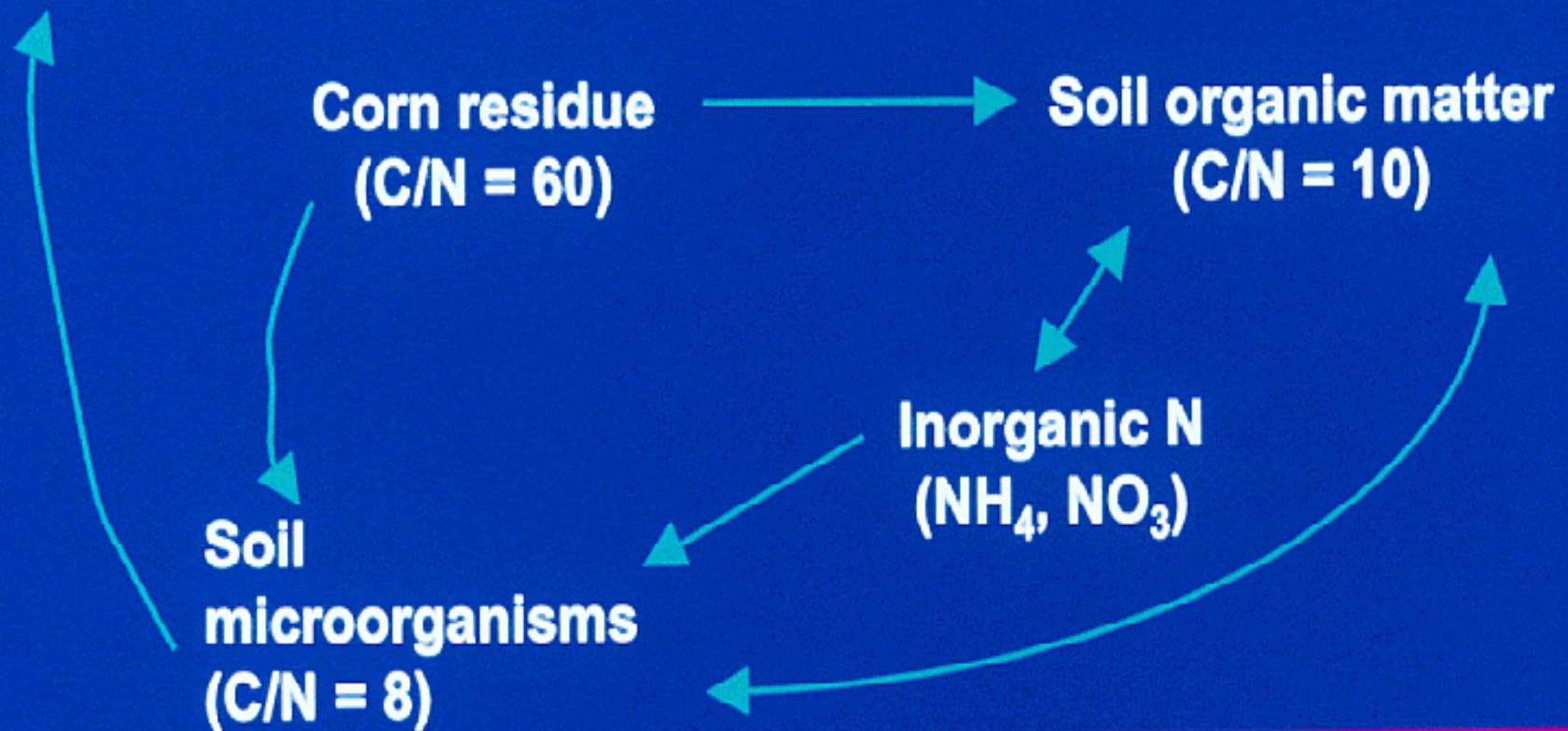
Nylon mesh bag for residue quantity & composition measurements





Carbon and nitrogen transformations in corn residue decomposition

Carbon dioxide



Dry matter amounts at several times in
the chopped residue treatment,
Arlington, WI 1998-2001

Sampling time	---- Residue (lb dry matter/acre) ----		
	1998-99	1999-2000	2000-2001
November	7030	5667	6023
April	6121	5102	4958
June	5417	4724	4799
September	---	1890	3621

Effect of N treatment on corn residue decomposition, Arlington, 1999-2000.

Fall N	Date		
	30 Apr 00	27 Jun 00	26 Sep 00
-lb N/acre-	-- % residue remaining --		
0	92 a	87	31
30 UAN	94 a	90	29
30 AS	97 a	79	35
100 AS	76 b	78	35

Carbon/nitrogen ratio and N content of corn residue at various dates, Arlington, WI, 1999-2000.

Date	C/N ratio	N content
		-- lb N/acre --
10 Nov 99	74	33
30 Apr 00	47	48
27 Jun 00	37	45
26 Sep 00	28	22

Nitrogen timing, source, & rate effects on corn grain yield, Arlington, 1999-2001

N timing & rate (lb N/acre)		Yield 1999	Yield 2000	Yield 2001
Fall	Spring	----- bu/acre -----		
0	0	167 b	63 e	105 e
30 UAN	0	180 b	60 e	126 d
30 AS	0	178 b	66 e	126 d
100 AS	0	209 a	112 d	175 c
0	100 AS	216 a	128 cd	171 c

Nitrogen timing, source, & rate effects on corn grain yield, Arlington, 1999-2001

N timing & rate (lb N/acre)		Yield 1999	Yield 2000	Yield 2001
Fall	Spring	----- bu/acre -----		
0	0	167 b	63 e	105 e
30 UAN	160 UAN	219 a	146 abc	191 b
30 AS	160 AS	220 a	158 a	202 ab
0	190 UAN	219 a	148 ab	194 b
0	190 AS	216 a	160 a	208 a
100 AS	90 UAN	220 a	136 bc	207 a

Summary

- About 60 to 70% of corn residue decomposed during the subsequent growing season.
 - C/N ratio of residue usually decreased from the initial November value through the following September.
 - Most of this change was due to carbon loss.
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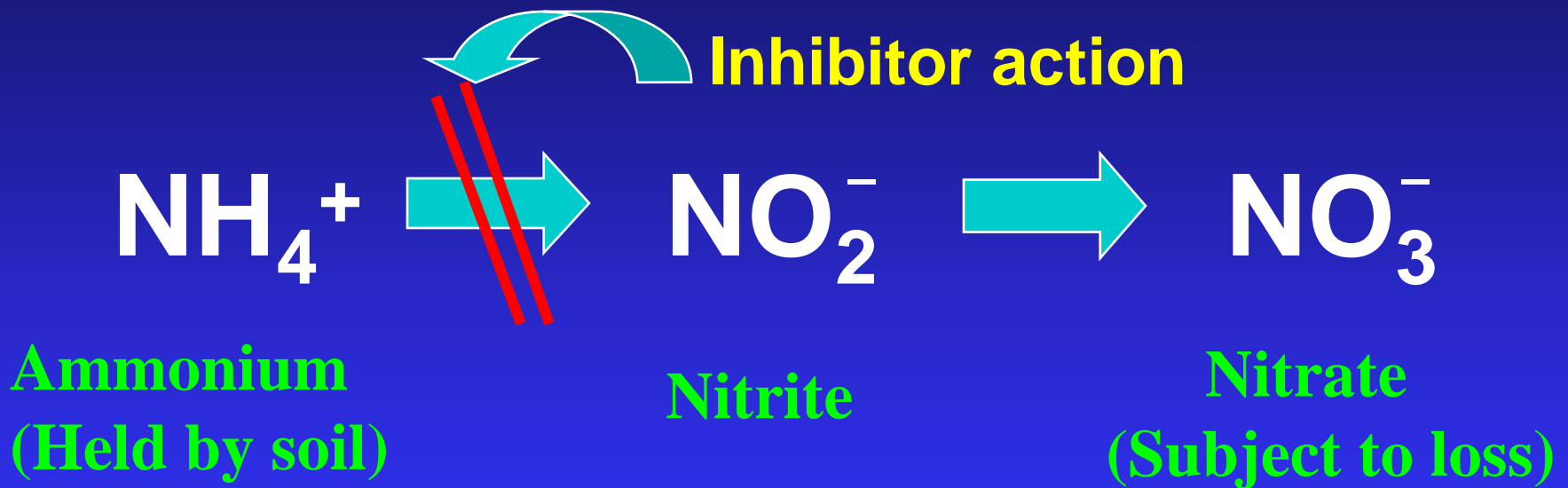
Summary

- For production, fall N additions to promote residue decomposition do not appear to be justified.
 - Improvements in yield or other agronomic benefits were not observed in this study.
 - Fall N can increase potential for over winter N loss.
 - Ammonium sulfate provided more consistent crop responses than UAN solution.
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Improving Fall N Effectiveness

- Use ammonium forms of N.
 - Use a nitrification inhibitor (N-Serve) with fall N.
 - Delay N application until soil temperature remains below 50° F.
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INHIBITION OF NITRIFICATION



Improving Fall N Effectiveness

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Time of anhydrous ammonia application and N-Serve effect on corn grain yield. Waseca, MN

Year	Timing			Signif.
	Fall	Fall +N-S	Spring	
	----- bu/acre -----			
1997	186	189	180	NS
1998	199	207	195	NS
1999	109	154	187	**
2000	135	139	160	**
14-yr ave ^{1/}	144	153	155	

^{1/} 1987-2000 ave., 135 lb N/a, Soybean-Corn rotation (Randall, 2000)

Soil nitrate to ammonium ratios as affected by date of anhydrous ammonia application and N-Serve

Sampling date	Application date ^{1/}		
	Oct. 28	Oct. 28	Nov. 19
	w/o N-S	w/ N-S	w/o N-S
----- Nitrate:Ammonium ratio -----			
Apr. 20	0.8	0.4	0.1
May 15	2.5	1.2	0.2
May 30	3.6	1.9	0.5

^{1/} Soil temp. (6 in. depth) = 47° on 10/28 and 34° on 11/19 (Randall, MN, 1997).

Effect of N Rate and Time of Application on Nitrate-N Losses and Corn Yield

Nitrogen		Annual Loss of	5-Yr Yield
Rate	Time	NO ₃ -N in Drainage	Average
lb/A		- lb/A/yr -	bu/A
0	- -	7	66
120	Fall	27	131
120	Spring	19	150
180	Fall	34	160
180	Spring	26	168

* Ammonium sulfate applied about 1 Nov. or 1 May. Minnesota

Nitrogen timing and nitrification inhibitor effects on corn yield, Fond du Lac Co., WI, 1994

N timing	N-Serve	Yield bu/acre
None	--	70
Fall	no	132
Fall	yes	143
Sidedress	no	169
Sidedress	yes	166

M. Rankin, UW-Extension
140 lb N/a as anhydrous ammonia

Fall N Applications

- Fall N has higher risk of loss.
 - Performance of fall N is better where over winter soil temperatures retard conversion of ammonium to nitrate.
 - Best results with medium-textured soils with relatively good drainage.
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Fall N Applications

- Soil temperature history (calendar date) may be more useful than daily measurements.
 - Low rates of ammonium sulfate in fall can provide S in combination with P&K fertilizers application.
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