Review of T-AGG Draft Report "Nitrous Oxide Emissions Reduction in Agriculture"

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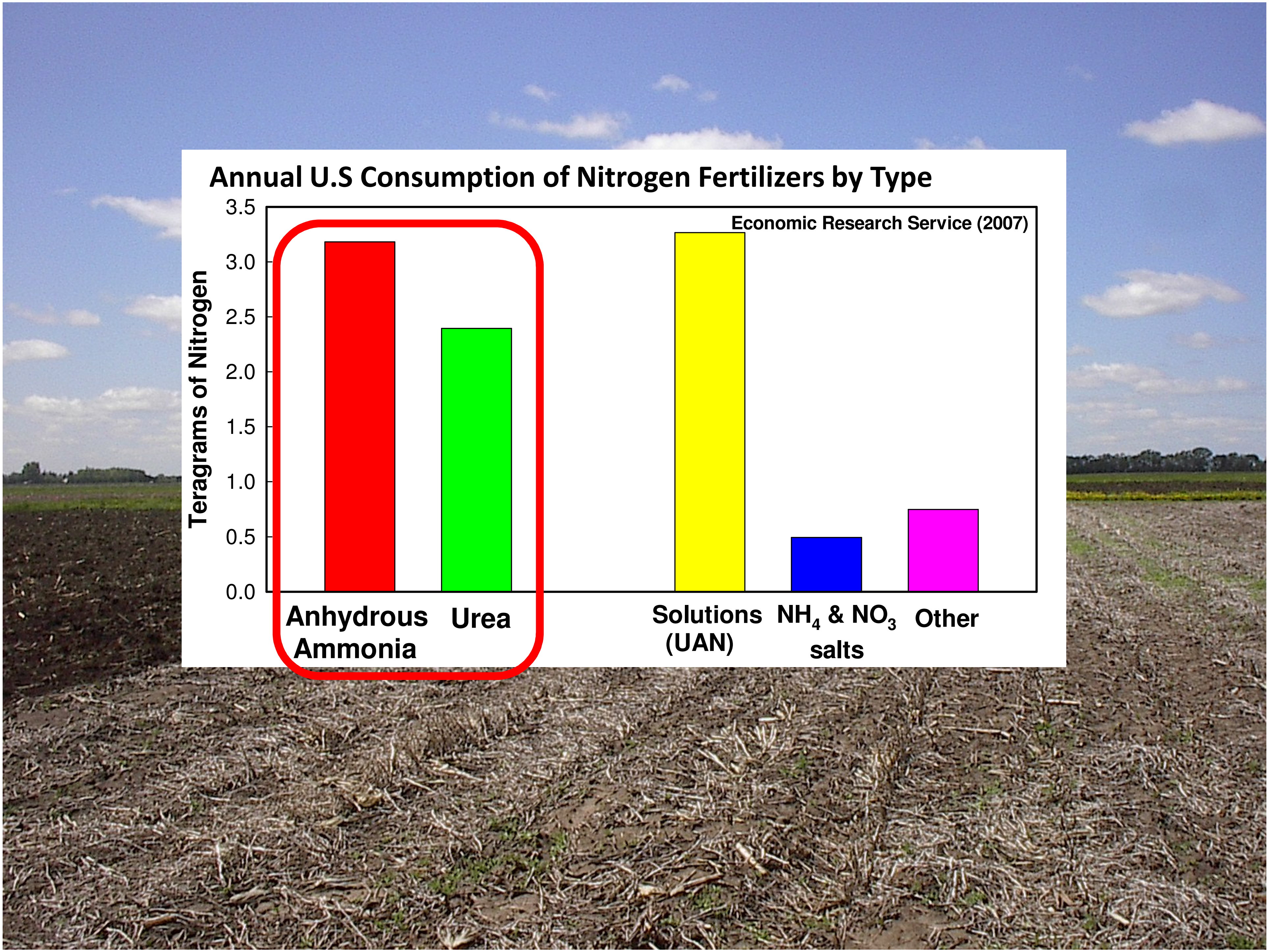
1. *Potential for N source effects*
2. *Optimizing N management under reduced tillage*
3. *How to address Indirect N_2O Emissions ?*

Fertilizer Management
P. 3 of draft.
Product recommendations

"From the literature evidence it appears that there is no directional certainty in relation to reducing or increasing emissions of N_2O with respect to the effects of N fertilizer type……."

"The available data suggest that no overarching conclusions can be made to differentiate the effects of sources of N fertilizer on emissions of N_2O…."



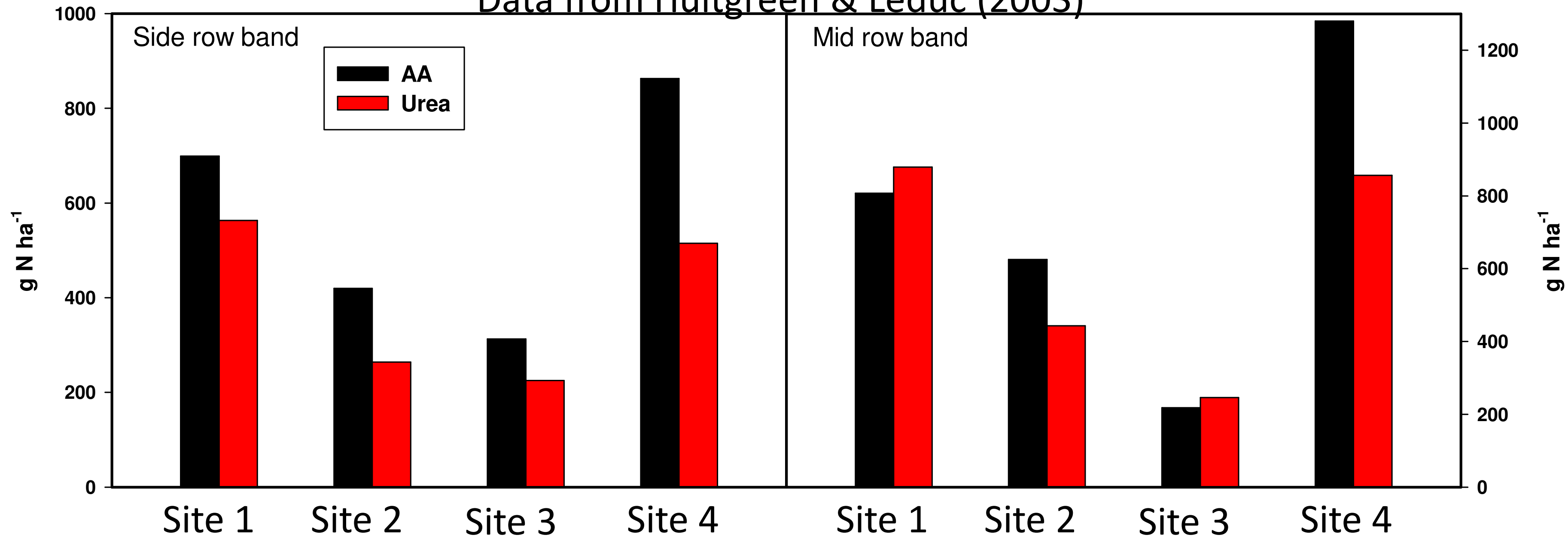
Annual U.S Consumption of Nitrogen Fertilizers by Type
Economic Research Service (2007)
Teragrams of Nitrogen
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Anhydrous Ammonia
Urea
Solutions (UAN)
NH_4 & NO_3 salts
Other

Comparison of conventional fertilizers: Anhydrous ammonia (AA) versus urea

Literature review includes 3 studies:

	Location	Duration / crop	Rate (kg N/ha)	Result
Venterea et al (2005)	Minnesota	1-yr / corn (3 different tillage systems)	120	AA > Surface-broadcast urea AA > UAN
Burton et al (2008)	Manitoba (2 sites)	3-yr / wheat	80	no differences
Hultgreen & Leduc(2003)	Saskatchewan (4 sites)	3-yr / flax/wheat/canola	60 –80	1 of 4 sites, AA > Urea (P=0.09) (trend was AA > Urea)

Data from Hultgreen & Leduc (2003)



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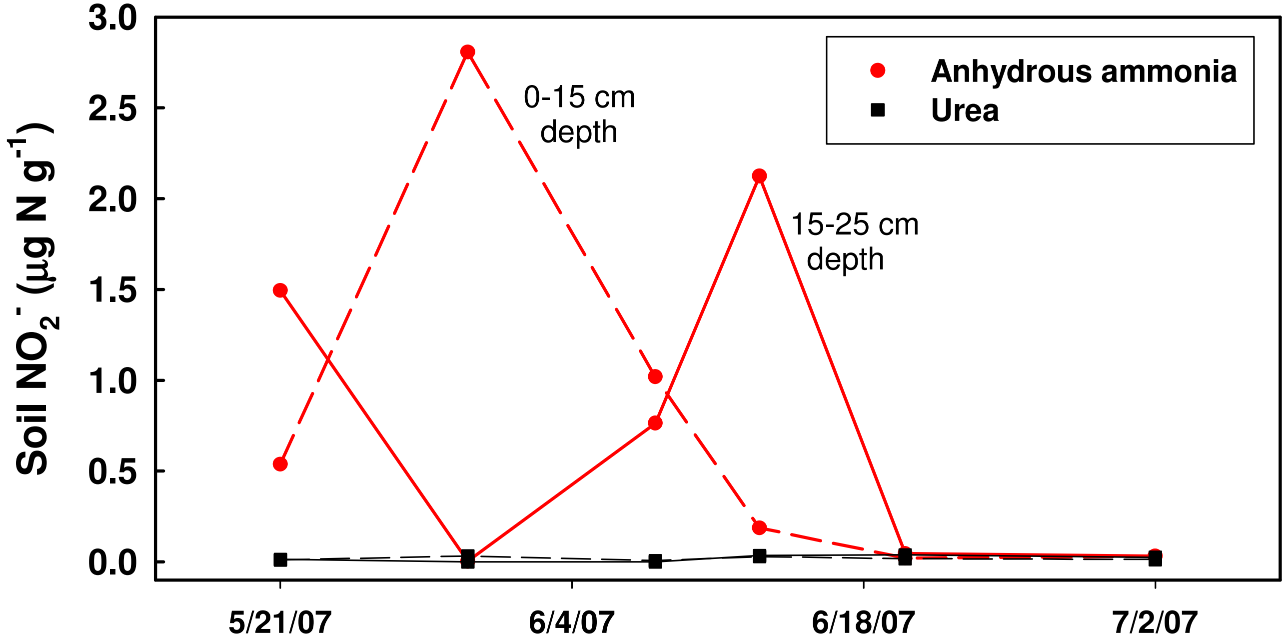
Not included in Literature review:

	Location	Duration / crop	Rate (kg N/ha)	Result
Venterea et al (2010)	Minnesota	3-yr / cont. corn 3-yr / corn after soybeans	150 150	AA twice as high as DI-urea AA twice as high as DI-urea
Thornton et al (1996) (semi-continuous, automated sampling)	Tennessee	1-yr / corn	170	AA twice as high as banded urea
Venterea et al (unpublished)	Minnesota	2-yr / cont. corn (1 yr completed)	180	AA > DI-urea

Other studies showing very high emissions from AA (but with no side-by-side comparison with other fertilizers)

	Location	Duration / crop	Rate (kg N/ha)	Result
Parkin & Hatfield (2010)	Iowa	1-yr / corn	125-168	Emissions > 3% of applied N
Venterea & Rolston (2000)	California	1-yr / tomato	120	Max fluxes > 1 kg N per ha per day
Bremner et al (1981)	Iowa	1-yr / corn	250	Emissions > 5% of applied N

Higher N_2O Production With Anhydrous Ammonia



Nitrite accumulation with AA.

Venterea et al. 2010. SSSAJ.

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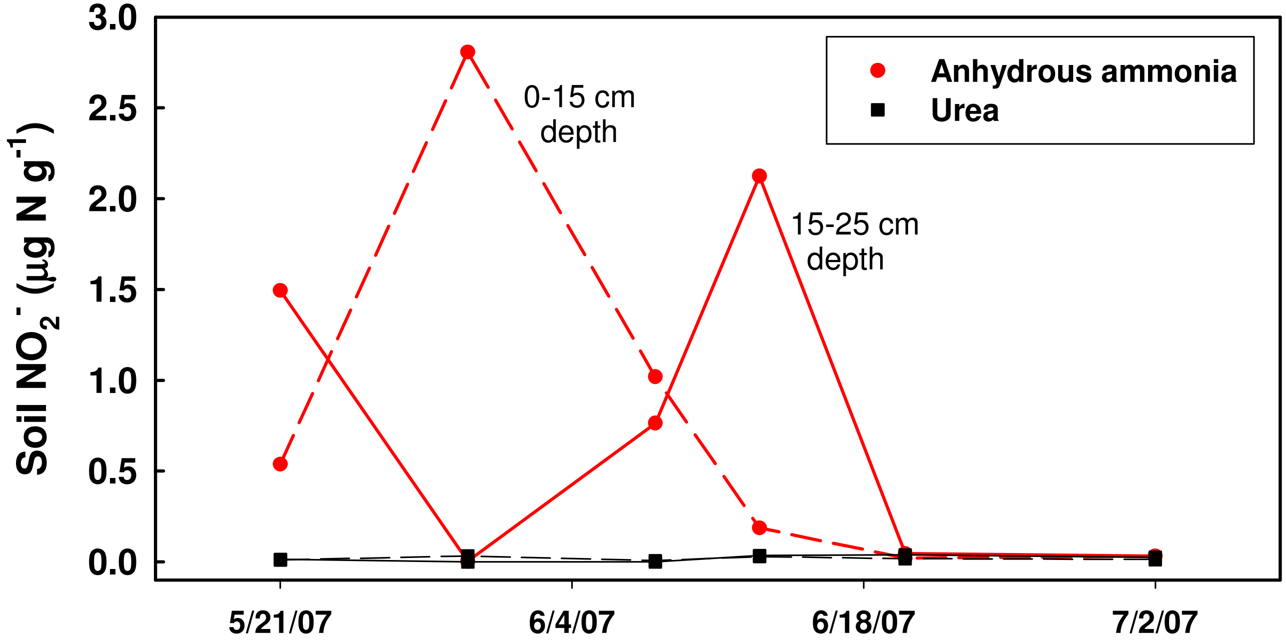

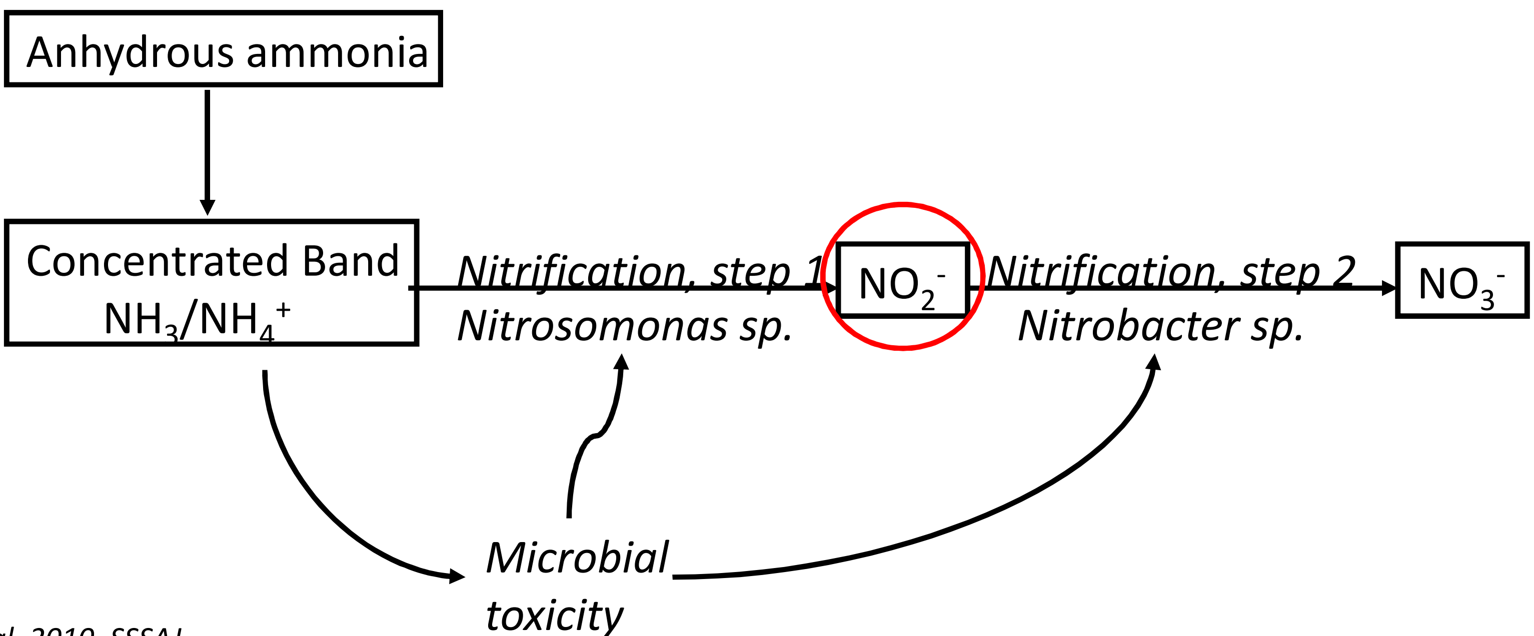

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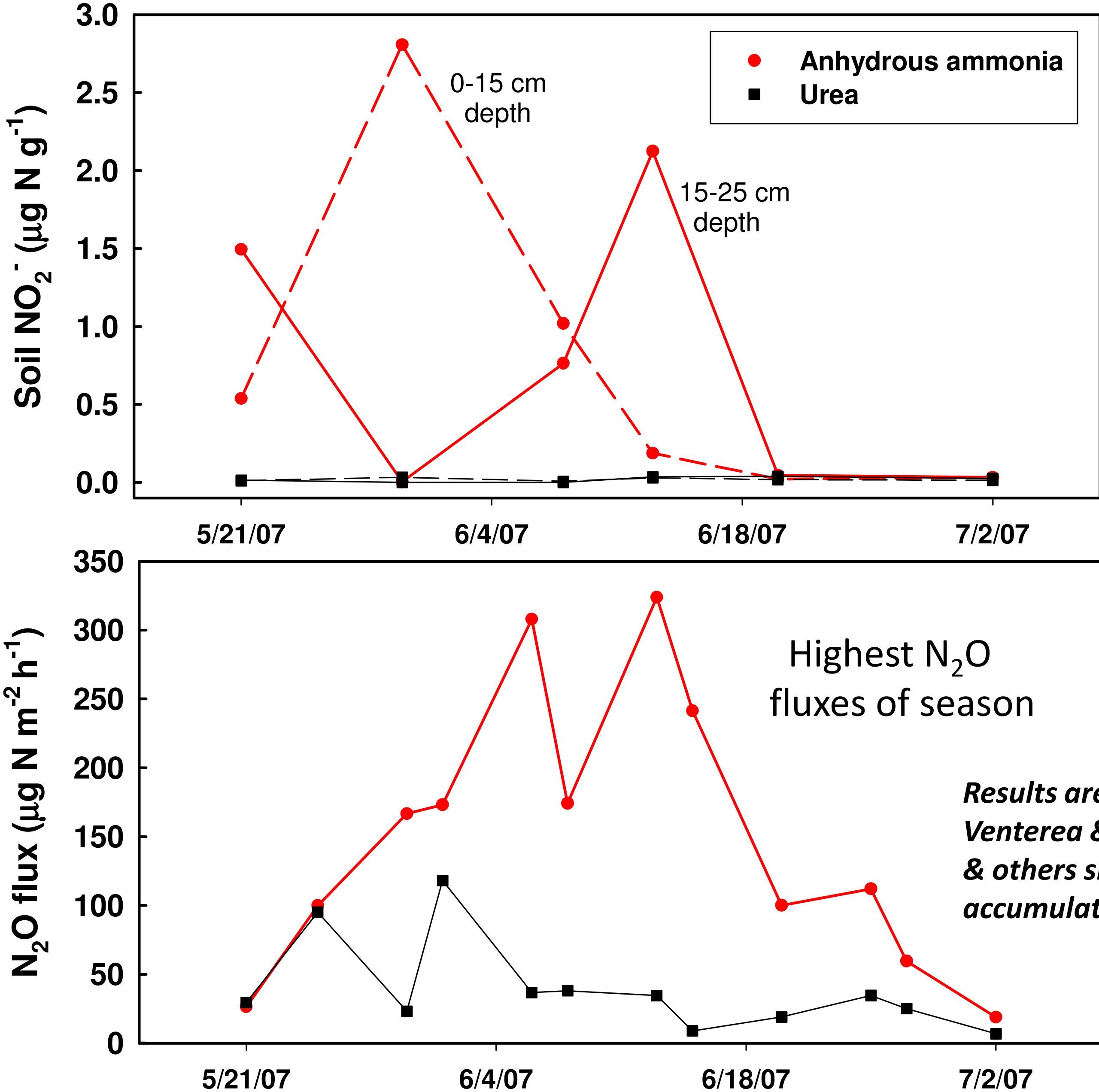
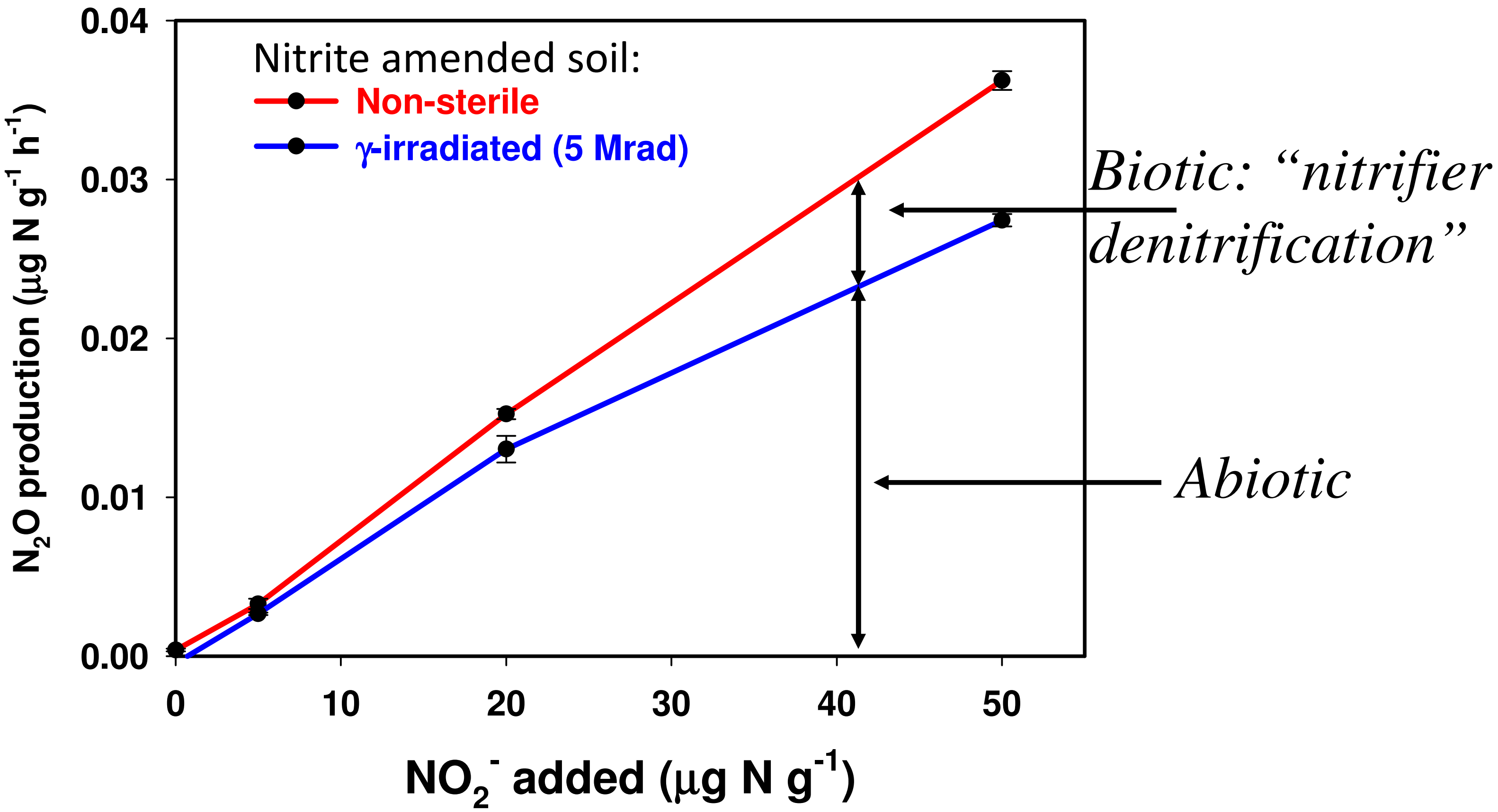


Results are consistent with Venterea & Rolston 2000. JGR, & others showing nitrite accumulation with AA.

Venterea et al. 2010. SSSAJ.

Kinetics of N_2O Production from Nitrite Under Fully Aerobic Conditions

Little if any reduction of N_2O to N_2 under aerobic conditions.



Venterea, 2007. Global Change Biol. 13, 1798–1809.

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- More studies are definitely needed in different soils and cropping systems.

- Weight of current evidence points to higher emissions with AA (at least at N application rates typical for corn production).

- Potentially practical to move away from AA, but cost of other N sources is generally higher. Also, GHG cost of producing AA is generally less than other N sources, and this factor needs to be included in analysis.

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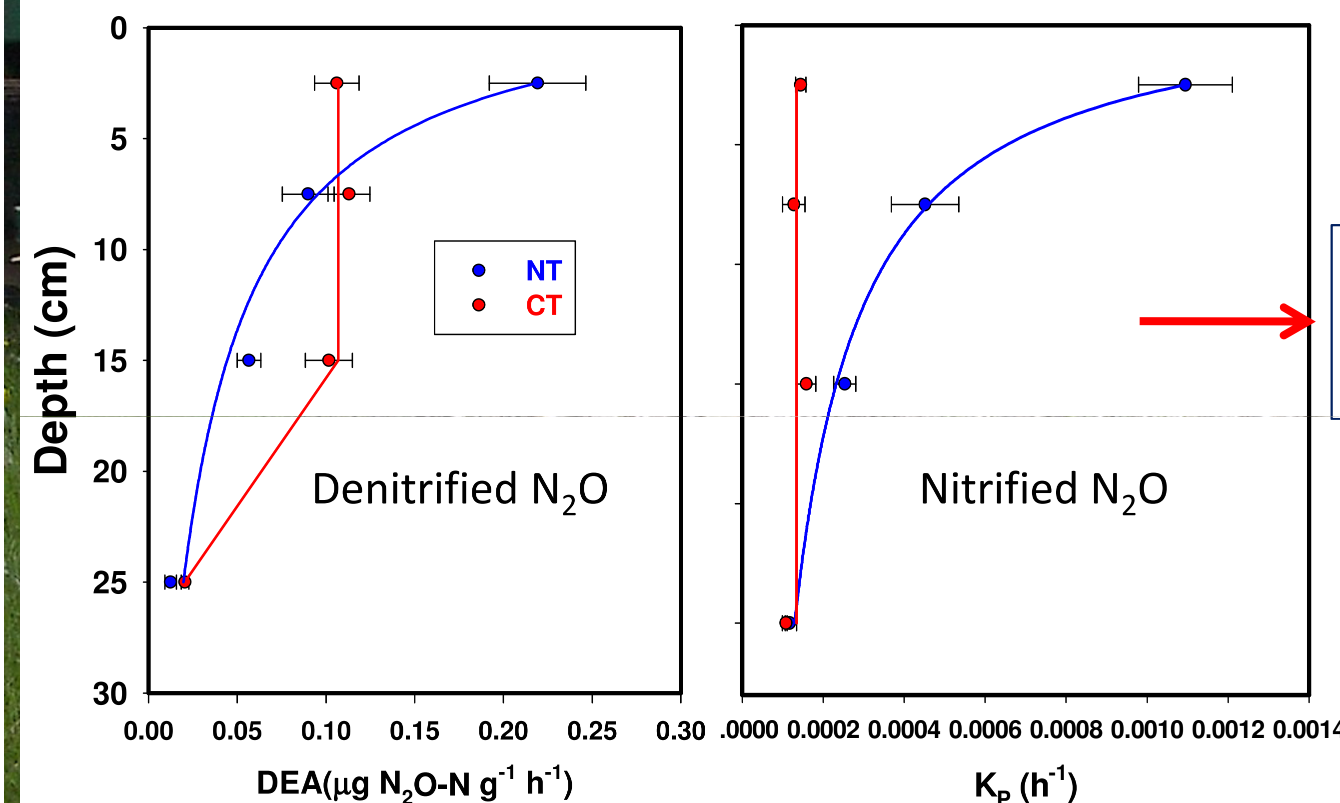
Tillage practice recommendations

"The above studies indicate that there is no compelling evidence to suggest that particular tillage management practices consistently reduce emissions of N_2O in cropland agriculture."

Doesn't address related question:

If reduced tillage is being practiced at a particular site what are the best recommended practices for reducing N_2O emissions ?

Potential N_2O Production Decreases with Depth In Soils Under No-Till



Venterea and Stanenas. 2008. JEQ.

Subsurface N placement should reduce N_2O emissions from NT soils

Similar results found by:

- Linn and Doran (1984)
- Groffman (1985):

Data to support the recommendation: Use of subsurface application can minimize N_2O emissions with reduced tillage.

1. Hultgreen and Leduc (2003):

In no-till flax/wheat/canola: Surface broadcast urea > Subsurface urea banding

2. Liu et al (2006):

In no-till corn in CO: Deeper injection of UAN reduced emissions compared to surface application or shallower injection

3. Venterea et al (2005):

Subsurface Injection of AA	Lower emissions from NT than CT
Surface Broadcast Urea	Higher emissions from NT than CT

Surface Application of Stabilized N to No-Till Soils May Reduce N_2O emissions

Halvorson et al, In press (JEQ):

In irrigated no-till corn in CO:

Polymer-coated urea:	Lower emissions than conventional Urea
Urea + inhibitors	Lower emissions than conventional Urea
UAN + inhibitors:	Lower emissions than conventional UAN
	Reductions ranged from 30% to more than 50%.

ARS Multi-Location Study: Stabilized N Fertilizer Effects on Direct N_2O Emissions
Mixed Results

Location	Crops	Soils	Irrigation	Tillage	Results	
					Polymer-coated urea	Urea plus inhibitors
WA	Wheat	Silt loam	No	No-till ★	< Urea	< Urea
CO	Corn	Clay loam	Yes	Strip-Till No-till ★	< Urea	< Urea
IA	Corn/ soybean	Loam Clay loam	No	Strip-till ★	> or = UAN	> or = UAN
MN	Corn	Sandy loam	Both	Disk	= Urea	= Urea
	Potato	Sandy loam	Yes	Disk	< or = Urea	Not evaluated
	Corn	Silt loam	No	No-till, MB ★	= Urea	= Urea
KY	Corn	Silt loam	No	No-till ★	> UAN > Urea	= UAN < Urea
PA	Corn	Silt loam well-drained	No	No-till ★	= UAN = Urea	= UAN = Urea
		Silt loam poorly-drained			= UAN = Urea	= UAN = Urea
AL	Cotton/ rye	Loamy sand	No	No-till ★	= UAN = Urea	= UAN = Urea

★ = Reduced tillage

Positive results = Reduced Emissions

Huge Uncertainty of Estimating Indirect N_2O Sources

Simultaneous measurement of Nitrate Leaching and Direct N_2O Emissions

- Measured leaching = 20 – 40 kg N ha^{-1} y^{-1}
- Wide Range for IPCC EFs: 0.05 – 2.5% of leached N converted to N_2O
- Equivalent to 0.1 – 1.0 kg N ha^{-1} of N_2O

Depending on Emission Factor used:

Indirect Emissions due to leaching represent ~ 10 % to more than 100 % of Direct Emissions

- Baseline emissions (prior to mitigation efforts) are likely much higher than estimated from direct emissions
- Mitigation efforts are likely to have greater benefits than estimated from direct emissions reductions