

# International Conference on Enhanced-Efficiency Fertilizers

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## THE EFFECT OF ENHANCED-EFFICIENCY FERTILIZERS ON NITROUS OXIDE EMISSIONS FROM VARIOUS CROPPING SYSTEMS

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## The Effect of Enhanced-Efficiency Fertilizers on Nitrous Oxide Emissions from Various Cropping Systems

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ARS Soil-Plant-Nutrient Research Unit

## Background Information:

- Agriculture contributes ~67% of U.S. total N<sub>2</sub>O emissions.
- Global Warming Potential of N<sub>2</sub>O is ~296 times greater than CO<sub>2</sub>.
- Applying N fertilizer generally increases N<sub>2</sub>O emissions.
- Developing management practices to reduce N<sub>2</sub>O emissions in agricultural systems is important.
- USDA-ARS is evaluating the effects of N source on N<sub>2</sub>O emissions at 7 locations with differing climates, soils, and cropping systems.

## Objective of N Source Studies:

- Compare N<sub>2</sub>O emissions resulting from application of several N sources to different cropping systems under varying soil and climatic conditions.
- N Sources Evaluated:
  - Conventional N fertilizers: Urea and/or UAN
  - Stabilized N sources containing urease (NBPT) and nitrification (DCD) inhibitors: SuperU and/or UAN+AgrotainPlus (AP).
  - Polymer-coated ureas: ESN, Duration III, Kingenta
  - Other Sources Examined: UAN + Nfusion; PiNT (Plant Impact N Technology); Ammonium Nitrate; Ammonium Sulfate; Urea-Ammonium Sulfate.

## Research Details

### Presented Separately for Each Site:

Soil Texture

Growing Season Precipitation

Irrigation Amount

Cropping and Tillage Systems

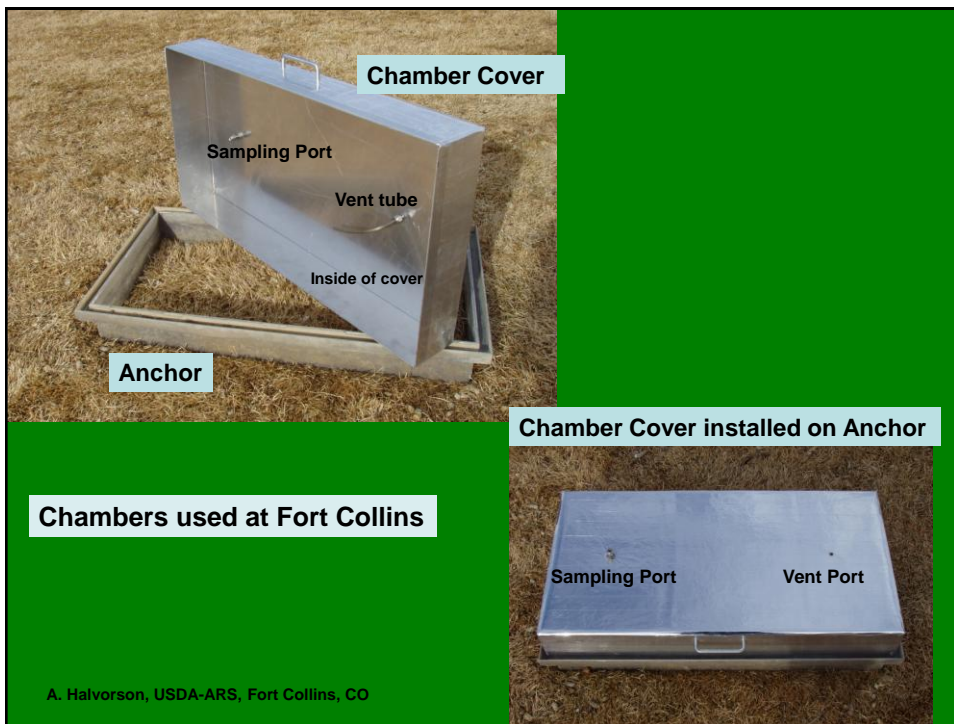
N Fertilization Rate

Fertilizer Application method

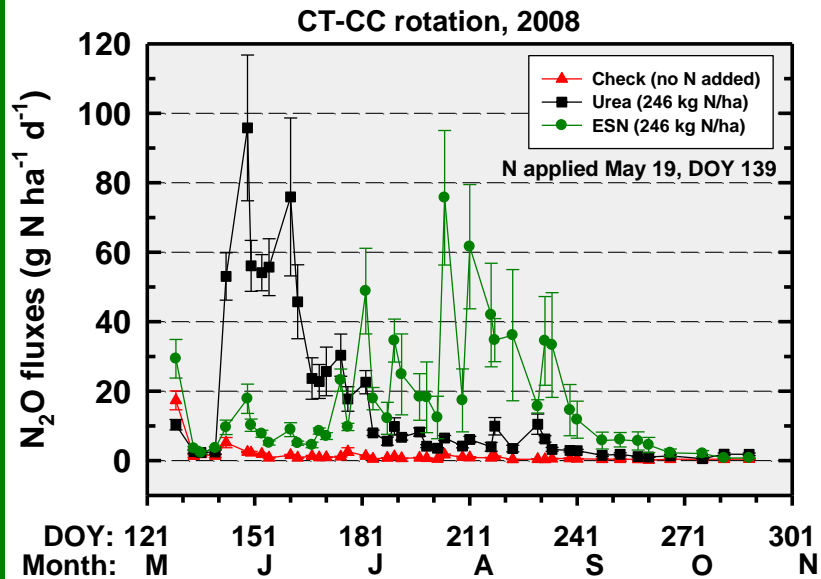


## Greenhouse Gas Measurements

- **Randomized complete block designs with 3 or 4 replications were generally used.**
- **N<sub>2</sub>O measurements: 1 to 3 times per week, immediately following crop planting until crop harvest (growing season).**
- **Static, vented chamber technique used to collect the gas samples in the field.**
- **Gas chromatograph used to determine N<sub>2</sub>O concentration in field gas samples.**

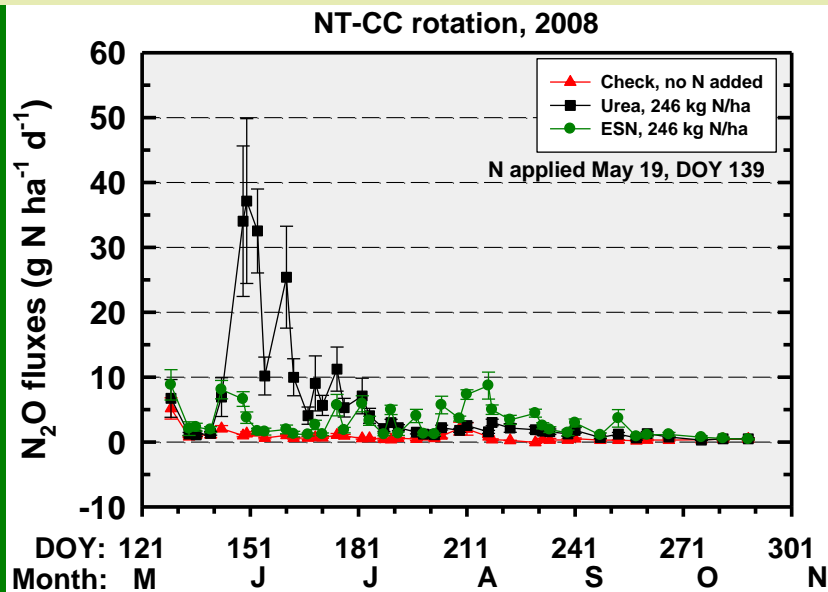


### Urea vs ESN in Conventional Till Corn, Fort Collins, CO

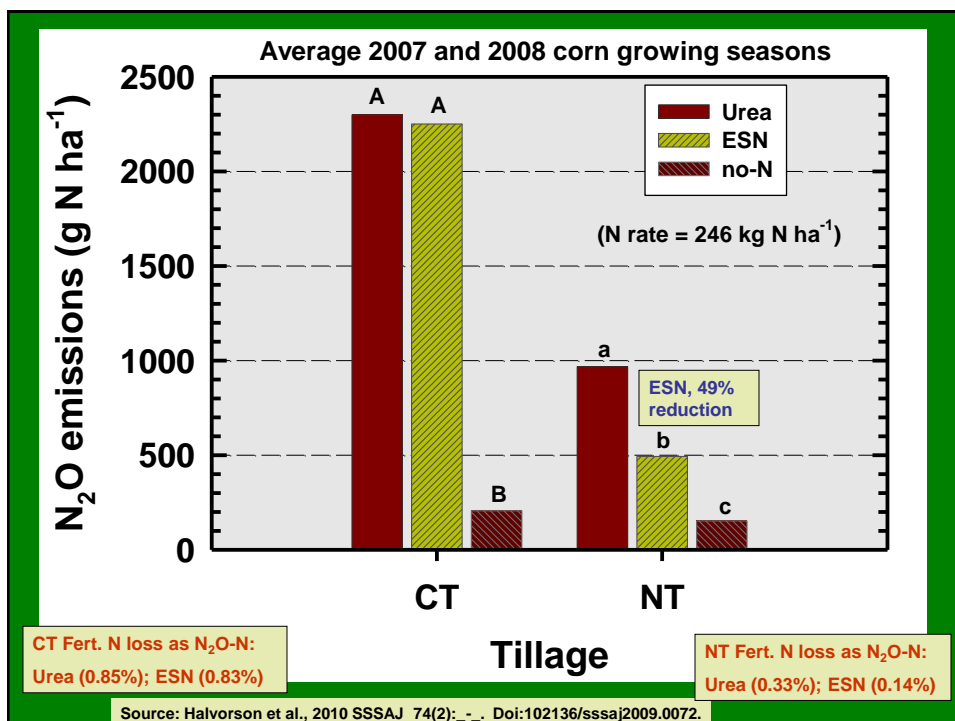
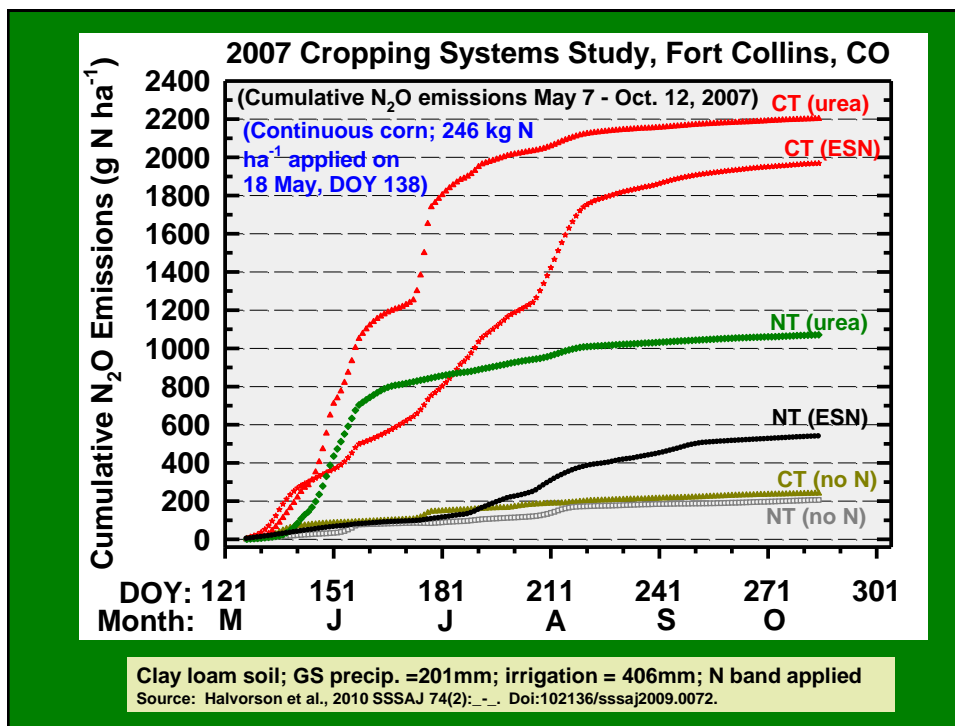


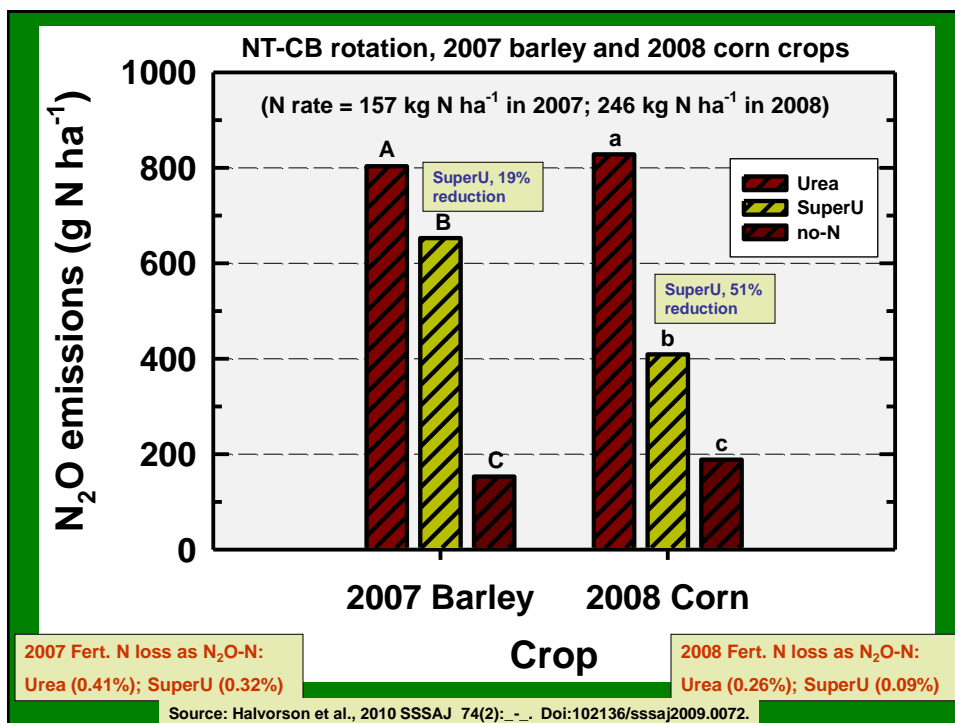
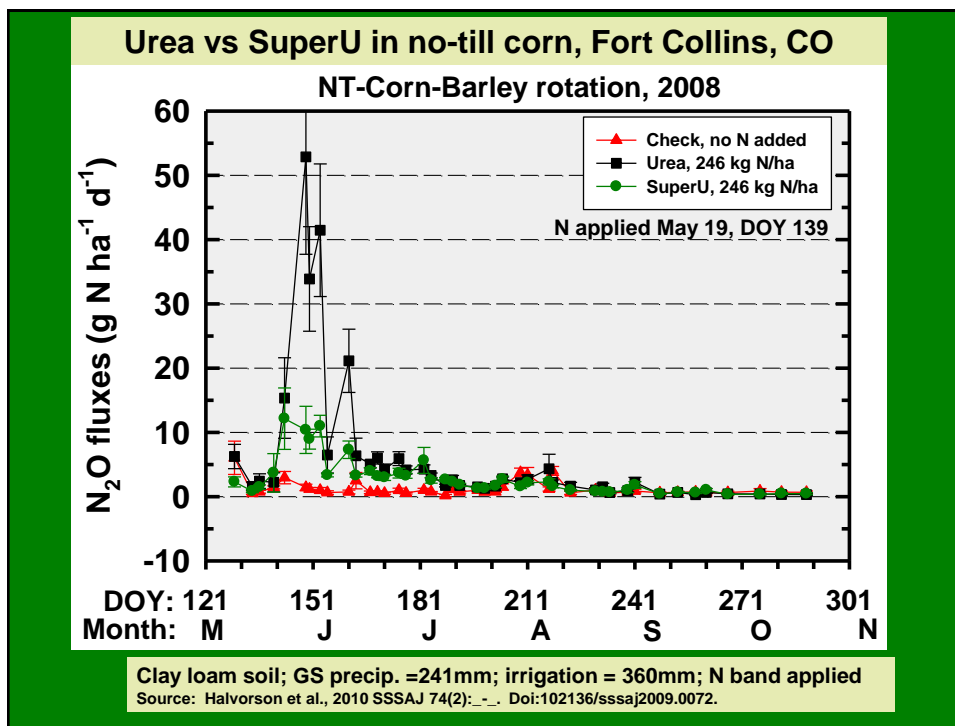
Clay loam soil; GS precip. =241mm; irrigation = 360mm; N band applied  
 Source: Halvorson et al., 2010 SSSAJ 74(2):\_-. Doi:102136/sssaj2009.0072.

### Urea vs ESN in no-till continuous corn, Fort Collins, CO



Clay loam soil; GS precip. =241mm; irrigation = 360mm; N band applied  
 Source: Halvorson et al., 2010 SSSAJ 74(2):\_-. Doi:102136/sssaj2009.0072.





## N Source Study at Fort Collins, CO under NT continuous corn

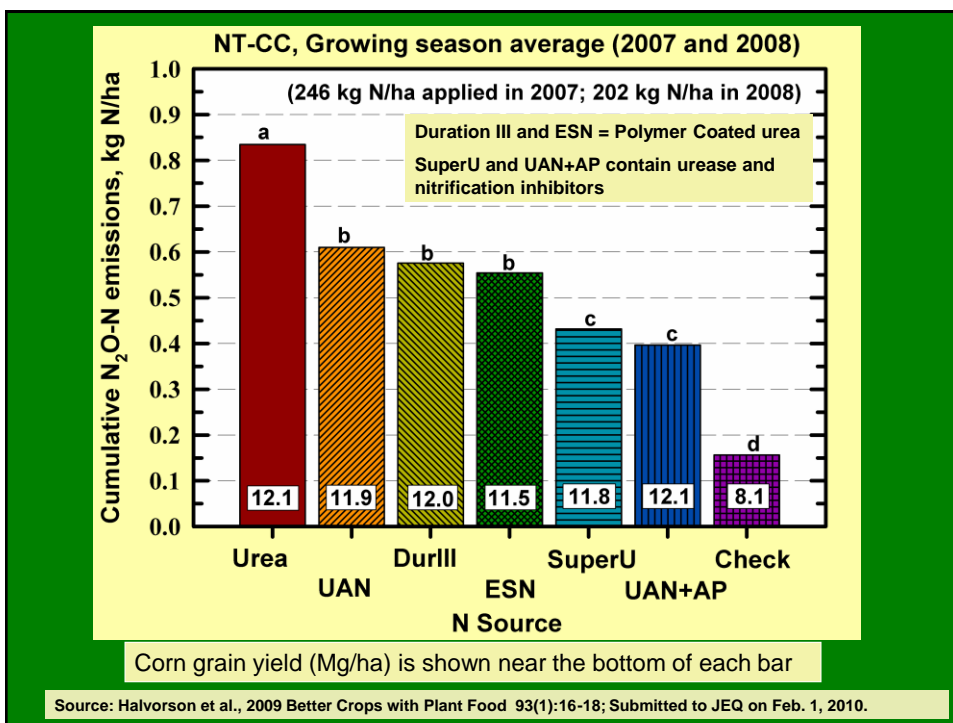
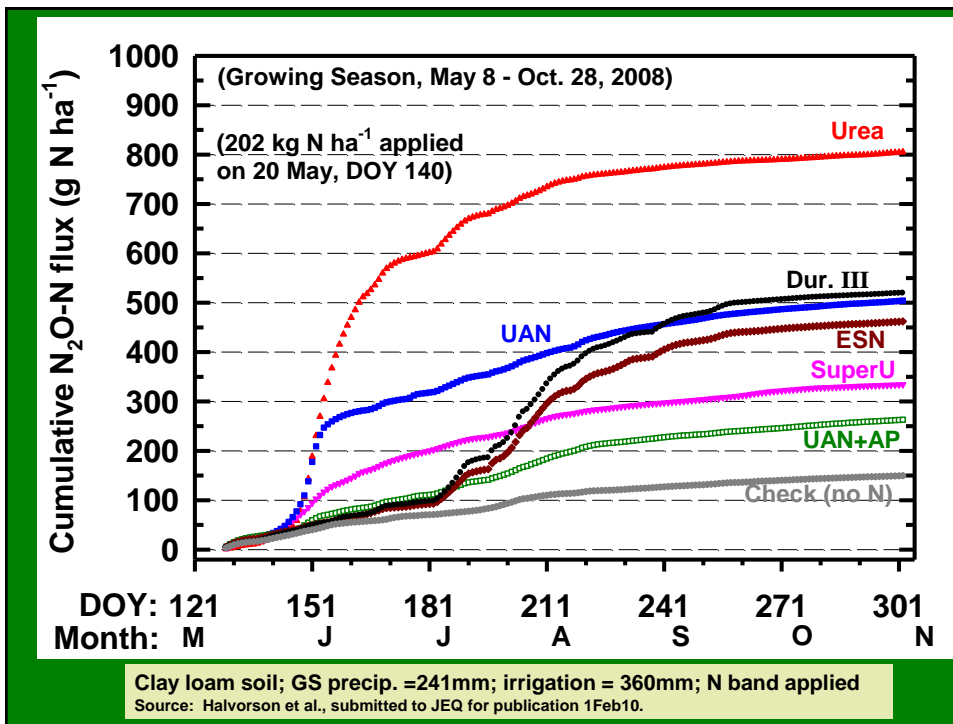
- **N Rates:**
  - 0 and 246 kg N/ha (2007);
  - 0 and 202 kg N/ha (2008)
- **N Sources Evaluated:** (all sources surface banded at crop emergence, followed by 13 mm irrigation water within 2 days)
  - Dry granular **Urea**
  - Polymer-Coated Urea (**ESN** and **Duration III**)
  - **SuperU** (contains urease and nitrification inhibitors)
  - **UAN**
  - **UAN + AgrotainPlus** (contains urease and nitrification inhibitors)

Source: Halvorson et al., 2009 Better Crops with Plant Food 93(1):16-18; Submitted to JEQ on Feb. 1, 2010.



Applying dry and liquid N sources to plots in N source Study (2008)

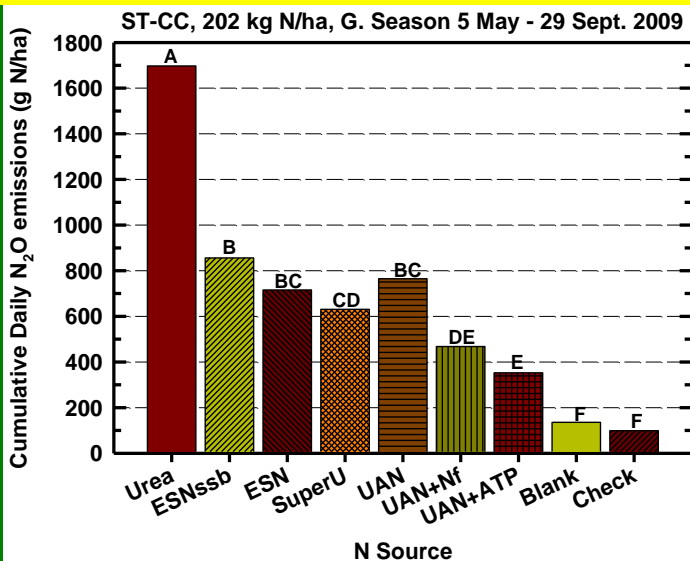




## N Source Effects on Reducing N<sub>2</sub>O-N Emissions in NT-CC

- Compared to Urea
  - UAN (27%)
  - Duration III (31%)
  - ESN (34%)
  - SuperU (48%)
  - UAN + AgrotainPlus (53%)
- Compared to UAN
  - Duration III (6%)
  - ESN (9%)
  - SuperU (29%)
  - UAN + AgrotainPlus (35%)

## 2009 N<sub>2</sub>O-N Emissions from Several N sources applied to Strip-Till Corn, Fort Collins, CO



N<sub>2</sub>O-N loss per unit of N applied was:

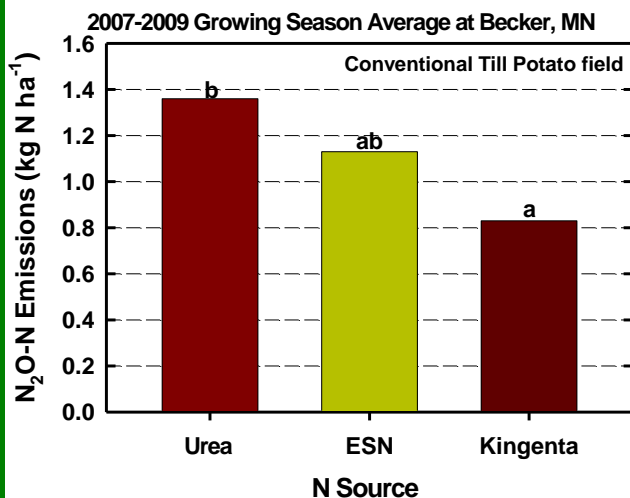
- 0.8% Urea
- 0.4% ESNssb
- 0.3% ESN
- 0.3% SuperU
- 0.3% UAN
- 0.2% UAN+Nf
- 0.1% UAN+AP

Clay loam soil; GS precip. =259mm; irrigation = 397mm; N banded at corn emergence.  
Source: Halvorson and Del Grosso, Proc. 2010 Great Plains Soil Fertility Conference, March 2-3, Denver, CO

## N Source vs N<sub>2</sub>O-N Emissions

Results from

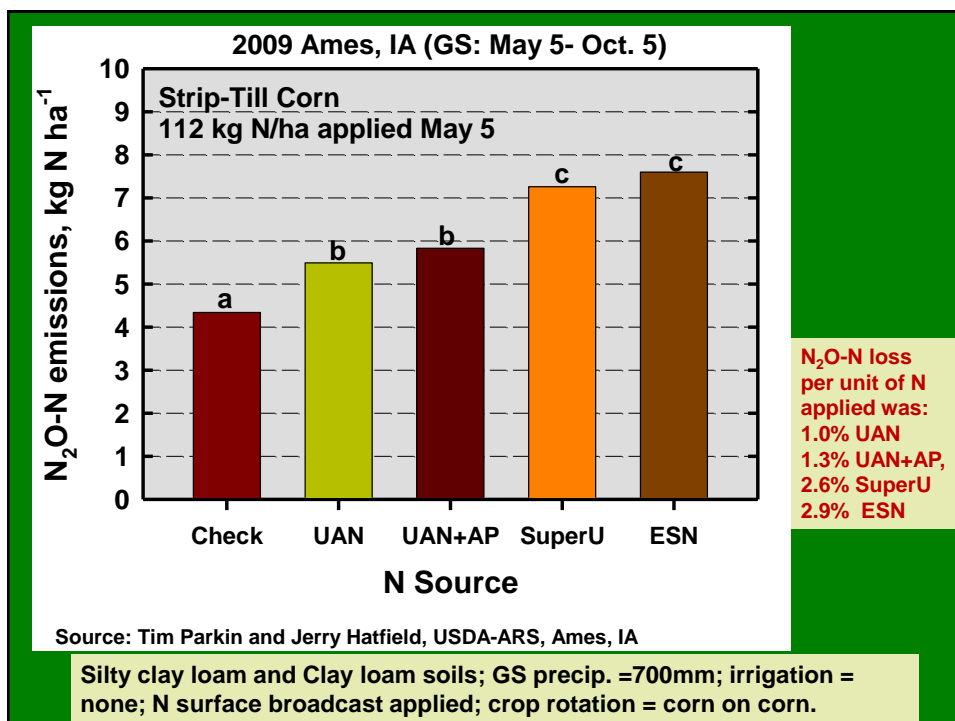
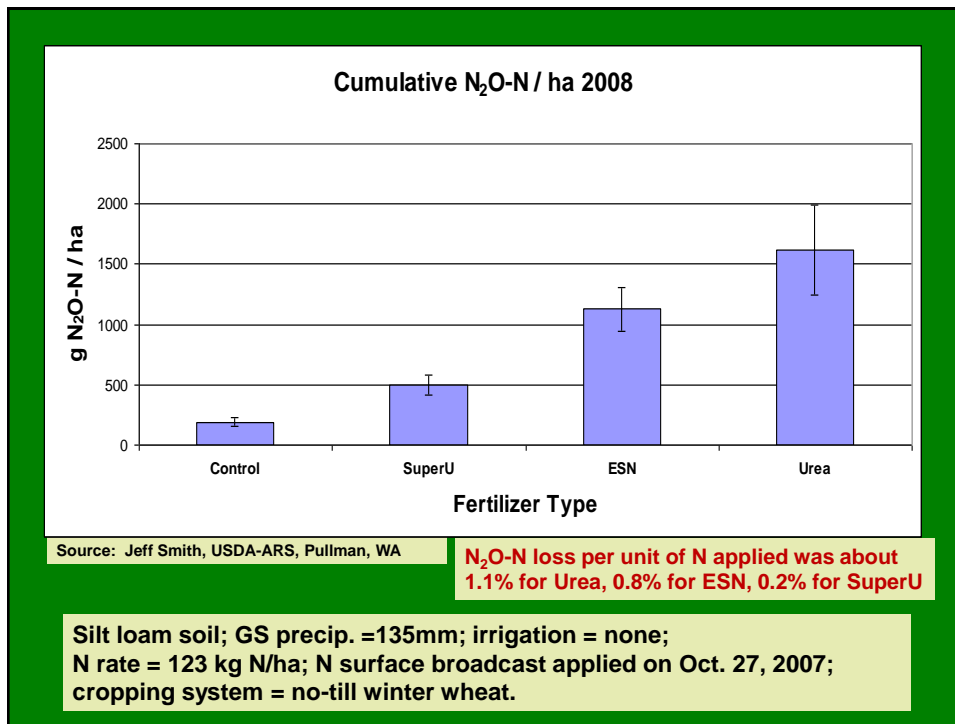
Other USDA-ARS Locations

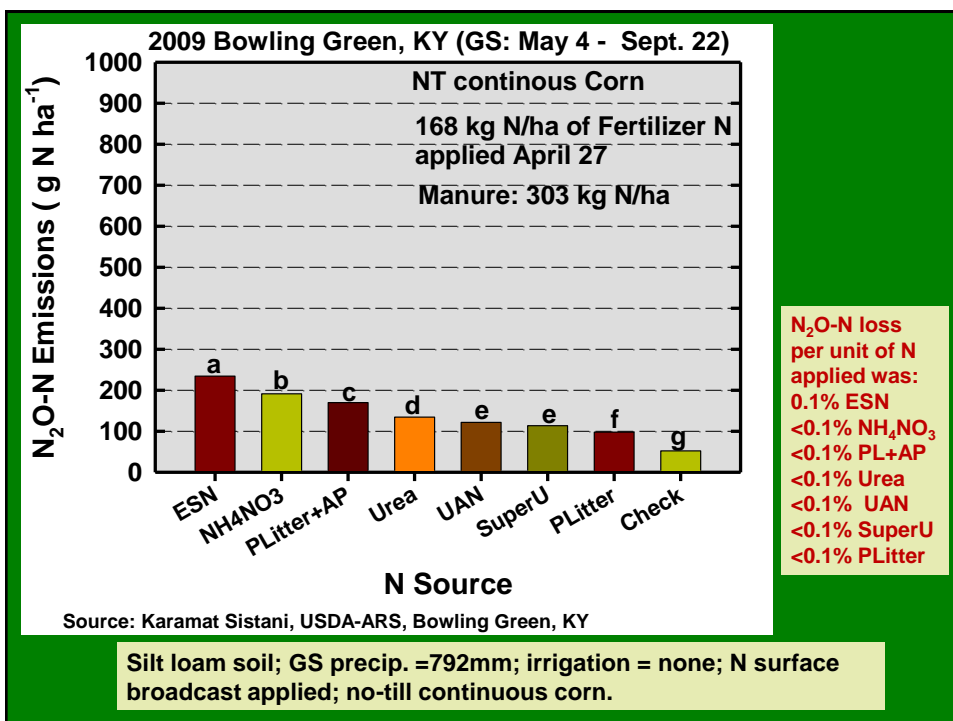
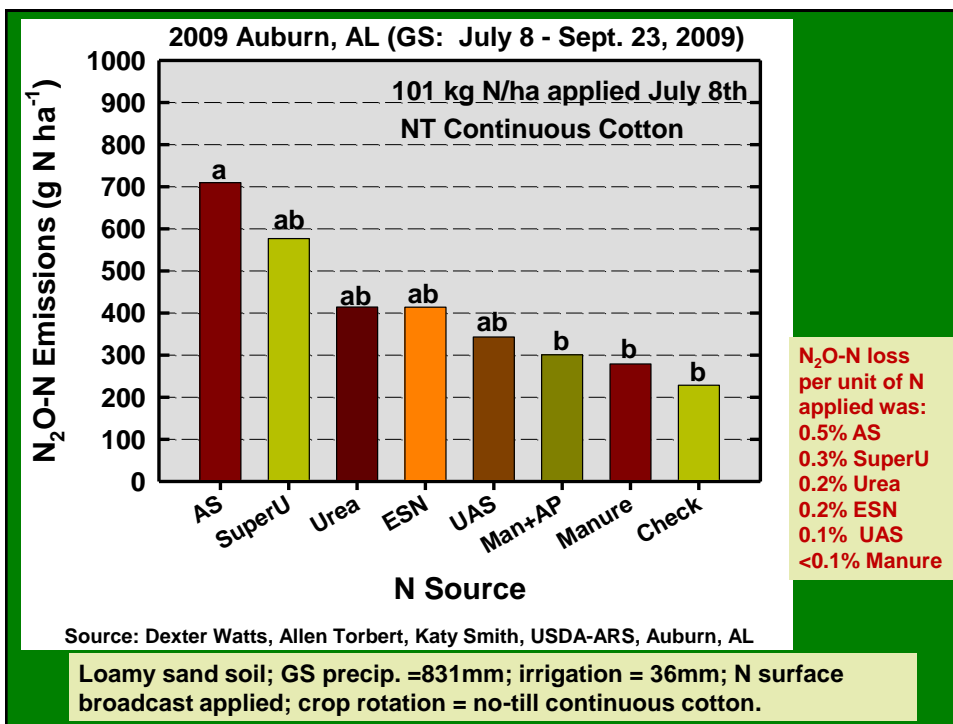


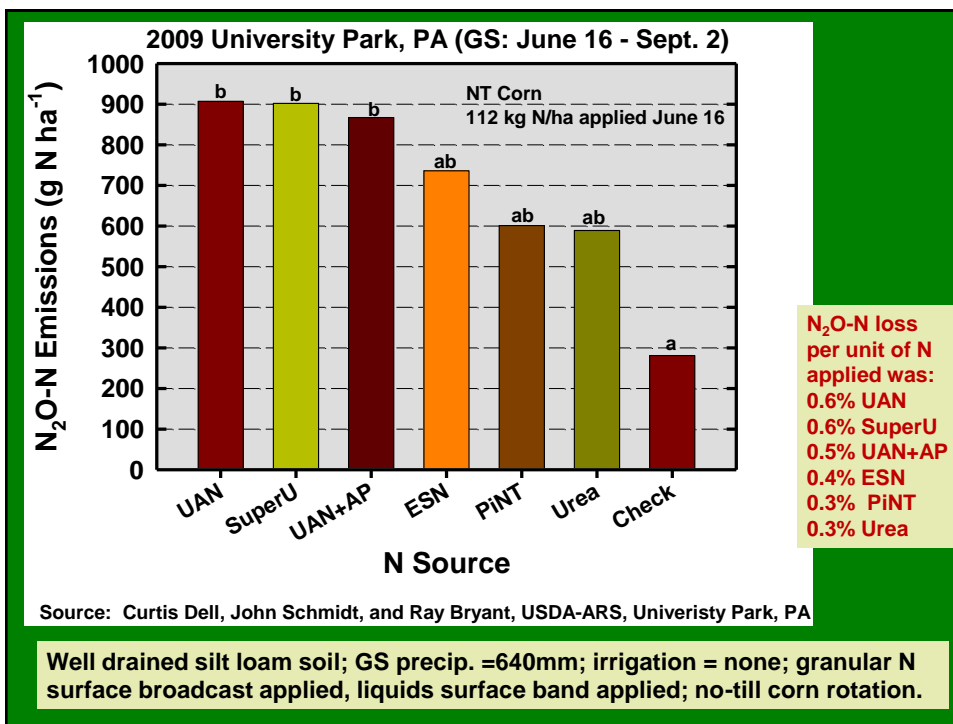
Source: Hyatt et al. 2010 SSSAJ 74(2). Doi:10.2136/sssaj2009.0126.

N<sub>2</sub>O-N loss as a percent of the N applied ranged from 0.1% to 0.5% in this study

Loamy sand soil; 3yr average GS precip. =394mm and irrigation = 423mm; N rates: **ESN and Kingenta** were applied at **225 kg N/ha preplant**; **Urea** was applied **112 kg N/ha at emergence** and **5 post-emergence applications of 22.5 kg N/ha** in 2007 and **4 post-emergence applications of 28 kg N/ha** in 2008 and 2009; N broadcast incorporated.







## Summary

- Enhanced-efficiency N sources ESN, SuperU, and UAN+ AgrotainPlus reduced N<sub>2</sub>O emissions up to 50% in NT production systems in the semi-arid western U.S. when compared to urea.
- ESN was not effective in reducing N<sub>2</sub>O-N loss in CT-CC but reduced N<sub>2</sub>O emissions 49% in NT-CC at Fort Collins.
- In the more humid areas (central, eastern and southern U.S.), the effectiveness of enhanced-efficiency N sources in reducing N<sub>2</sub>O-N emissions is not as obvious and needs more study.
- Growing season N<sub>2</sub>O-N losses per unit of N applied were generally well below the 1% loss value used by IPCC and generally <0.6% at most locations except for Ames, IA where N<sub>2</sub>O-N losses per unit of N applied were >1%.

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