Hermiston Agricultural Research and Extension Center

Ammonia Volatilization

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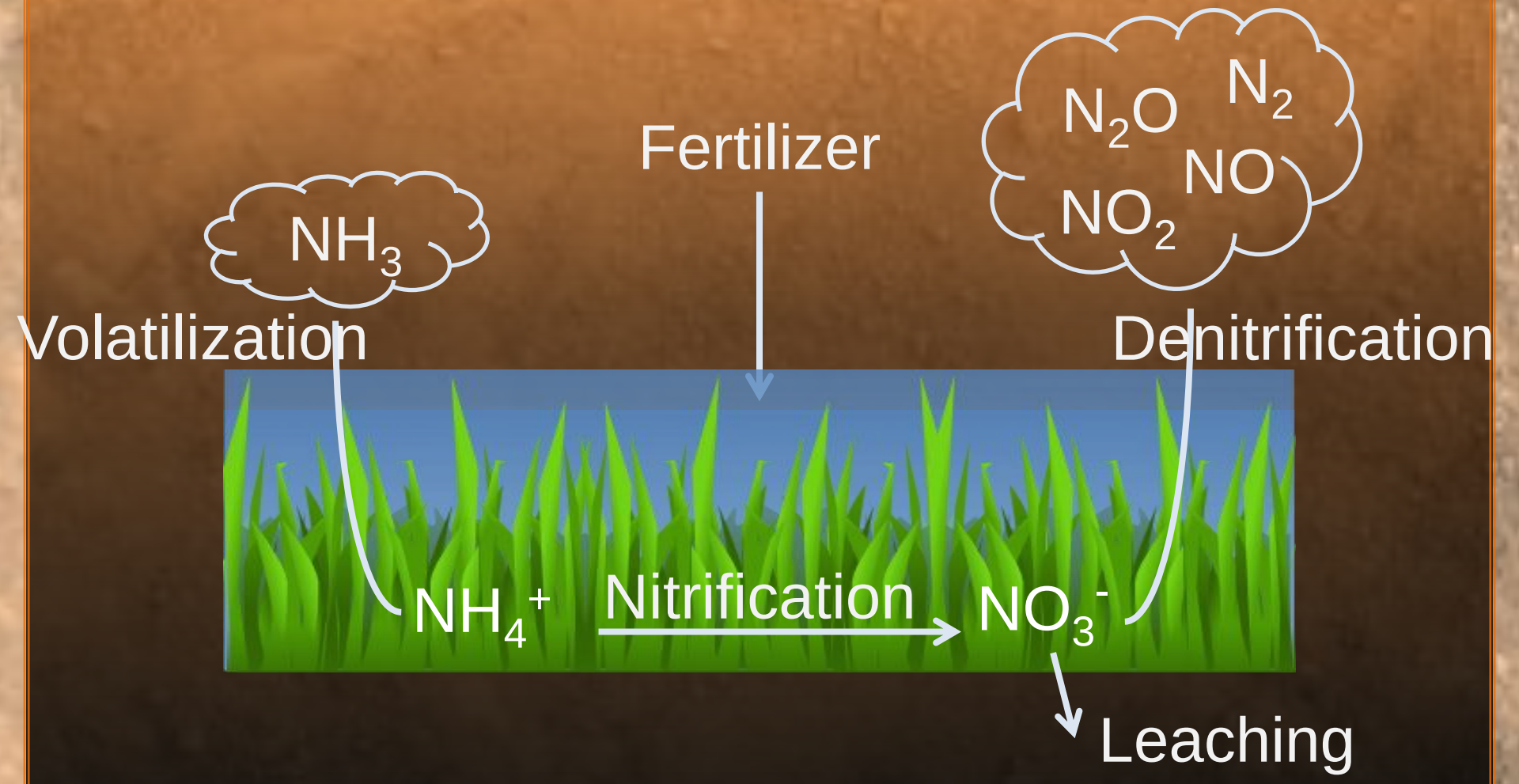
Gas in the Nitrogen (N) Cycle



Ammonia Volatilization

- How it happens
- Factors increasing volatilization
- How we measure it

The Problem

- Up to 50% of ammonium (NH_4^+) based and urea fertilizer lost as ammonia (NH_3)

(1) $Urea + 2H_2O \xrightarrow{urease} NH_4^+ + CO_3^{2-}$

Hydrolysis increases soil pH

(2) $NH_4^+ \rightarrow NH_3\ gas + H^+$

Volatilization rate increases at high pH

- N fertilizer accounts for ~20% of NH_3 and ~ 70% of N_2O (anthropogenic, globally)

Why We Care About NH_3

- Reacts with SO_x and NO_x → aerosol particles

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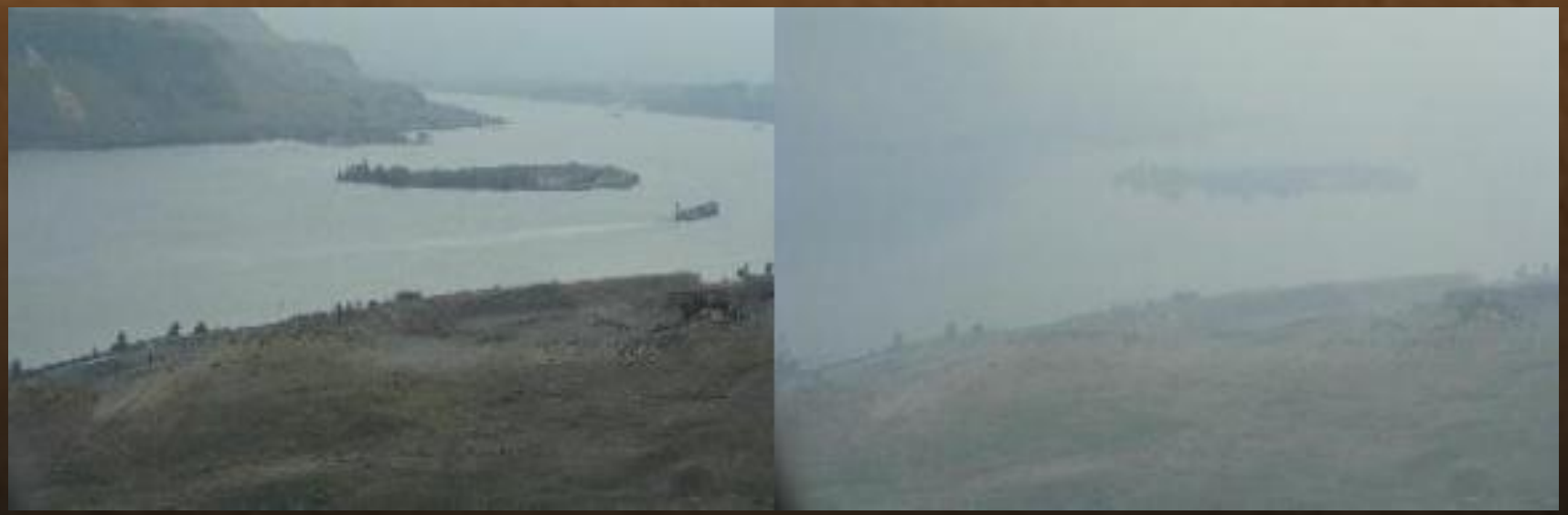

Why We Care About NH_3

- Reacts with SO_x and NO_x → aerosol particles
- Unintended deposition to N sensitive ecosystems
- Nitrogen loss is economically bad

= $$$

Factors Increasing Volatilization

Environmental

- Moisture
- High Soil Temperature
- High wind speed
- Low CEC
- High Soil pH

Controllable… sometimes

- Irrigation
- Crop Residue
- Fertilizer Type

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So many products...
Which ones work?

Choosing Fertilizer Additive to Limit Volatilization

- Urease inhibitor, NBPT
  - Active ingredient: (N-(n-butyl)thiophosphoric triamide)
  - In Agrotain® and others
  - >70% reduction of NH_3-N loss

Choosing Fertilizer Additive to Limit Volatilization

- Urease inhibitor, NBPT
- Controlled/Slow release
  - Degradable plastic coatings
    - Temperature
    - Moisture
  - Duration® & ESN ®

Choosing Fertilizer Additive to Limit Volatilization

- Urease inhibitor, NBPT
- Controlled/Slow release
- Ammonium sulfate (AS)
  - All of N is in NH_4^+ form
  - >60% reduction of NH_3-N loss
  - Results nearly as good as Agrotain®

Choosing Fertilizer Additive to Limit Volatilization

- Urease inhibitor, NBPT
- Controlled/Slow release
- Ammonium sulfate (AS)
- Urea with AS
  - Theory:

    acidifying effects of AS nitrification

    +

    alkaline effects of urea hydrolysis

    = no change in pH
  - Does it work?

Products

- (46-0-0) Urea
- (46-0-0) Urea + Agrotain®
- (21-0-0-24) AS
- (40-0-0-5) Urea + AS: separate
- (40-0-0-5) Urea + AS: fused
- (26-0-0-13) AS Nitrate (ASN)
- (39-0-0-12) Sulfur-coated urea (SCU)

Study Goals

- Find methods and products that limit NH_3 volatilization
- Estimate how much NH_3 is *actually* lost

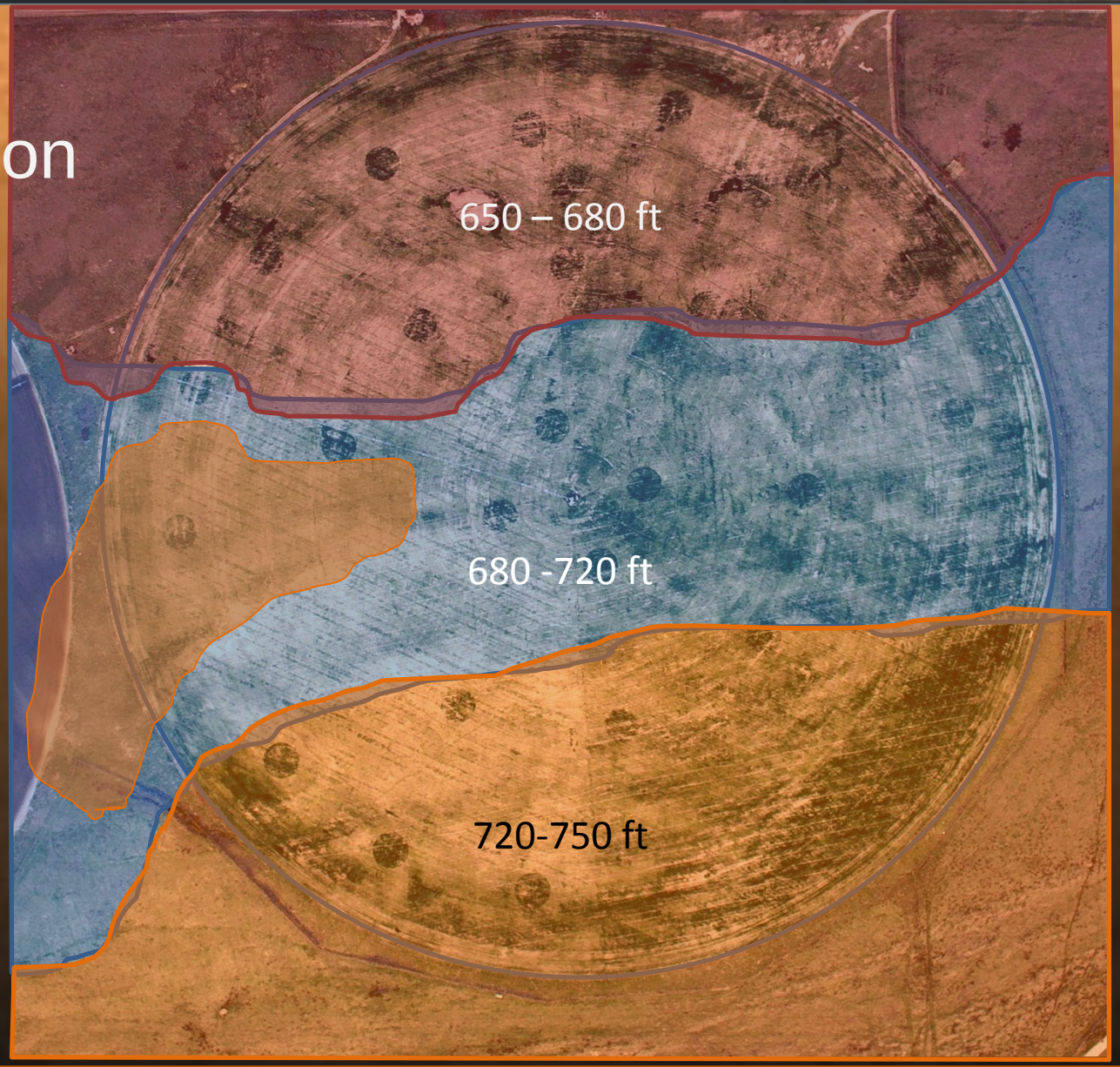
Methods

- 10’ poles with wind vane
- Passive = no power, no influence on environment
- Tubes coated with oxalic acid: traps $NH_3 \rightarrow NH_4^+$
- Lab analysis of $[NH_4^+]$ translates into actual NH_3 loss estimate

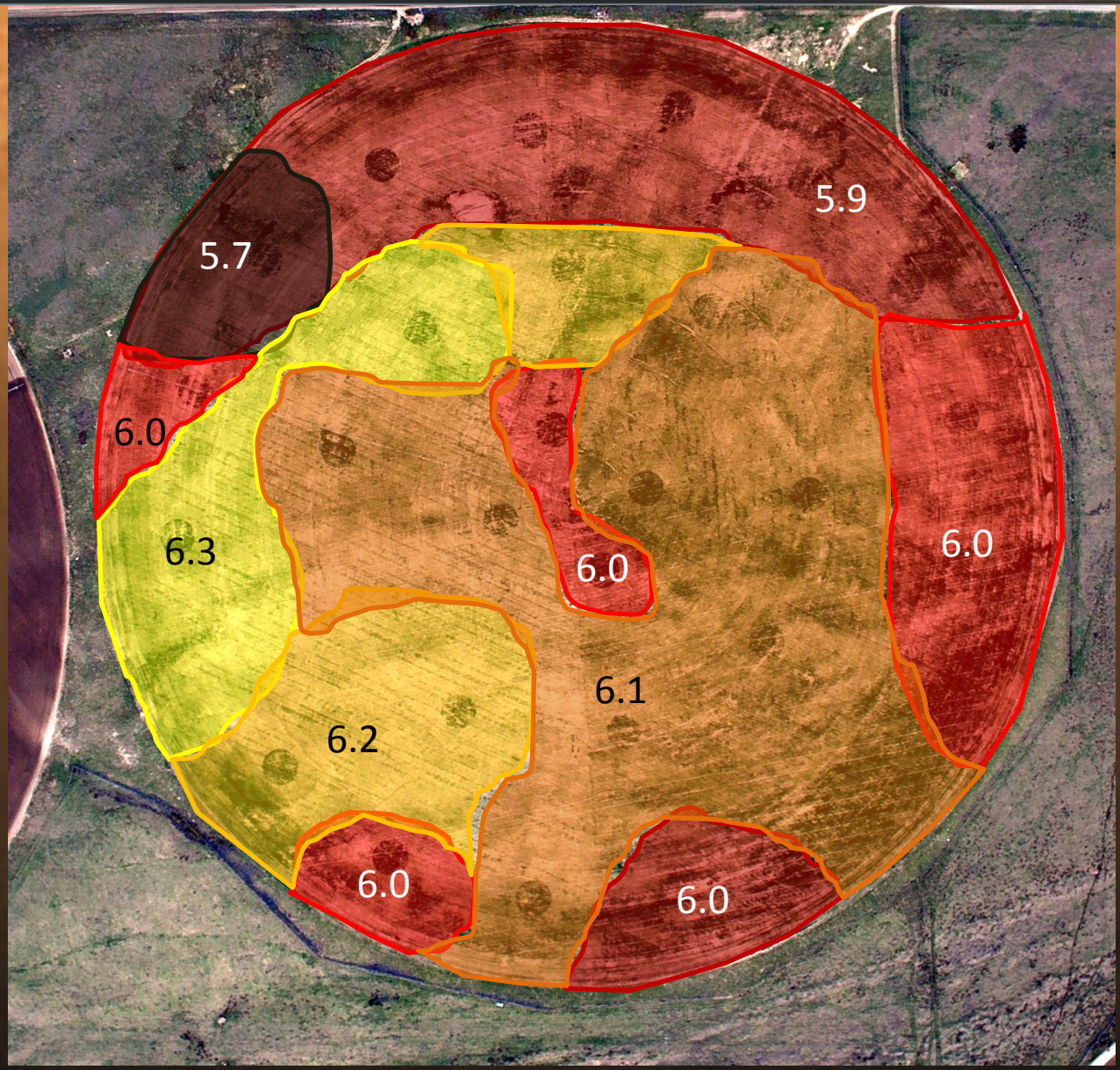
Details

- Pre-applied 2” irrigation
- Average high temperature between 80 – 90 F
- Average high soil temperature between 80 – 90 F
- Sandy loam soil
- pH 7.3 – 7.9 overall
- pH 5.8 – 6.3 in top 3” of soil
- Applied to thick wheat stubble
- Study duration: Aug. 20 – Sept. 23
- Application rate: 150 lbs N per acre

Elevation

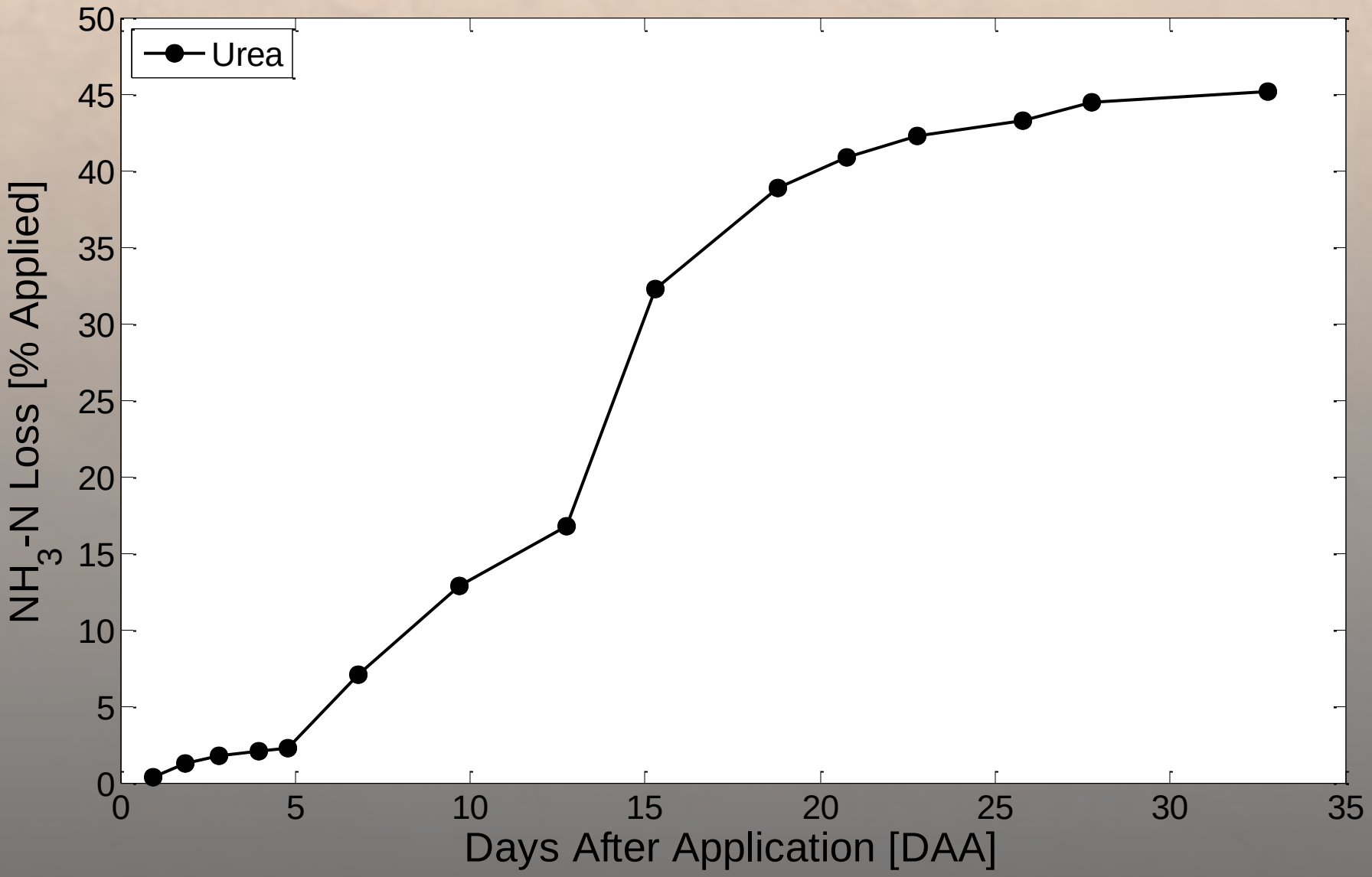


pH



Results

Cumulative NH_3-N Loss by Treatment



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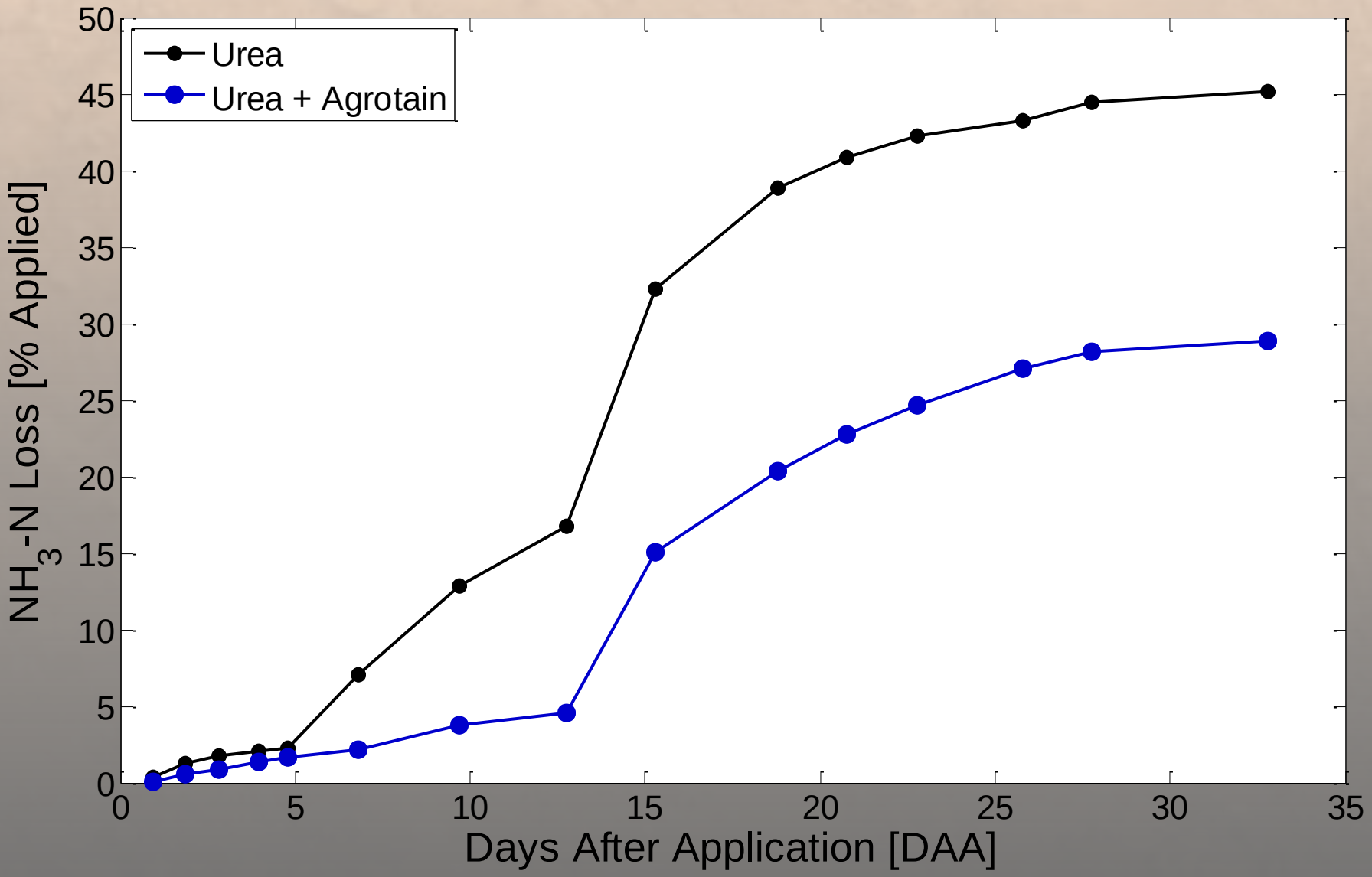

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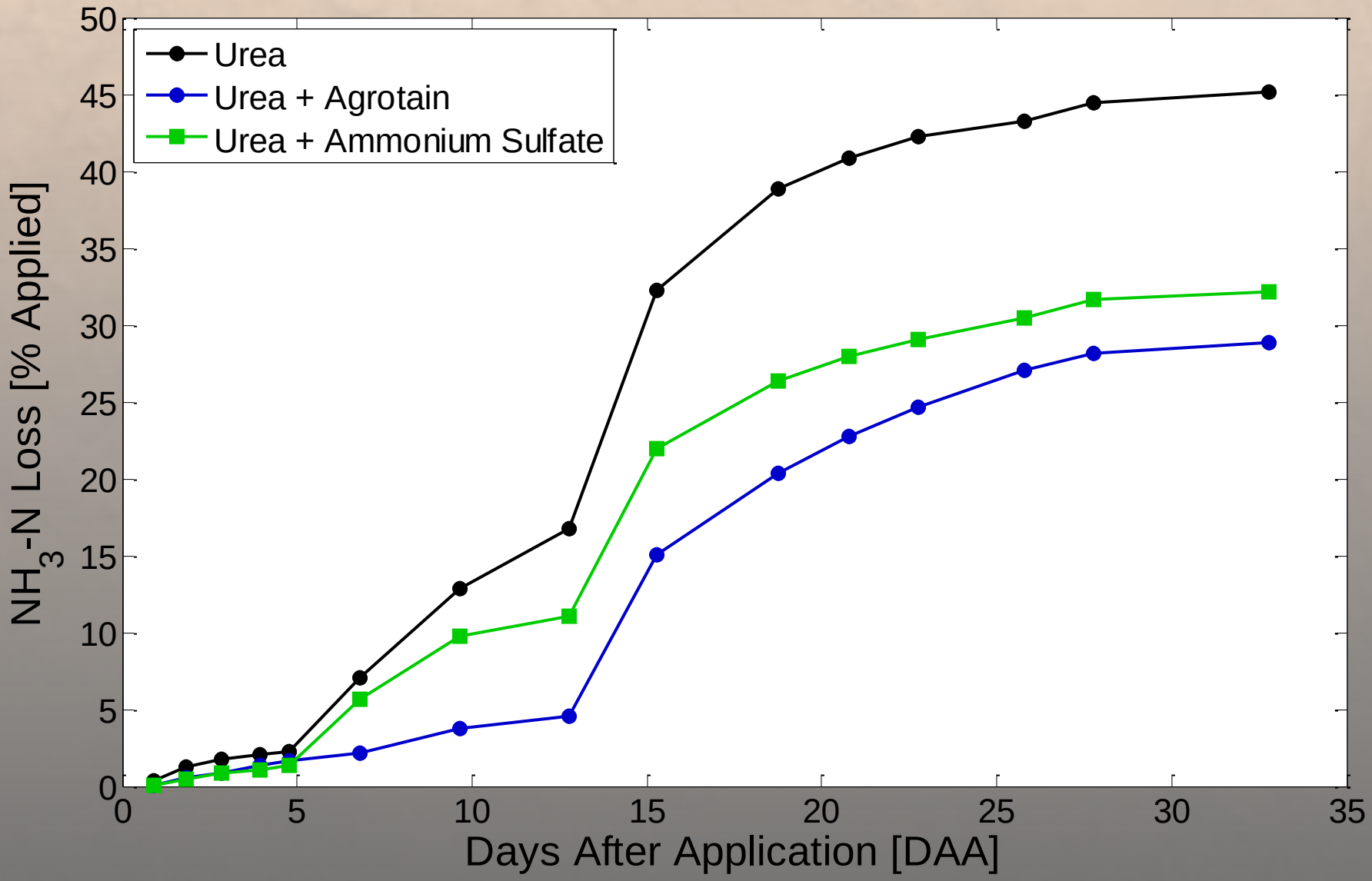

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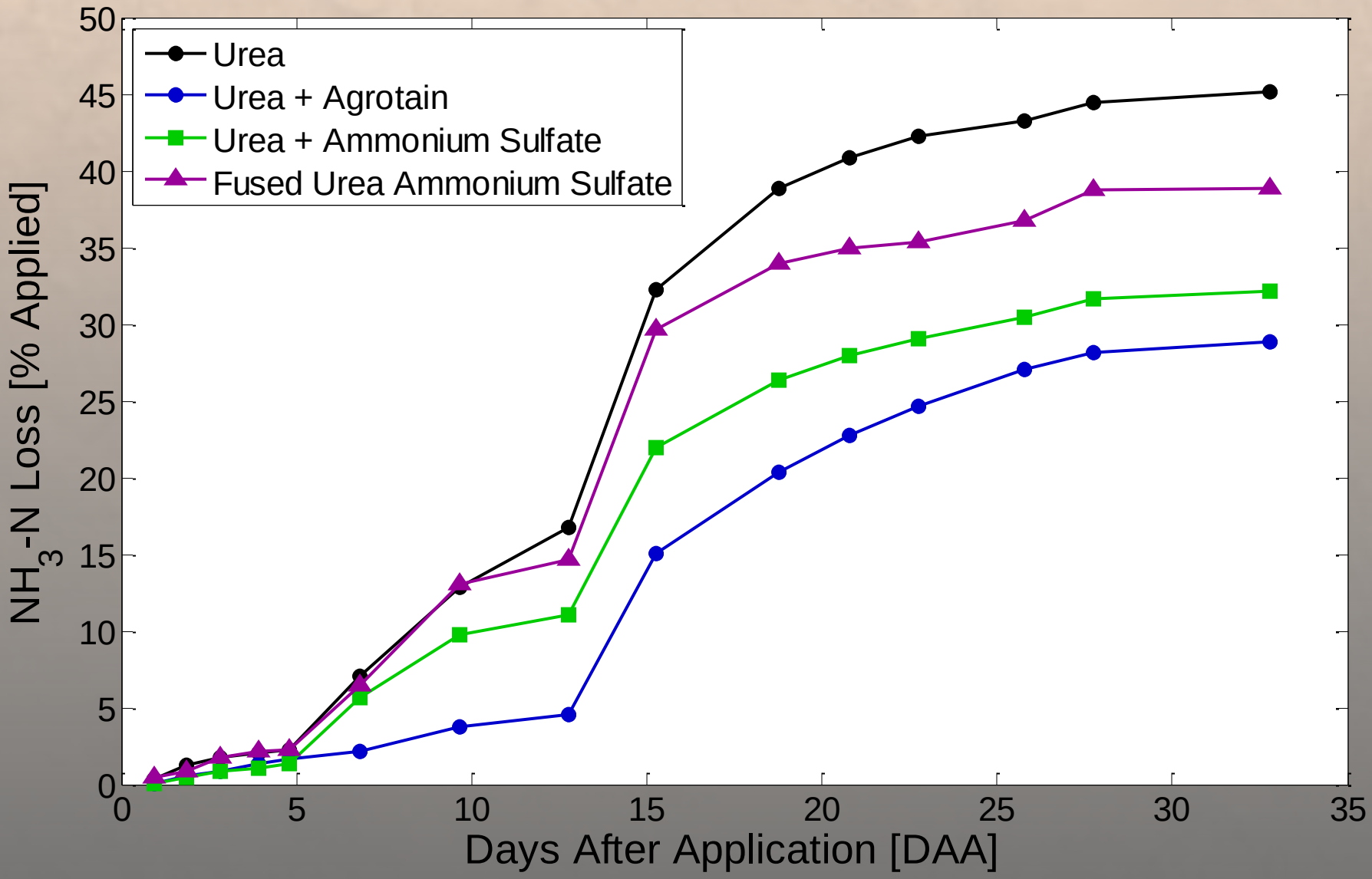

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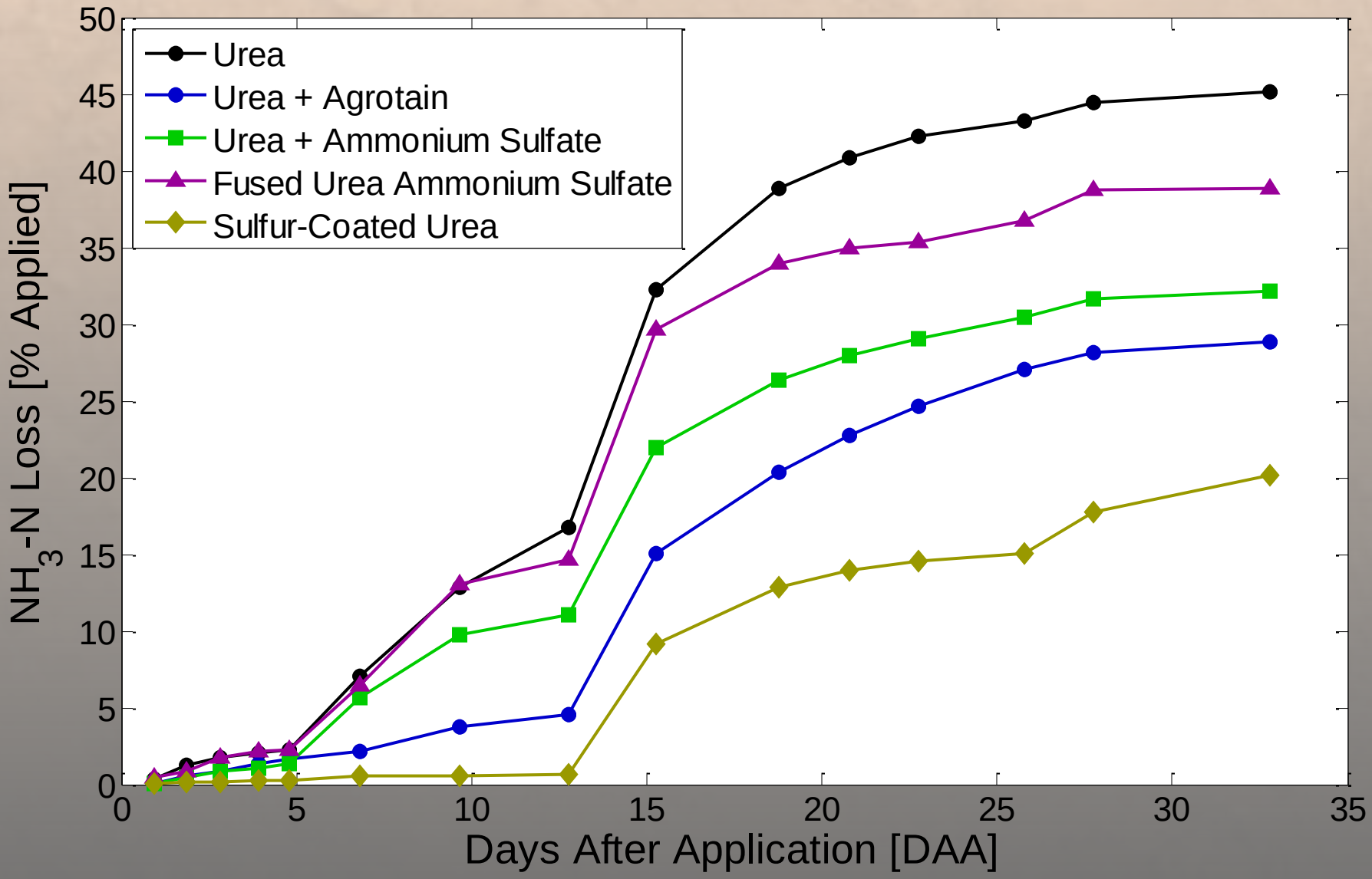

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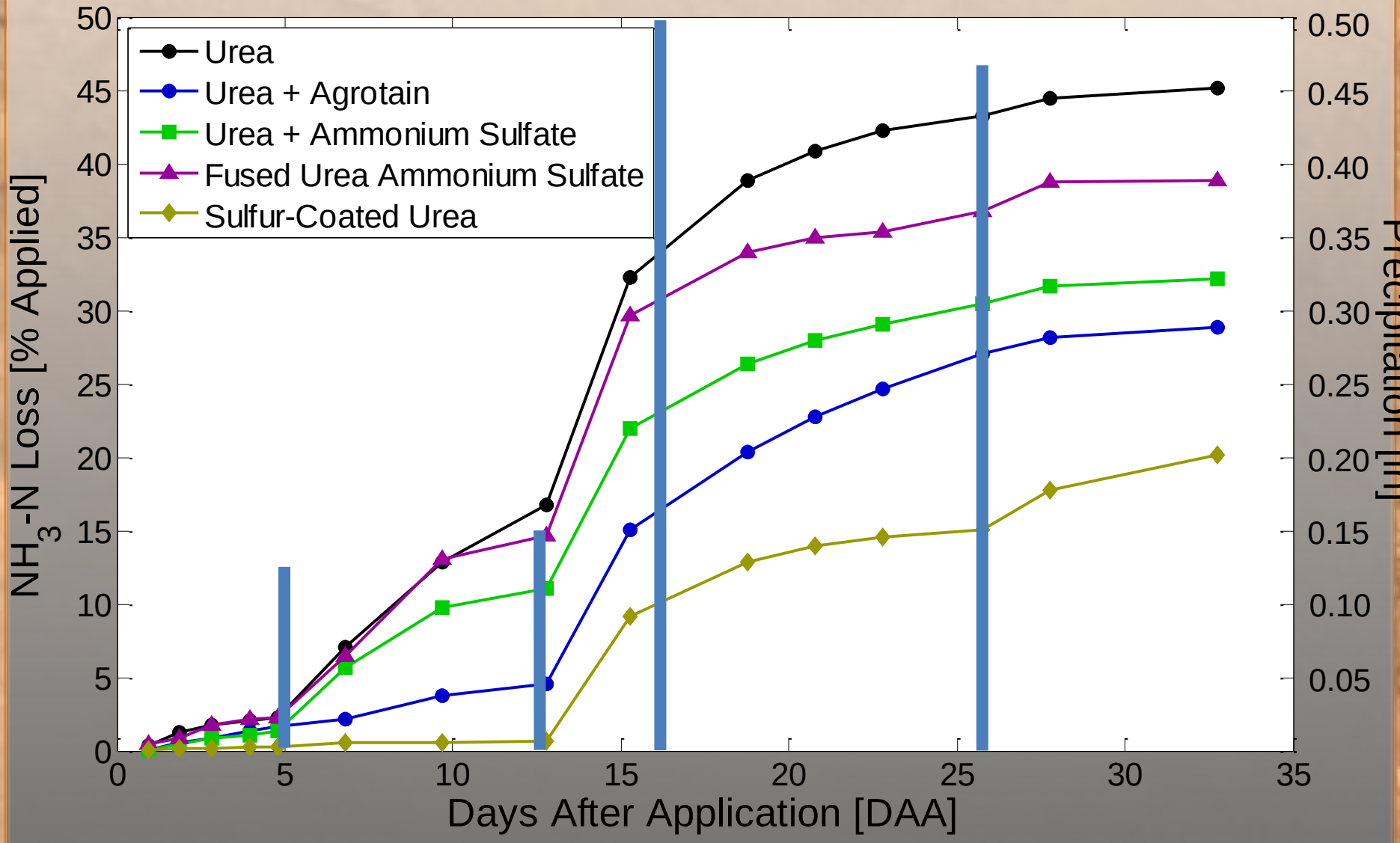

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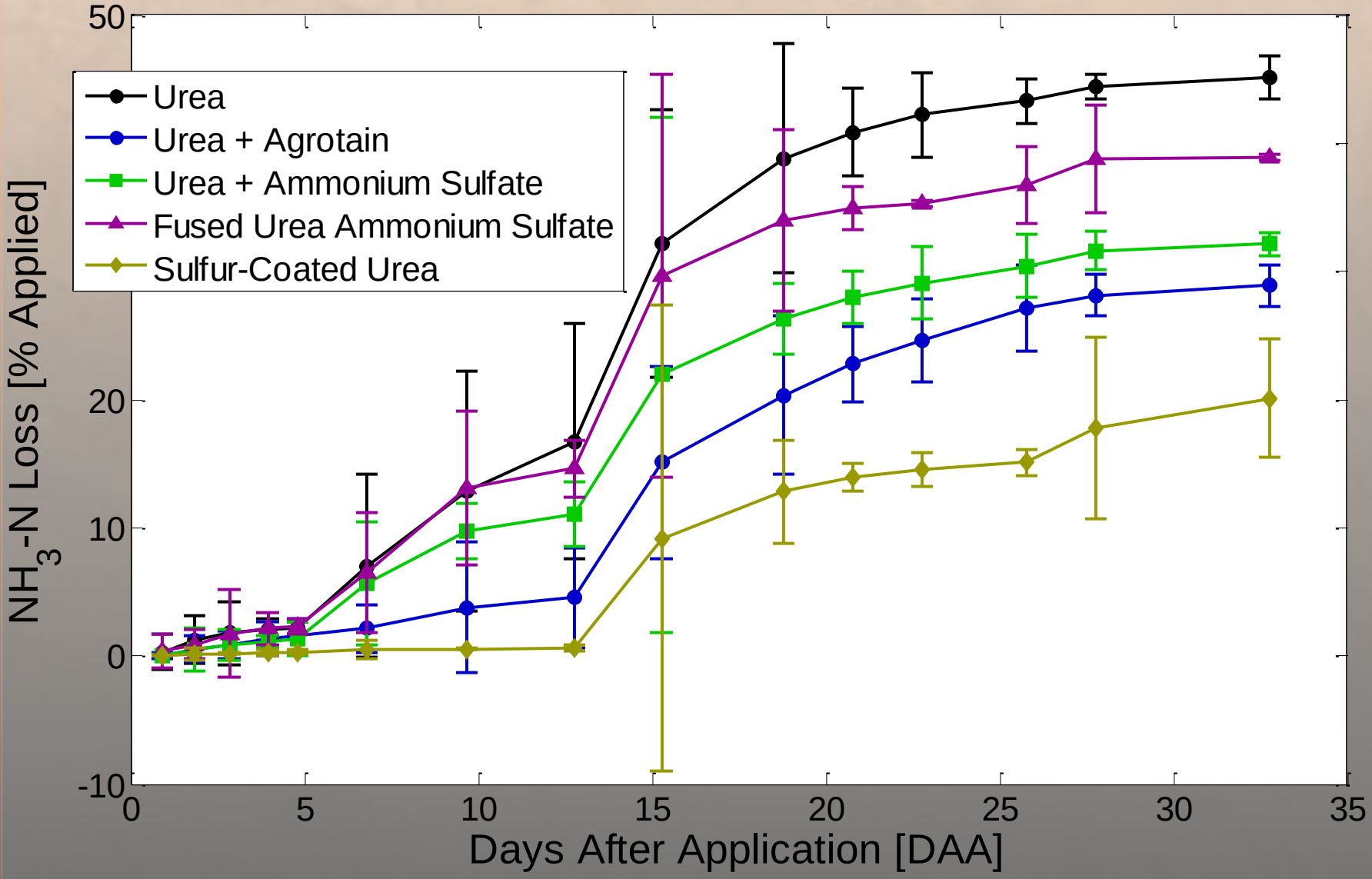

Conclusions

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- Hydrolysis occurs at a faster initial rate
- AS provides extra NH_4^+ to volatilize until urea hydrolysis slows down.

Ways to Reduce NH_3 Volatilization

- Incorporate fertilizer
  - Irrigation
  - Tillage
- Apply in favorable environmental conditions
  - Not 100 outside or after a mild rain
- Choose fertilizer type or additive that reduces loss depending on environmental conditions and loss mechanism
  - Inhibitors, controlled/slow release, NH_4^+, NO_3^-, or urea based fertilizer

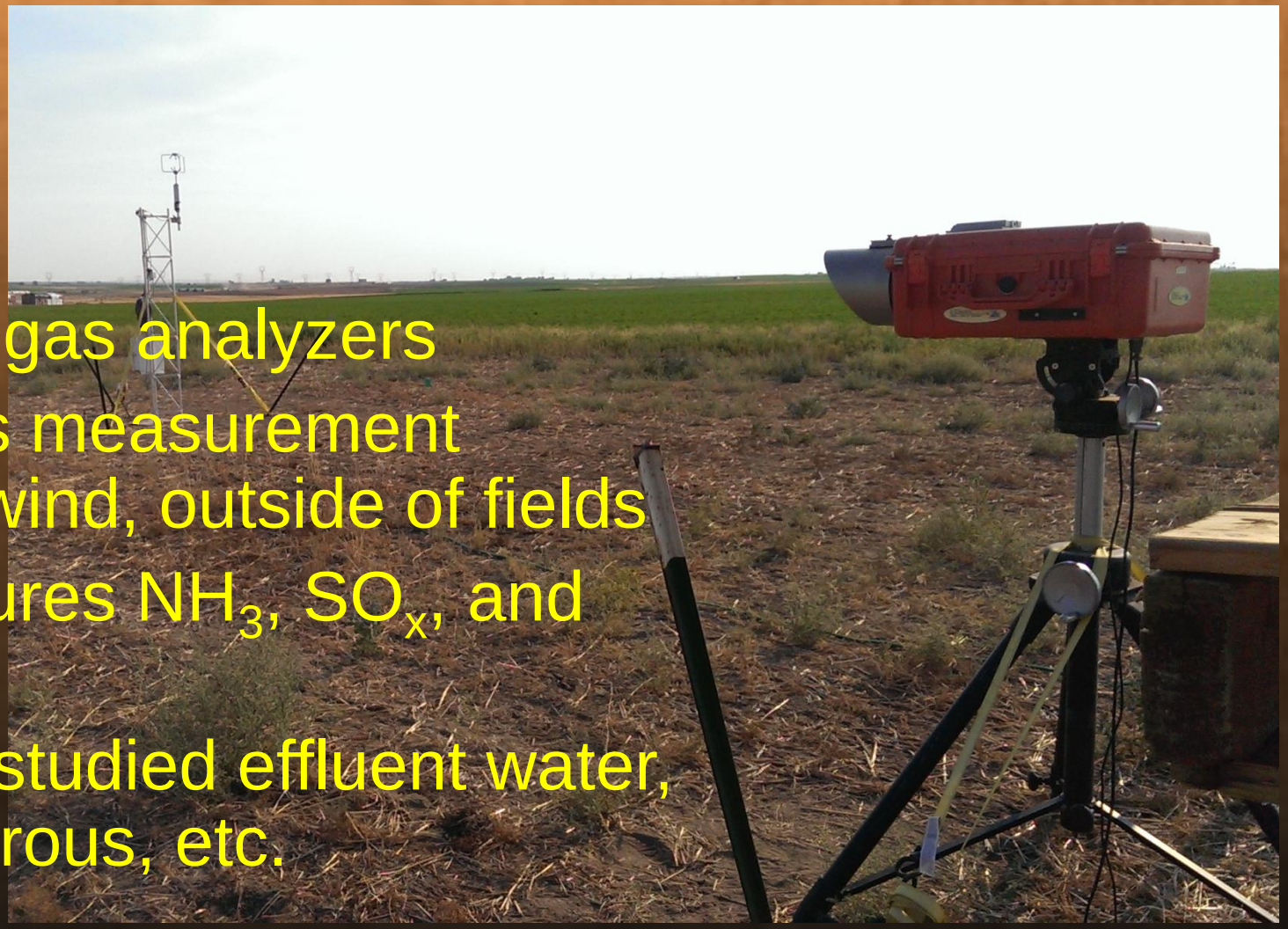
Acknowledgements

- Yara International
- Koch Industries, Inc.
- J.R. Simplot Company
- Two Rivers Terminal, LLC
- The growers that make it possible
- My major professor, mentors from campus
- HAREC

Concurrent Research

- Fertigation studies using our mini-center pivots: 61 ft, irrigates ~1/5 acre

Concurrent Research



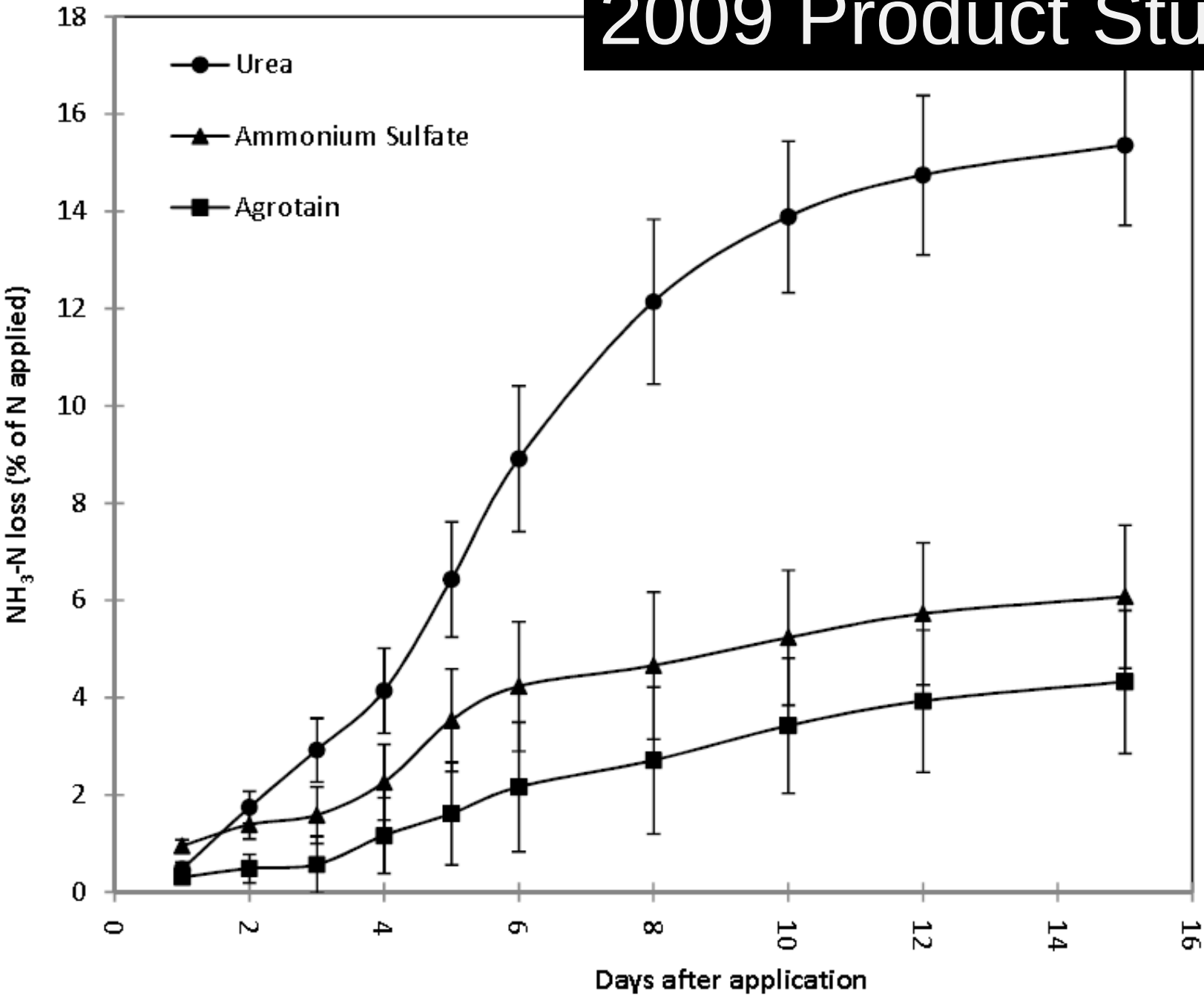
- Laser gas analyzers
- Allows measurement downwind, outside of fields
- Measures NH_3, SO_x, and NO_x
- Have studied effluent water, anhydrous, etc.

Questions?

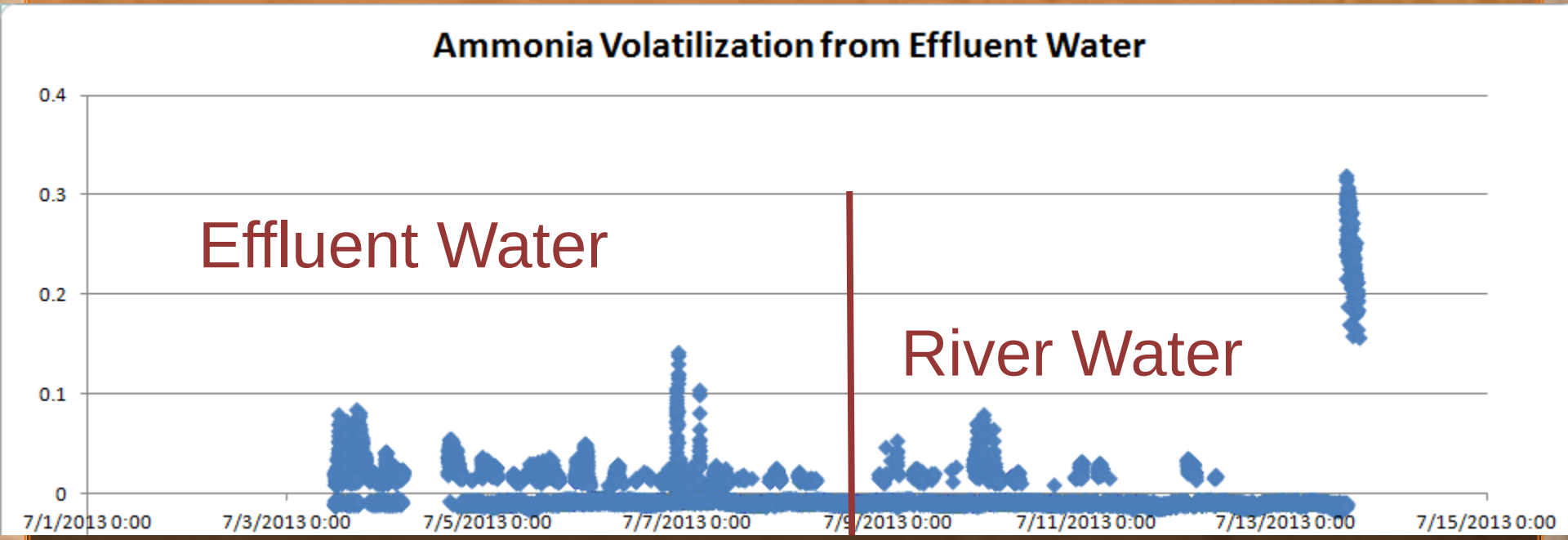
Thank you!

Appendix Slides

2009 Product Study

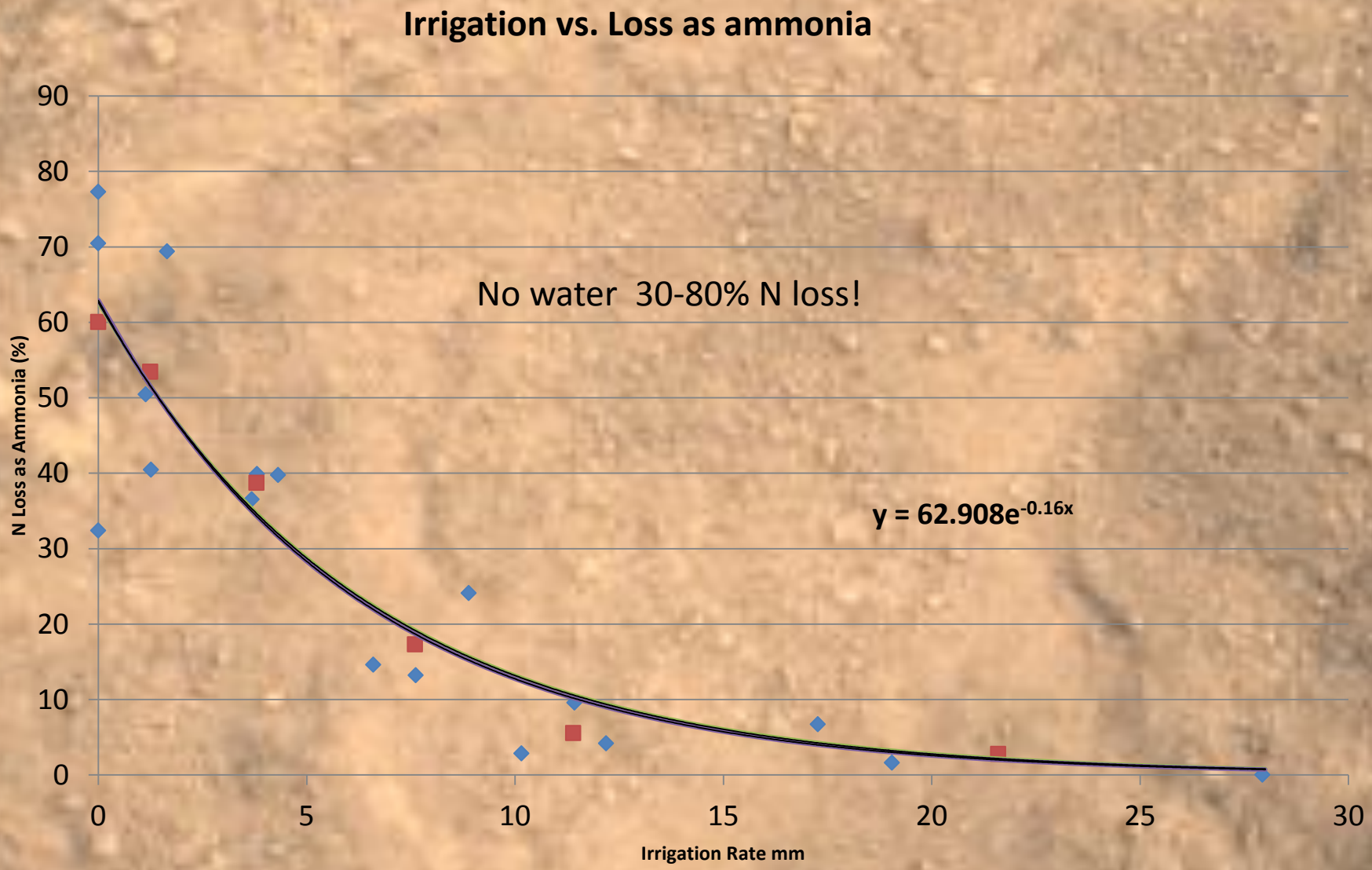


Effluent Results



- Effluent estimated to contain 100 ppm TKN
- Need to be cleaned up still
- Large amounts of data contains some noise

Effect of irrigation



Agrotain vs. Urea