

Ammonia Emissions from Agriculture in the Mid-Atlantic

John (Jack) Meisinger

**Soil Scientist, USDA-ARS Beltsville, MD
Adj. Assoc. Prof, UMCP College Pk, MD**

Jerry Hatfield

**Plant Physiologist, USDA-ARS Ames, IA
Research Leader, Nat. Soil Tilth Lab. Ames, IA**

John Prueger

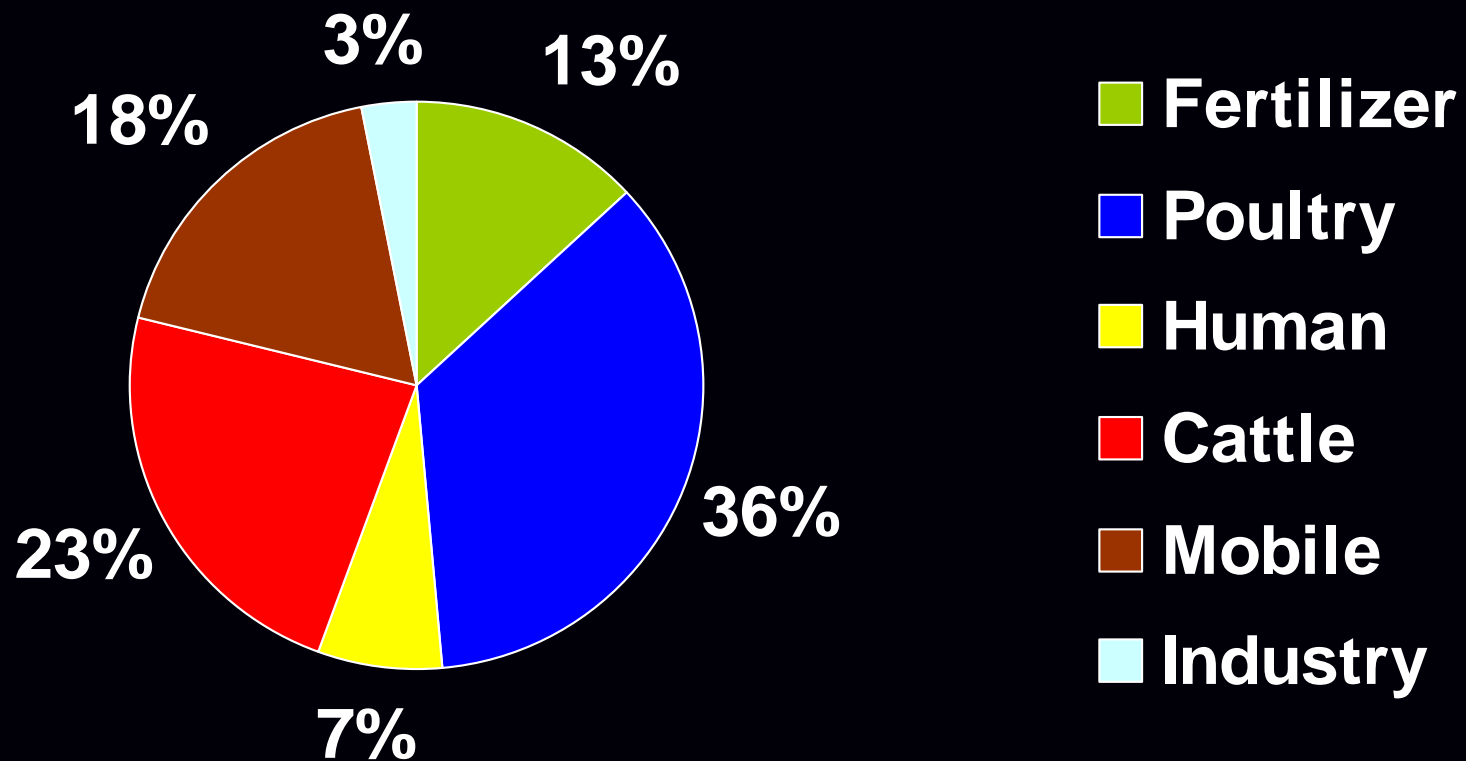
Atmospheric Scientist, USDA-ARS Ames, IA

Problem: Ammonia Losses Are

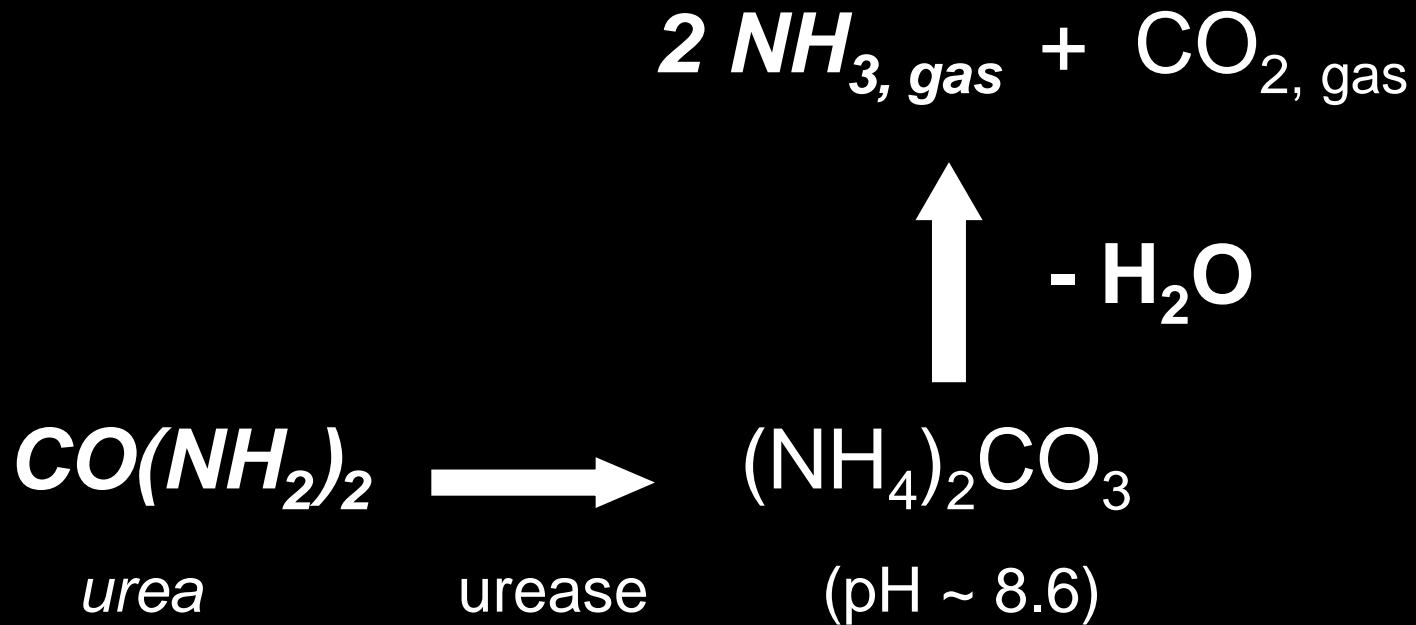
- ***Economic loss*** of plant available N
 - ✓ lose \$0.45 / lb N emitted, lowers N:P ratio in manures
- ***Environmental*** affects, ***re-deposition, aerosols $PM_{2.5}$***
 - ✓ natural ecosystems acidification and species shifts
 - ✓ ***aerosols increase regional haze, respiratory ailments***
- ***Estimation challenges*** for N management
 - ✓ managing ammonia losses requires estimating losses

Estimated Ammonia Emission Sources for Chesapeake Bay Watershed

(Per. Comm. Battye et al, 2000 – NH₃ in Airsheds & Watersheds Workshop)



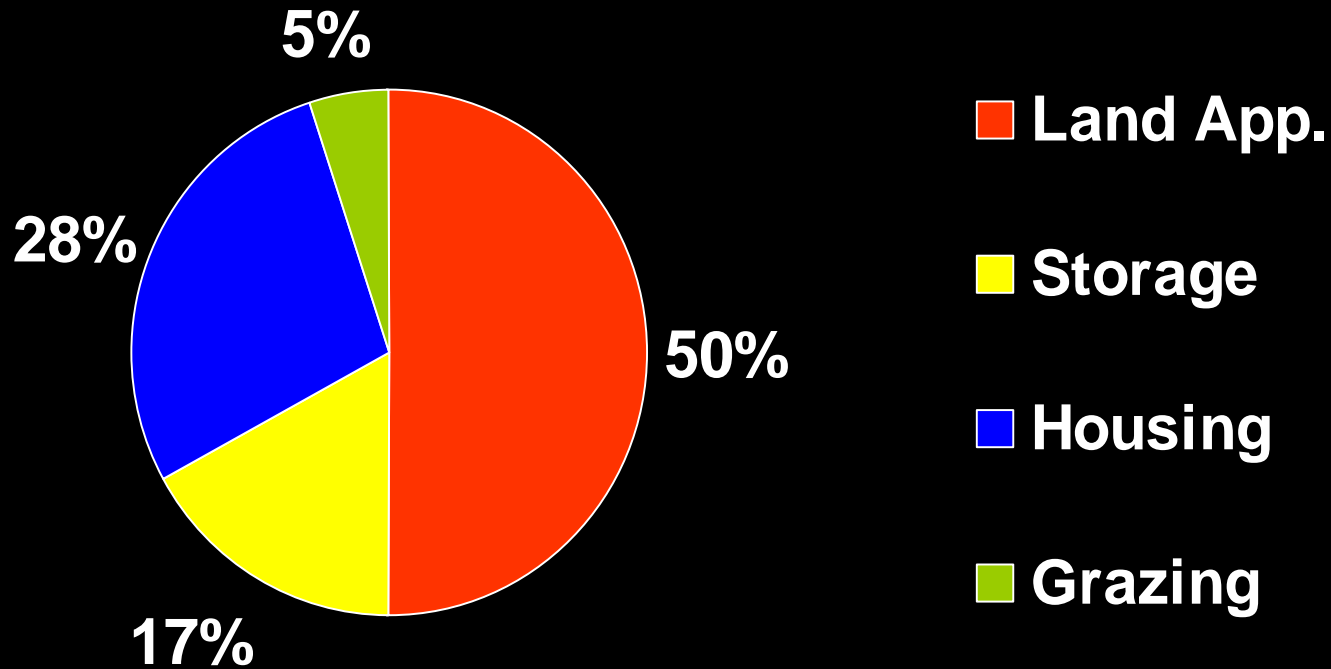
Urea Reactions



Note: rapid reaction w/ urease in manure

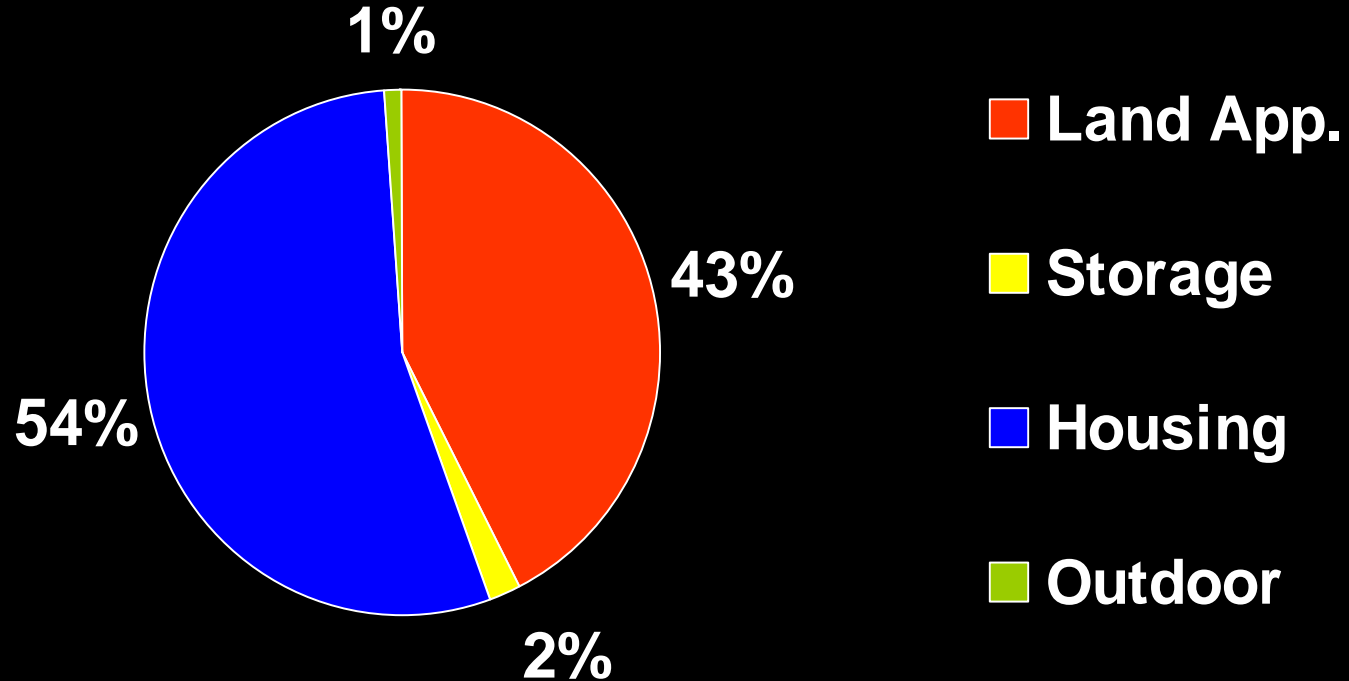
NH₃ Emissions from UK Cattle

(Pain et al., 1998)



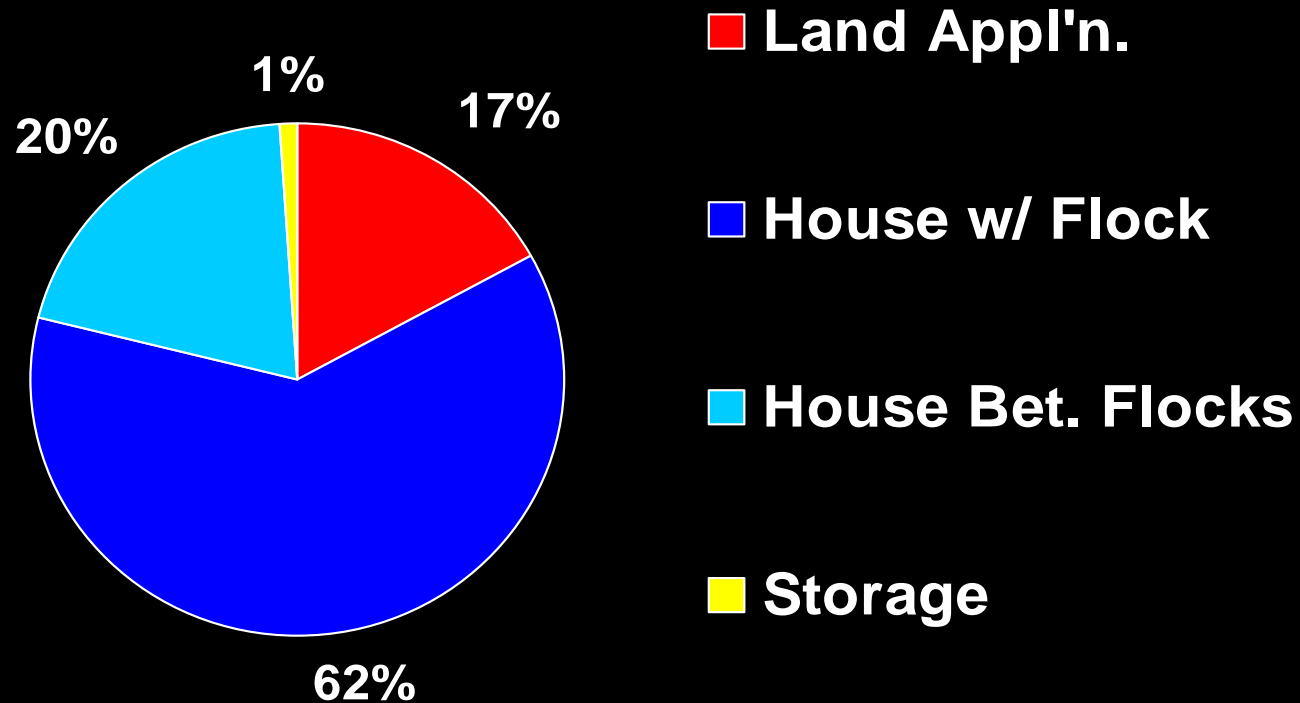
NH₃ Emissions from UK Poultry, Traditional Side-wall Ventilation

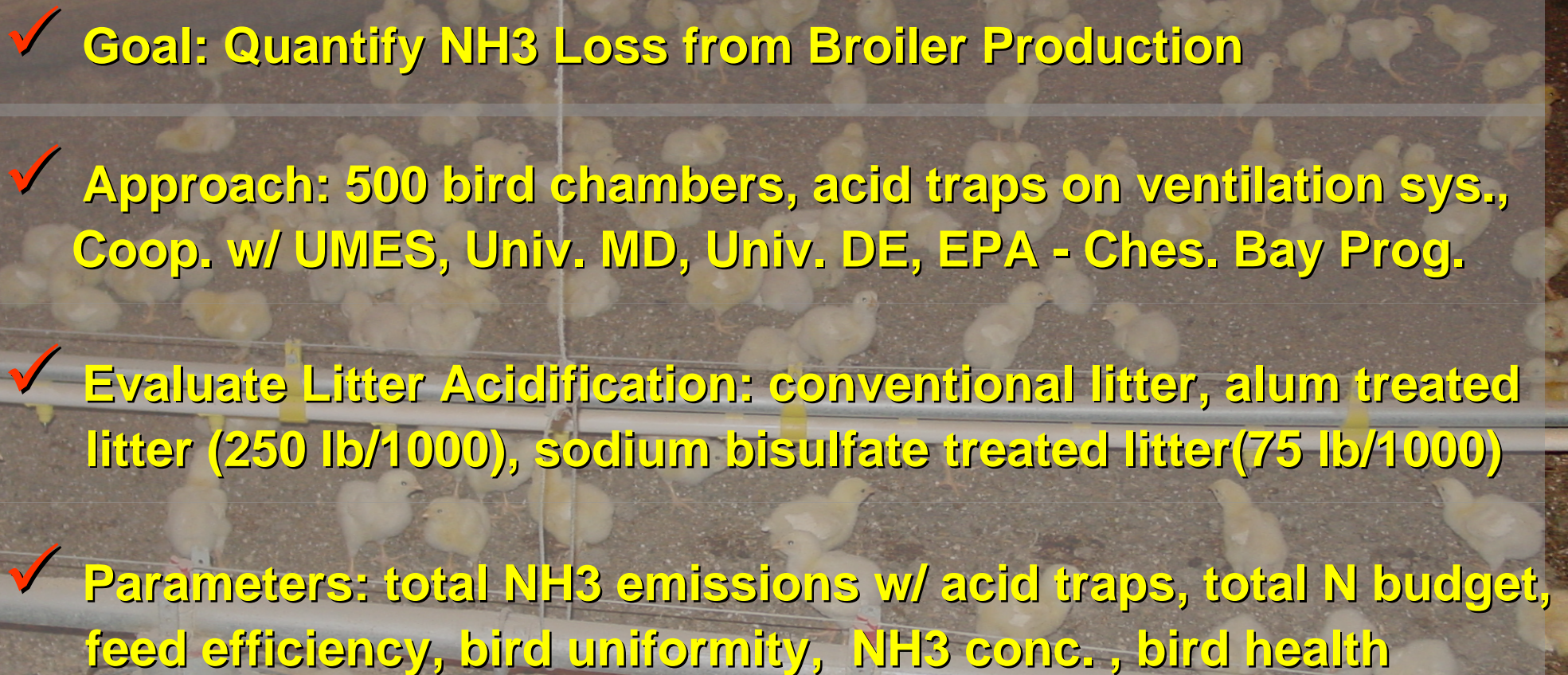
(Pain et al., 1998)



NH₃ Emissions from Poultry Grown in Tunnel Ventilated House, Arkansas

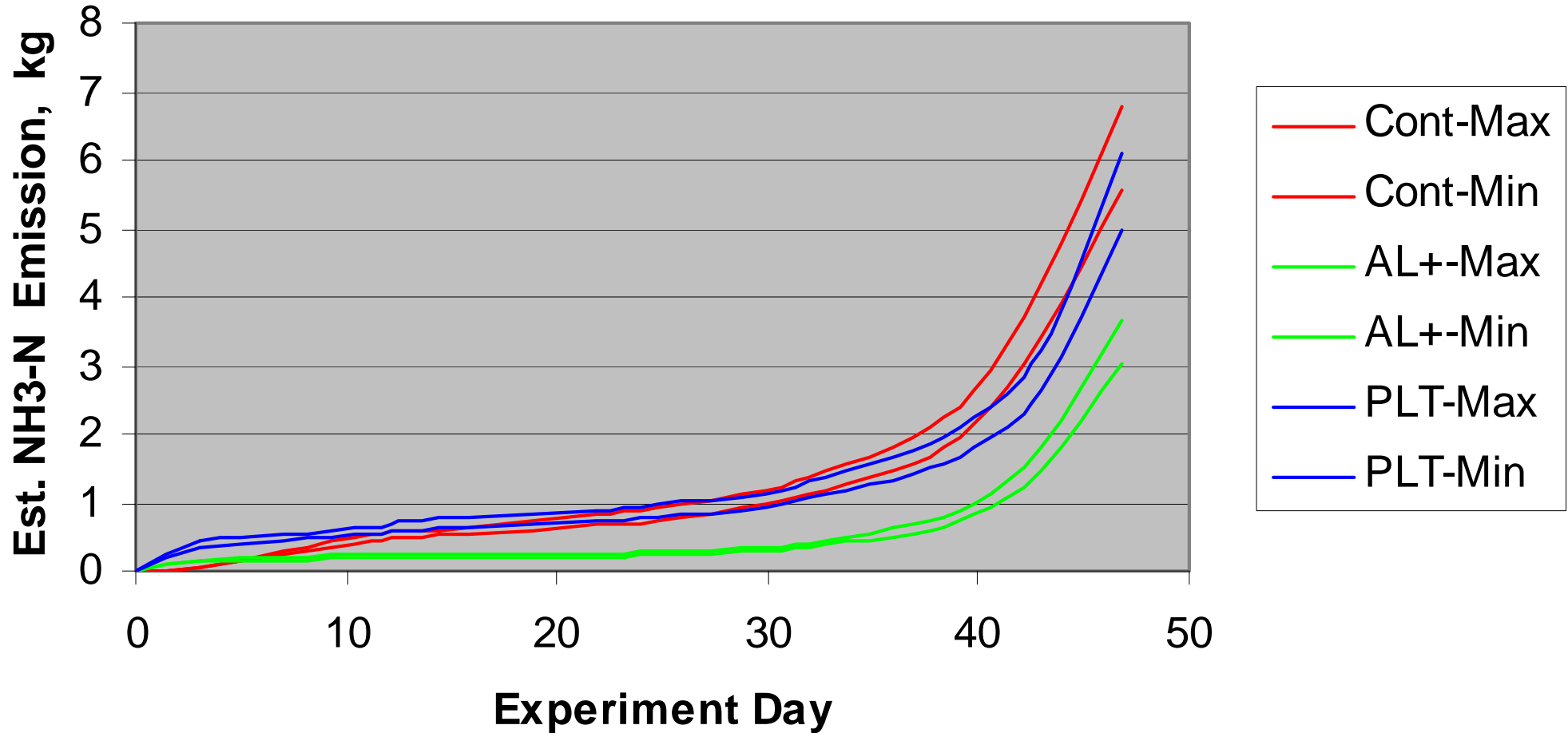
(Moore et al., 2010)



- 
- ✓ **Goal: Quantify NH₃ Loss from Broiler Production**
 - ✓ **Approach: 500 bird chambers, acid traps on ventilation sys., Coop. w/ UMES, Univ. MD, Univ. DE, EPA - Ches. Bay Prog.**
 - ✓ **Evaluate Litter Acidification: conventional litter, alum treated litter (250 lb/1000), sodium bisulfate treated litter(75 lb/1000)**
 - ✓ **Parameters: total NH₃ emissions w/ acid traps, total N budget, feed efficiency, bird uniformity, NH₃ conc. , bird health**

NH₃ Emissions, Broilers in MD, Side-wall Ventilation, after litter treatments

(Meisinger, Harter-Dennis, unpublished 2008)



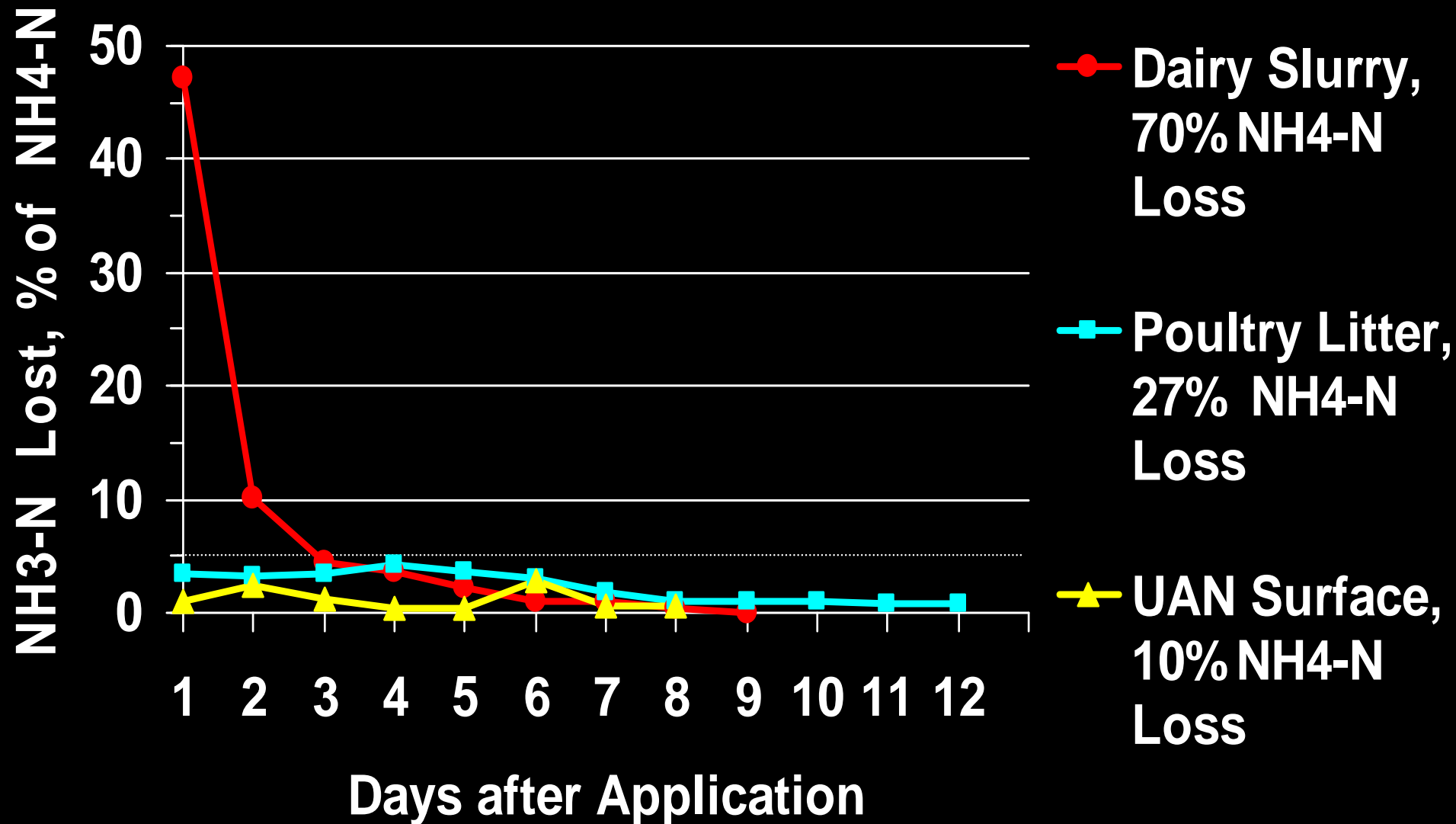


Ammonia Volatilization



Ammonia Losses from Manure Types or UAN Fertilizer over Time

(Thompson & Meisinger, 2000; Meisinger et al. 1999; McInnes et al. 1986)



NH₃ Losses from Land Application

(Meisinger & Jokela, 2000)

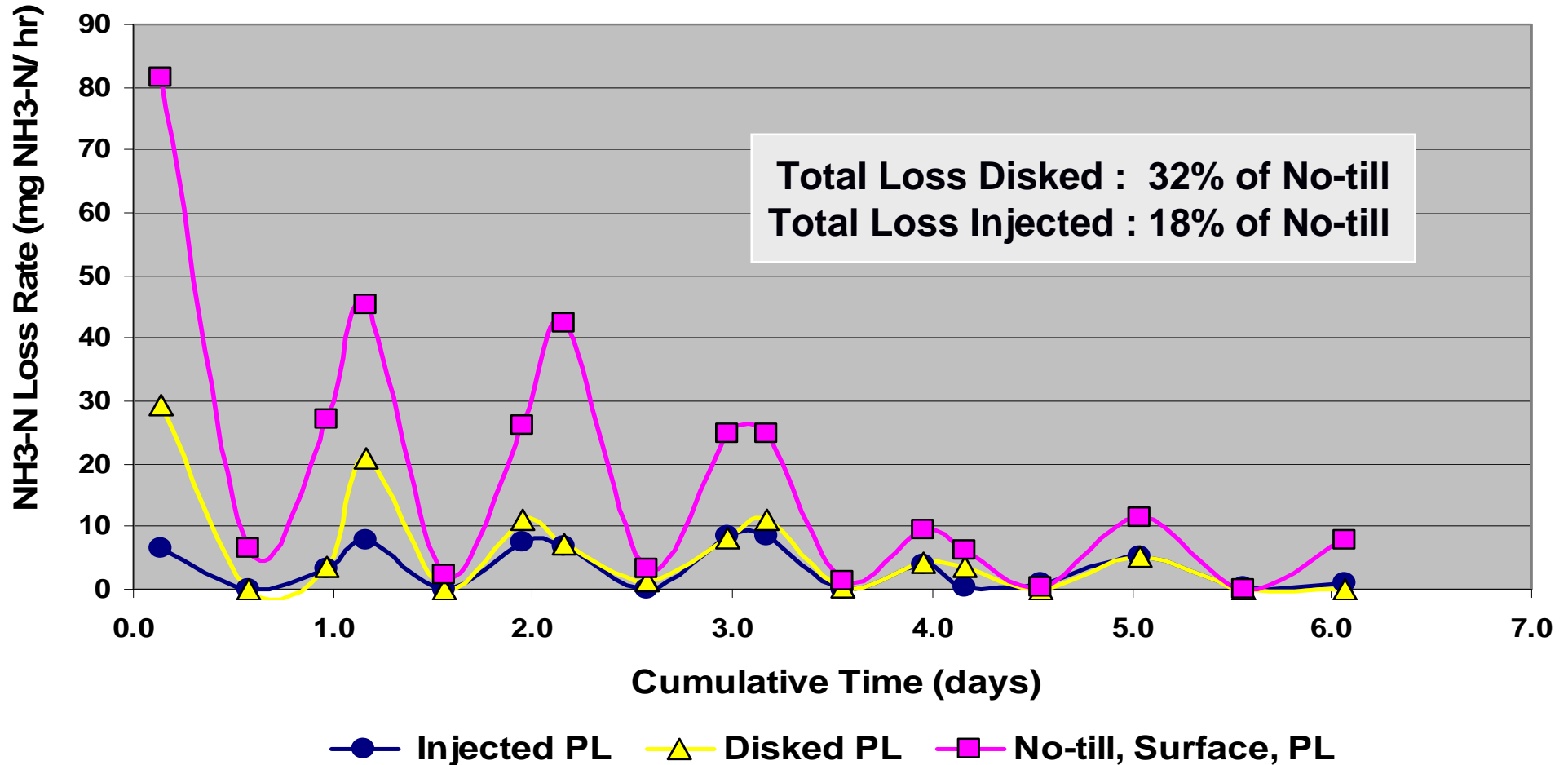
- **Ammonia losses affected by:**
 - ✓ **Manure characteristics** : TN, NH₄-N, % DM
 - ✓ **Application method**: sfc. vs. incorp. vs. band
 - ✓ **Weather conditions**: temp., wind, rainfall
 - ✓ **Soil properties**: infiltration, sfc. residues, CEC, pH

Ammonia Wind Tunnels



Tillage Effects NH₃ Loss, Poultry L., Wind Tunnels, 6 d

(Meisinger & Pote unpub. data 2008)



Question: What affect does tillage have on ammonia loss?



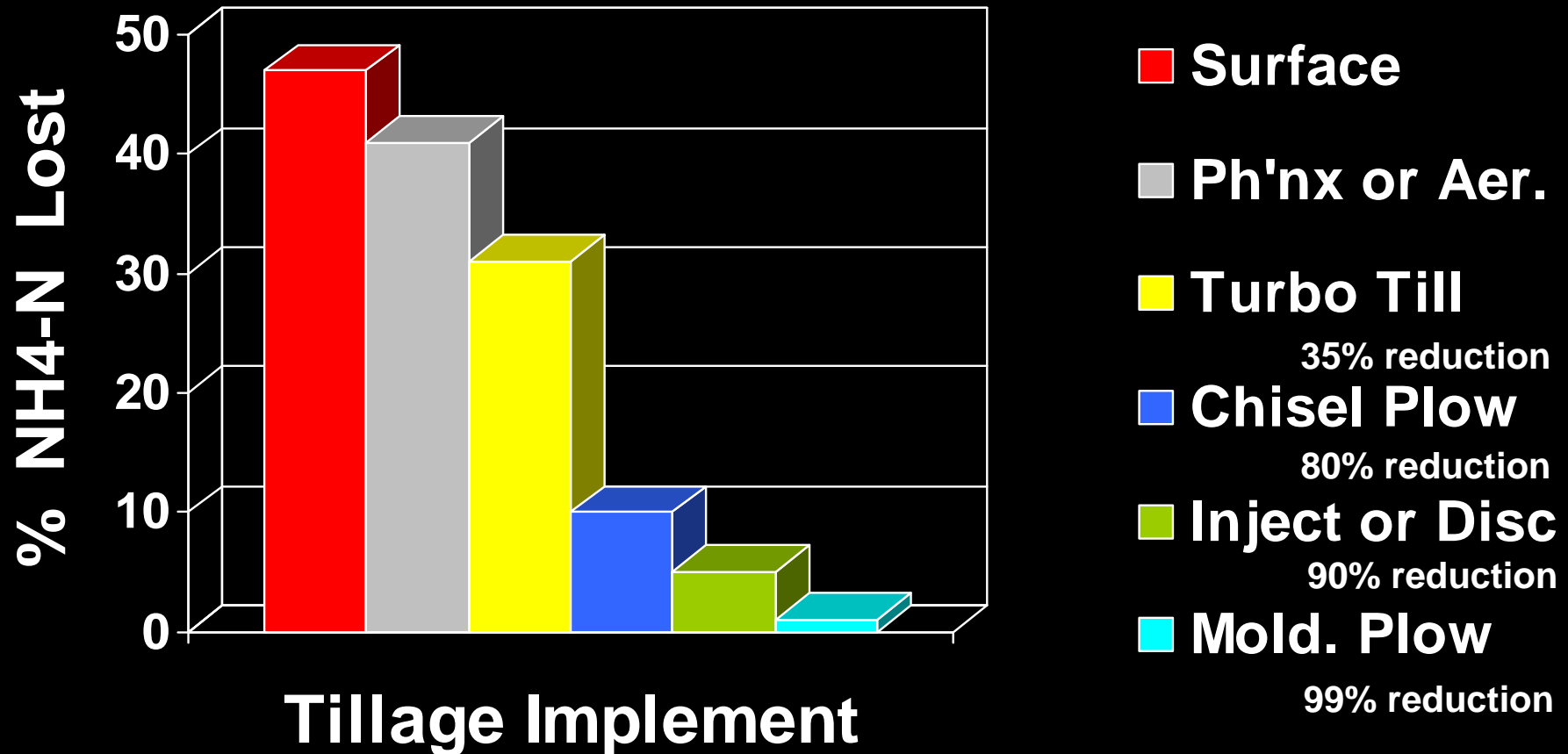
Poultry Litter Injector (Pote, 2008)



Tillage Effects on NH_3 Loss

Dairy Slurry, Wind Tunnels, 7d

(Thompson & Meisinger, 2001, Meisinger unpub. 2009)



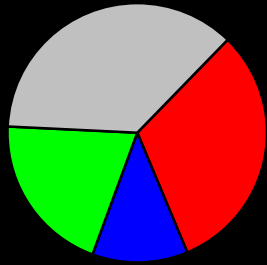
Question: Can NH_3 losses be managed in forage systems?



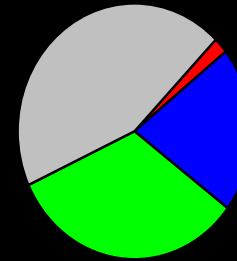
N Budget for Slurry Placement

(Thompson et al, 1987)

Sfc. Broadcast



Injected

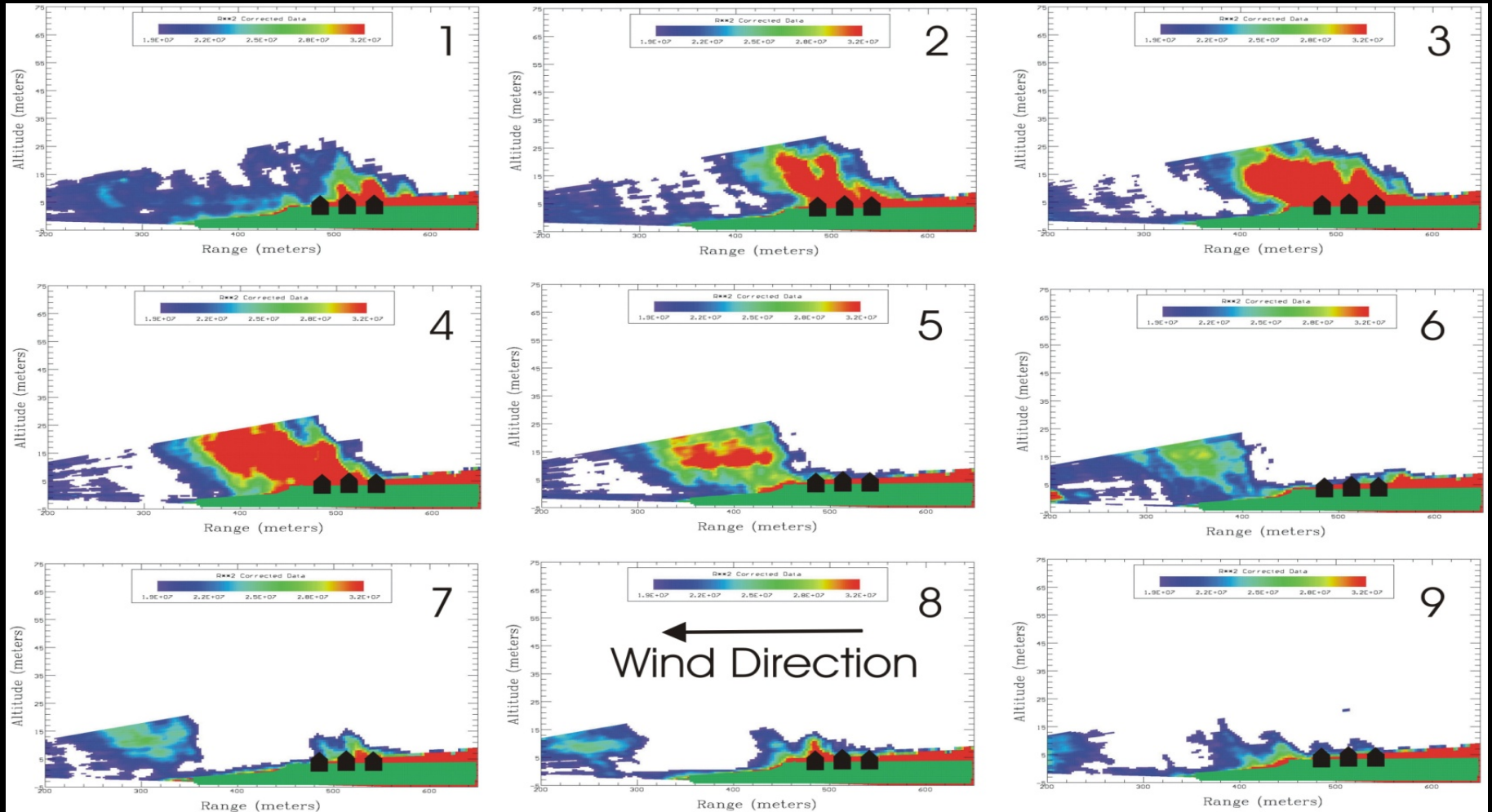


The Soil N Cycle is still at work
(lower NH₃ loss promotes > denitrification)

Question: What happens to the ammonia after it is volatilized?

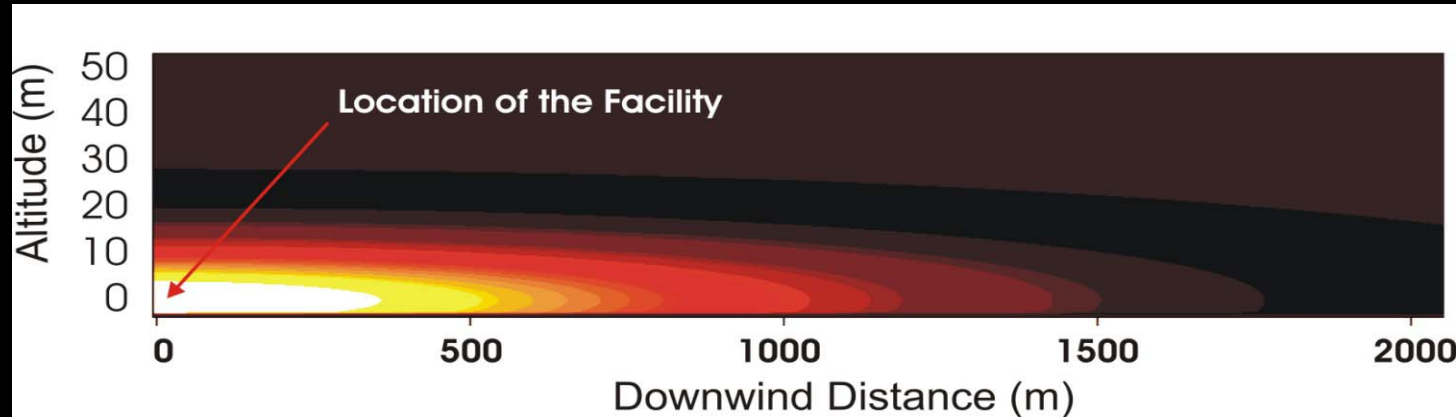
- 1) Atmospheric deposition within the Bay watershed**
 - 2) Atmospheric transport out of Bay watershed**
 - 3) Deposition & transport - but in what proportions?**
- Answer requires real-world data on the characteristics of Atmospheric Ammonia Dispersion**

Plume Dynamics over Time

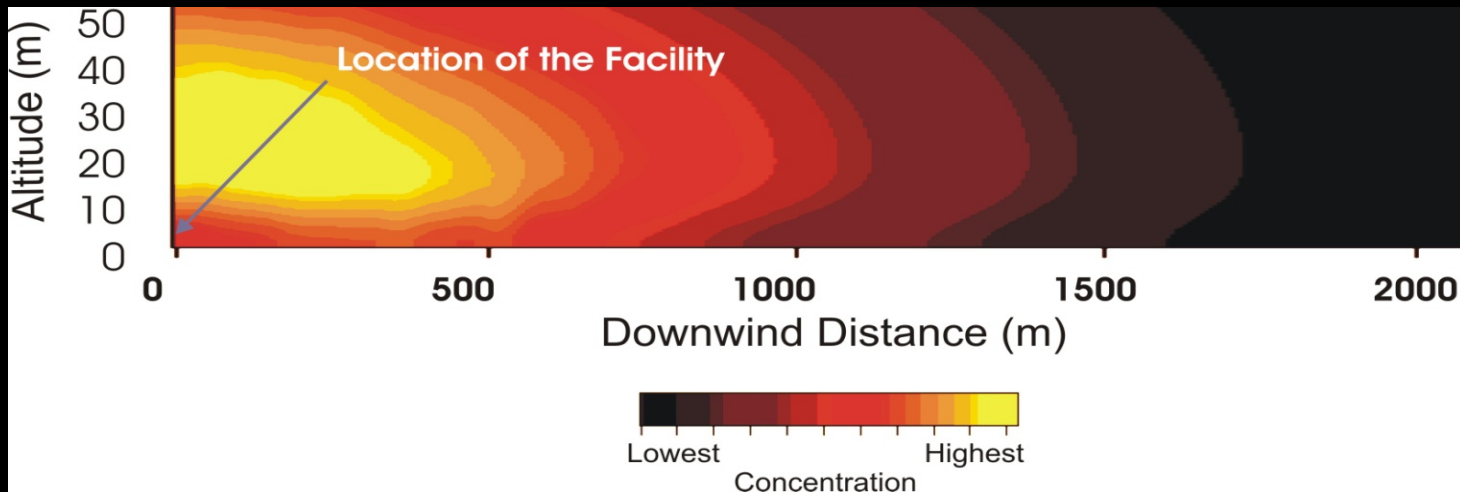


Each panel = a 9 second interval

Horizontal view of typical NH_3 Plume

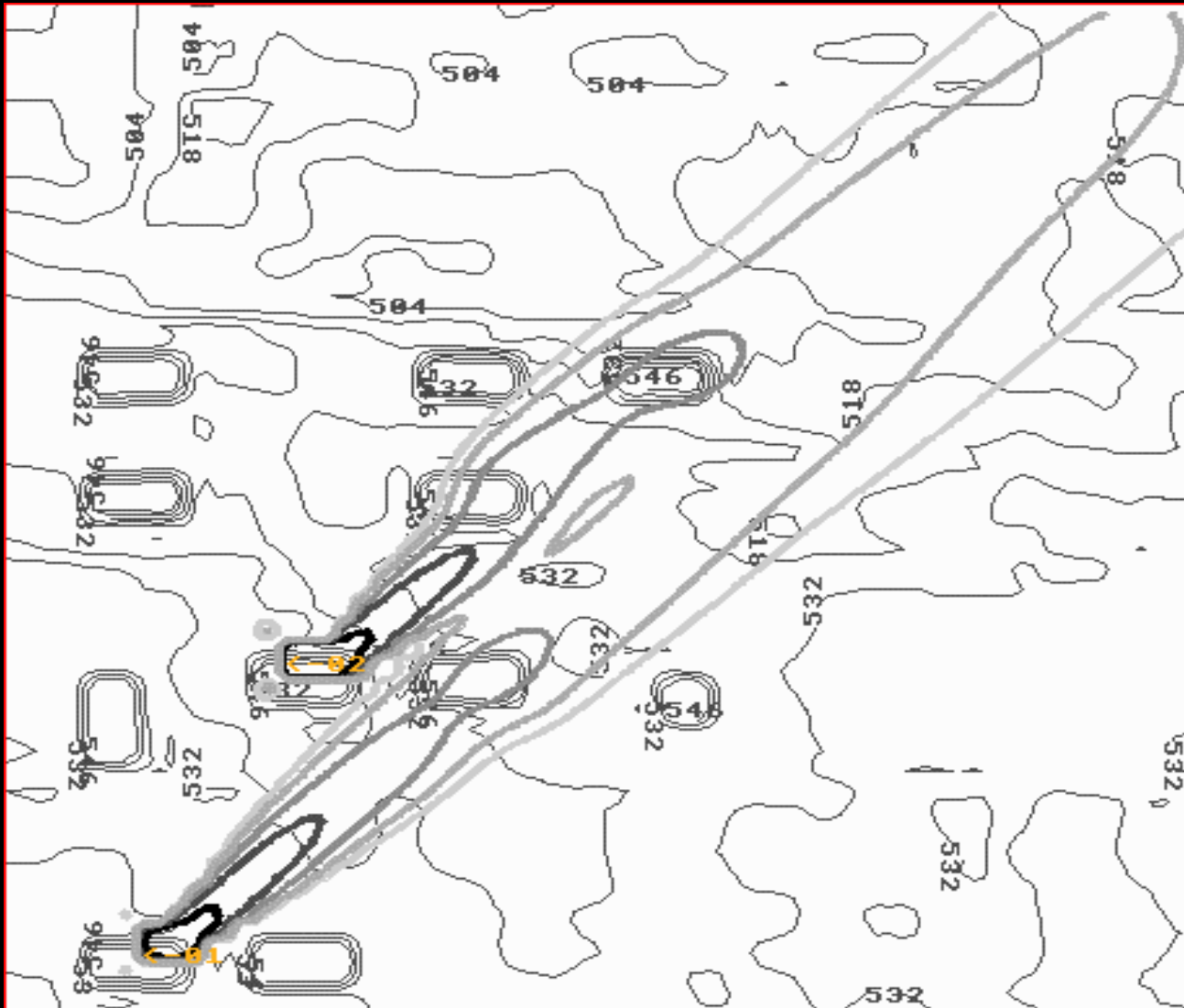


Conventional
Gaussian
Plume



Averaged
Lidar
Measurements

Atmospheric Dispersion



1000 m

RIMPUF Demonstrati
TIME: 11.11.1997
Wind Field:
dathrw

Contour Lines
E mg (*min) / m³
.10E+04 imair.h
.30E+03
.10E+03
.30E+02
.10E+02

Question: What happens to the ammonia after it is volatilized?

- 1) Atmospheric deposition within the Bay watershed**
 - 2) Atmospheric transport out of Bay watershed**
 - 3) Deposition & transport - but in what proportions?**
-
- Answer requires real-world data on the characteristics of Atmospheric Ammonia Dispersion.**
 - Answer: Estimate that 15-30% of NH₃ volatilized remains in Chesapeake Bay watershed, remainder out to N. Atlantic.**

Summary :

✓ **Ammonia Management Principles** are well known:

- **NH₃ losses can be large & will vary w/ source,**
Liq's. : 40 - 70% NH₄-N (20 - 35% TN) w/ in 1-3 days
P. Lit. : 20 - 40% NH₄-N (5 -10% TN) w/ in 7 days
- **Balance NH₃ cons. (low residues) w/ erosion control (hi residues)**
Injection lowers NH₃ loss & preserves residues, but slows appl'n.
- **NH₃ losses highly variable, e.g. 5 - 75% NH₄-N**
depending on: manure type, applic'n. method, weather, soil

✓ **Monitor w/ PSNT:** check N sufficiency (NH₃ loss, leaching, etc.)

Short-term and Long-term Needs

- **Short-term Implementation needs:**
 - Expand use of manure injection, or high-residue soil tillage implements
 - Expand use of litter acidification agents in poultry houses
 - Expand low crude protein diets to reduce ammonia losses in dairies
- **Long-term Implementation needs:**
 - Research and develop non-litter flooring for broilers
 - Research fate & transport of atmospheric NH_3 in the Bay air-shed
 - Research and develop practices to minimize nitrous oxide (N_2O) losses from injected manure

Questions ?