

US & European Ammonia Monitoring & Mitigation

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What do we know?

Notes from the European experience

European Approach to Air Quality

- "Directives to reduce the burden on the environment will lead to extra costs for the poultry farms."



Europe: Environment and Welfare

- Directives on welfare in addition to environmental legislation.
- "These regulations on welfare will result in a higher emission of ammonia. Also the consumption of energy will be higher. And this will effect the possibility of reaching the aim on reduction of greenhouse gases."

H.H. Hilko, 2004



Emission Measurement Variation from Animal Housing

Standard Deviation of Ammonia Emissions

Sources of Variation	Fattening Pigs	Sows
Between Farms	44%	32%
Within Farm	45%	23%

“These large deviations make it difficult to differentiate between different low-emission housing systems.”

Mosquera and Ogink, 2004



Emission Measurement Variation from Animal Housing

- "Measurements on more farms would be preferred rather than increasing the measurements in a particular farm or improving the accuracy of the measurement equipment in order to arrive to a more accurate emission measurement."

Mosquera and Ogink, 2004





Where are we?

USA ammonia emission values

Concentrate on Poultry

- Poultry largest current USA ammonia emission database

Example Emissions Data

- NOT comprehensive
- Selected due to recent collection in modern US or European commercial poultry houses
- Refer to references on final slides

USA CERCLA and Clean Air Act Regulatory Limits

For each farm, sum of all houses

Particulate Matter (PM ₁₀)	100 ton/yr
if hazardous air pollutant (HAP)	25 ton/yr
non-attainment area state limits	
Hydrogen Sulfide (H ₂ S)	100 lb/day
Ammonia (NH ₃)	100 lb/day

- These compounds national and global air pollution
- Odor a Local Concern

Ammonia Emissions above CERCLA 100 lb/d limit

- Current practices put many poultry houses > 100 lb/d
- 30,000 bird broiler house
 > 1.5 g/bird/d
- 100,000 hen layer house
 > 0.45 g/bird/d

22 Poultry House Study

Ammonia Data Collection & QA/QC

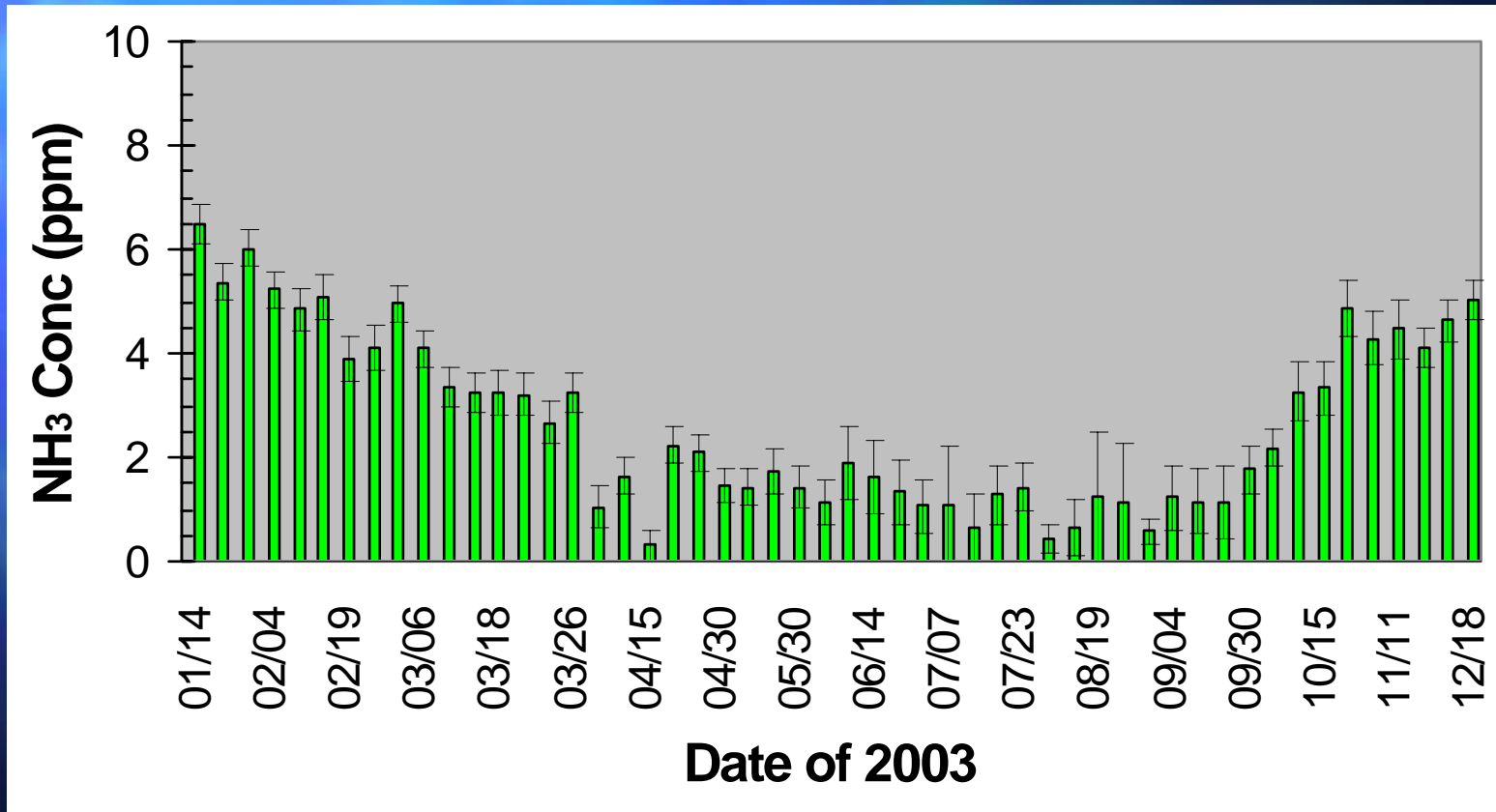
- Data collected weekly or bi-weekly for at least one year
- Each collection episode/visit, at least 2-day continuous (30-s) measurements
- Electrochemical instruments calibrated and checked before and after each collection episode/visit



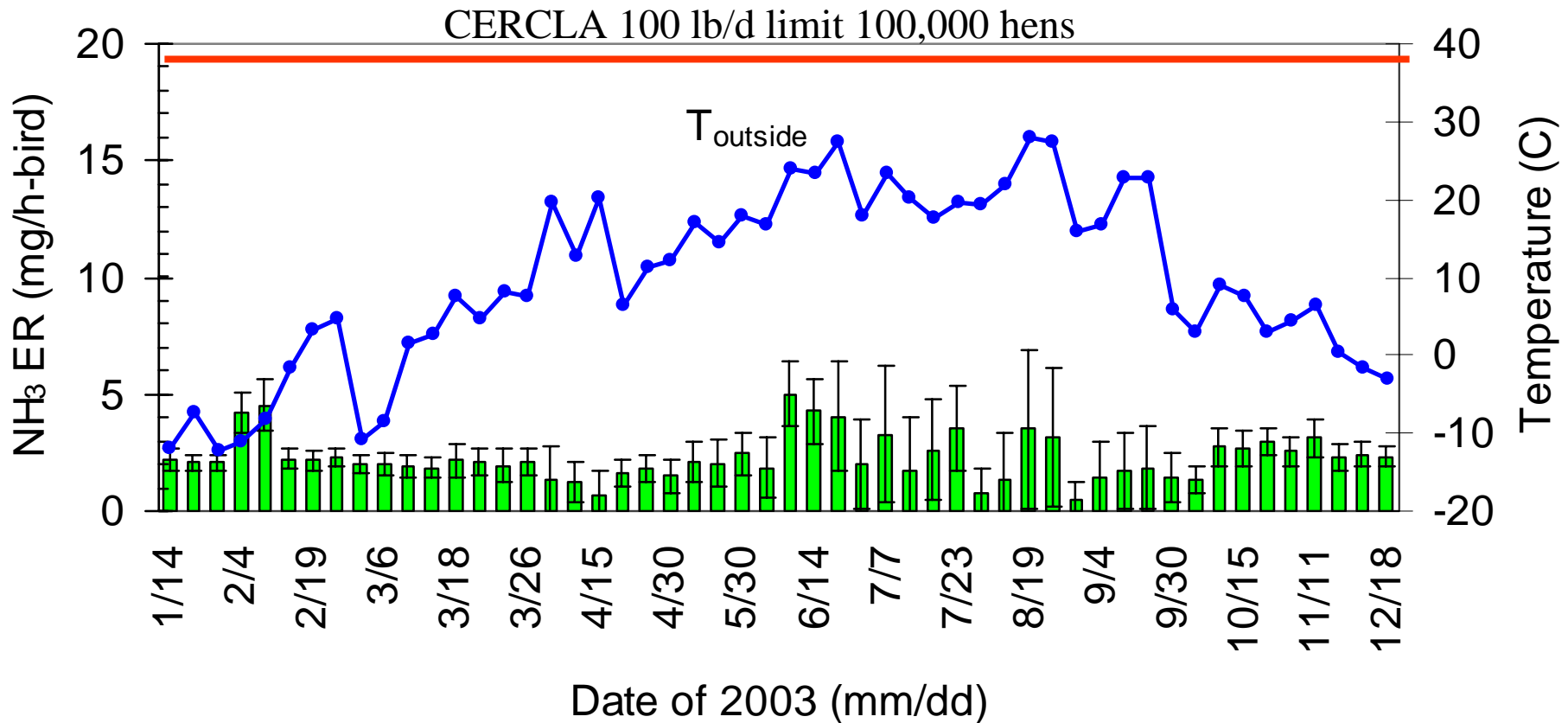
Manure Belt Layer Houses

From Liang et al. 2003 and Xin et al. 2004

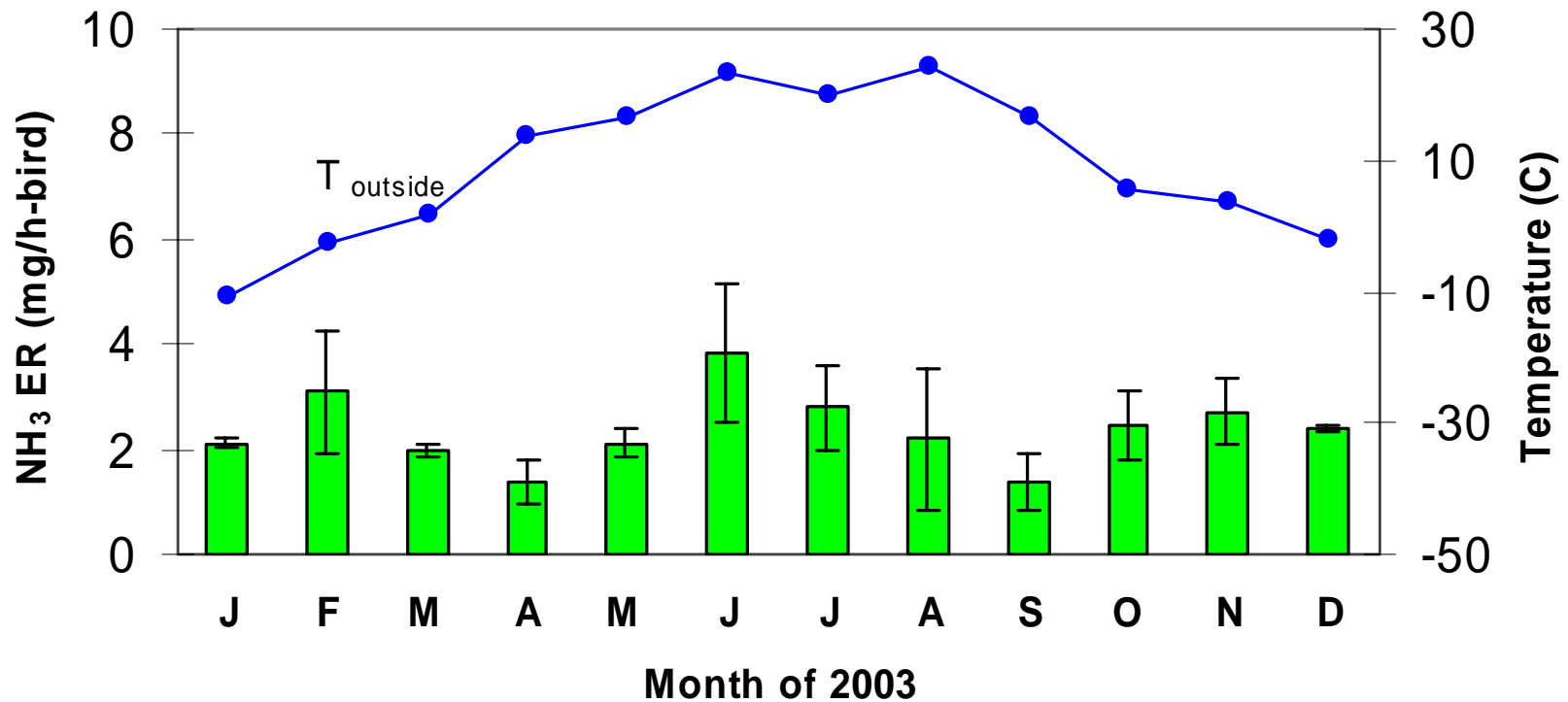
Daily NH₃ Concentration of Belt Houses



Daily NH₃ Emission Rate of Manure Belt Layer Houses



Monthly NH₃ Emission Rate of Manure Belt Layer Houses

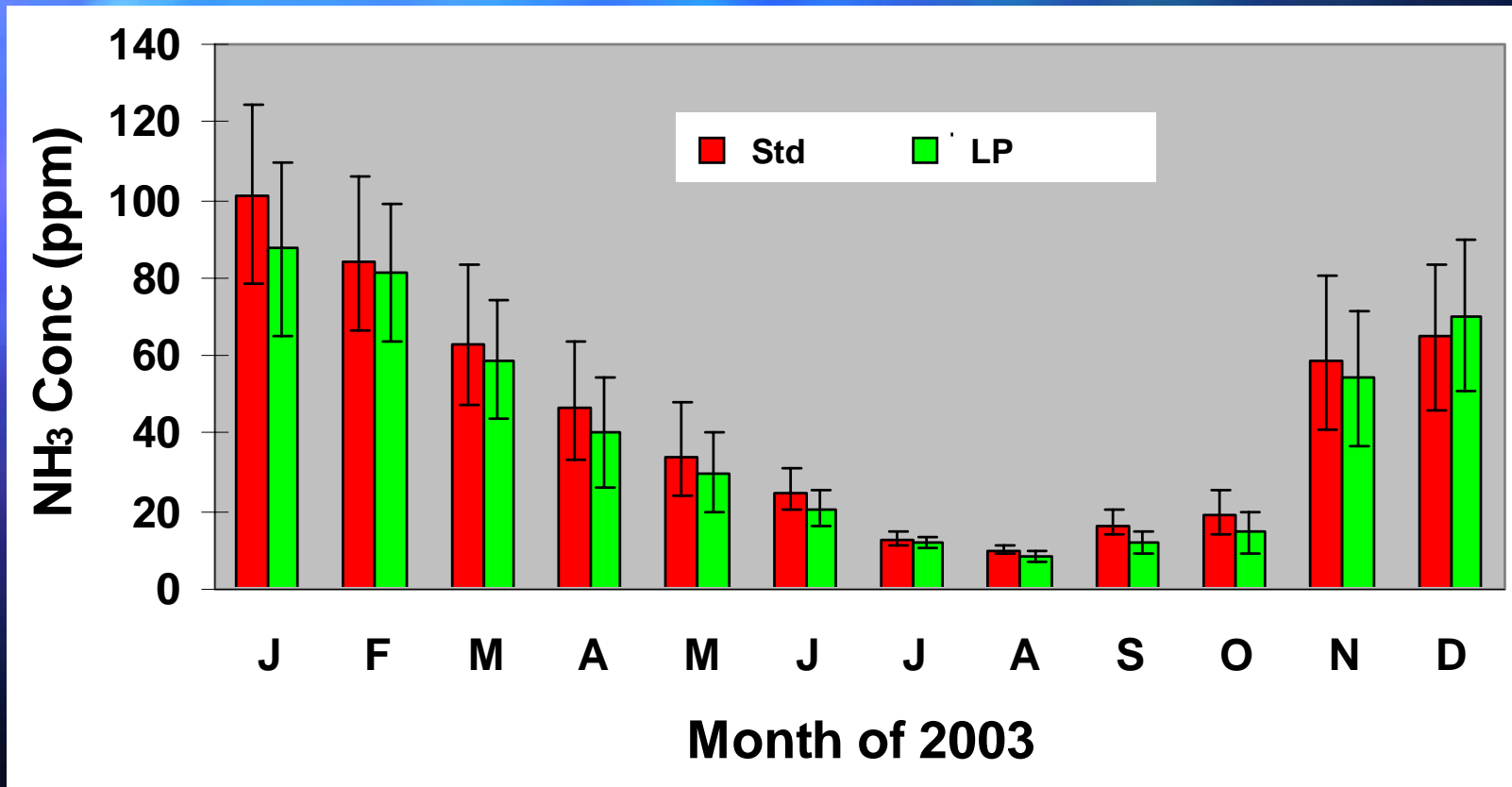




High-Rise Layer Houses

From Liang et al. 2003 and Xin et al. 2004

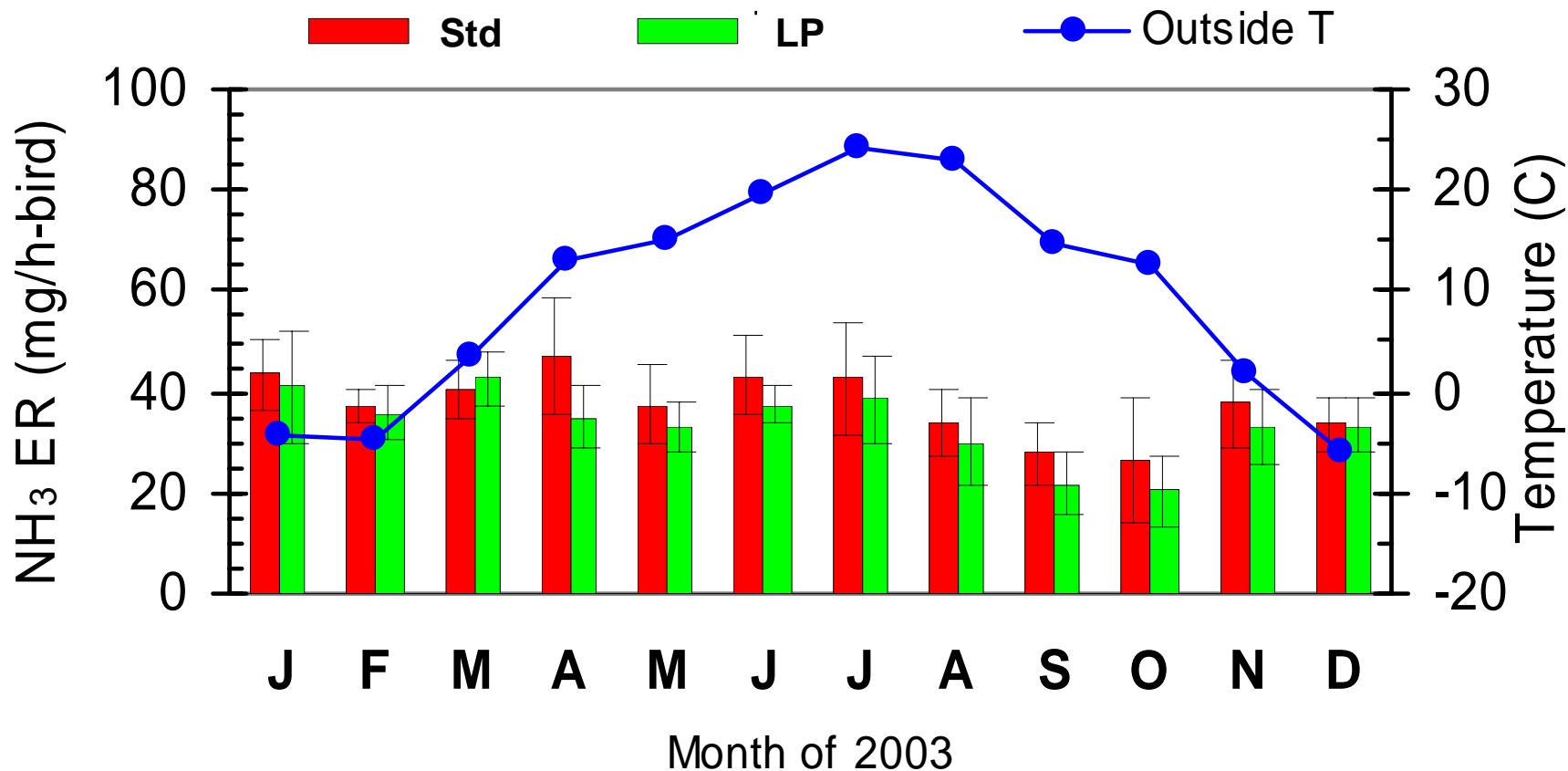
Monthly NH₃ Concentration of Exhaust Air in High-Rise Houses



Std = standard diet

LP = low protein diet; 1% less protein + supplemental amino acids

Monthly Mean NH₃ Emission Rates of High-Rise Houses



Std = standard diet

LP = low protein diet; 1% less protein + supplemental amino acids

Summary of Ammonia Emission Rate from Layer Houses in Iowa

House Type	NH ₃ ER (g/d-hen)	
High-Rise	Standard Diet	Low Protein Diet
	0.90 (0.24-1.58)	0.80 (0.19-1.37)
Manure Belt	0.06 (0.003-0.15)	

CERCLA NH₃ threshold = 0.45 g/hen-d

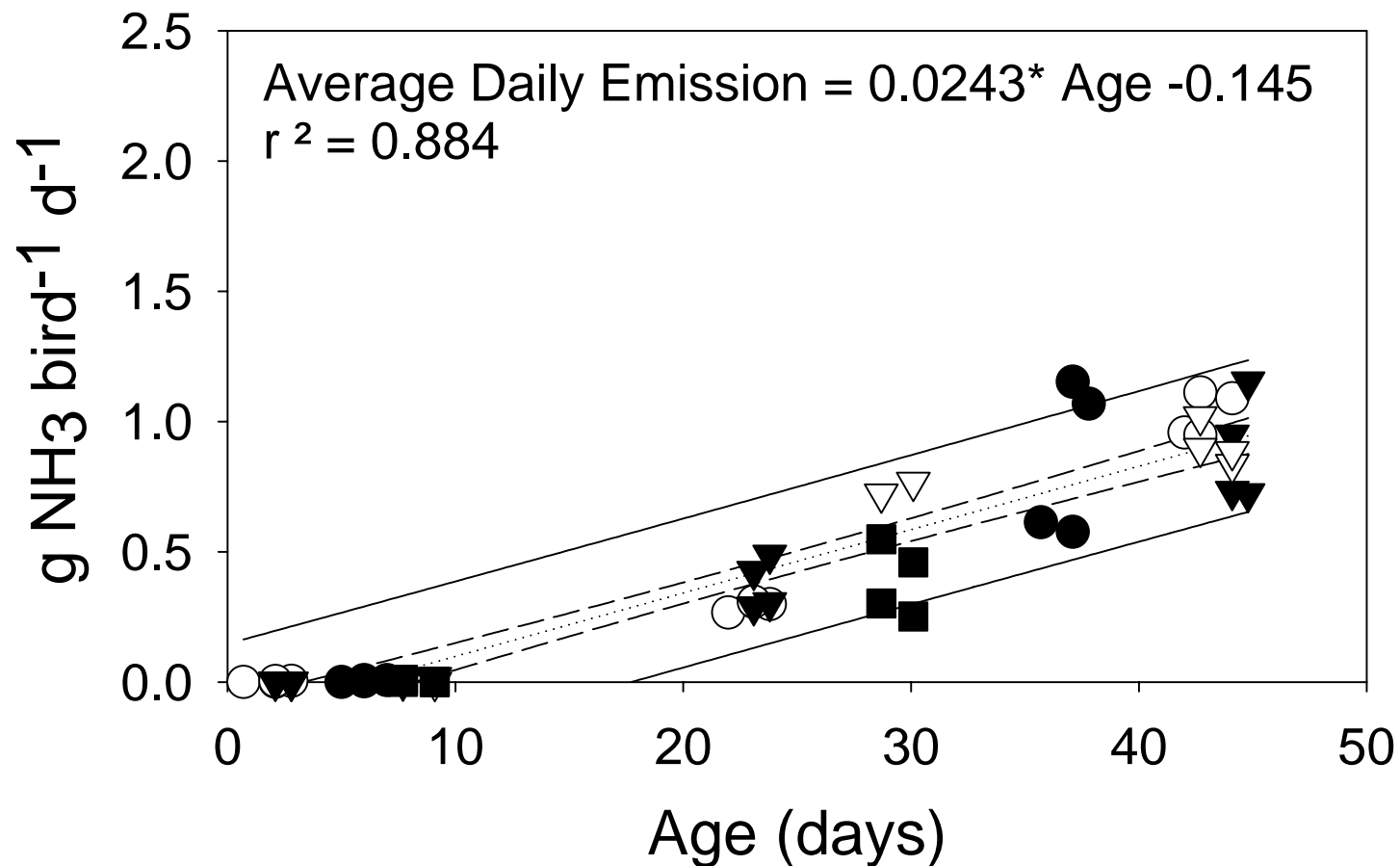
From Liang et al. 2003 and Xin et al. 2004

Literature

Layer Ammonia Emission Rates

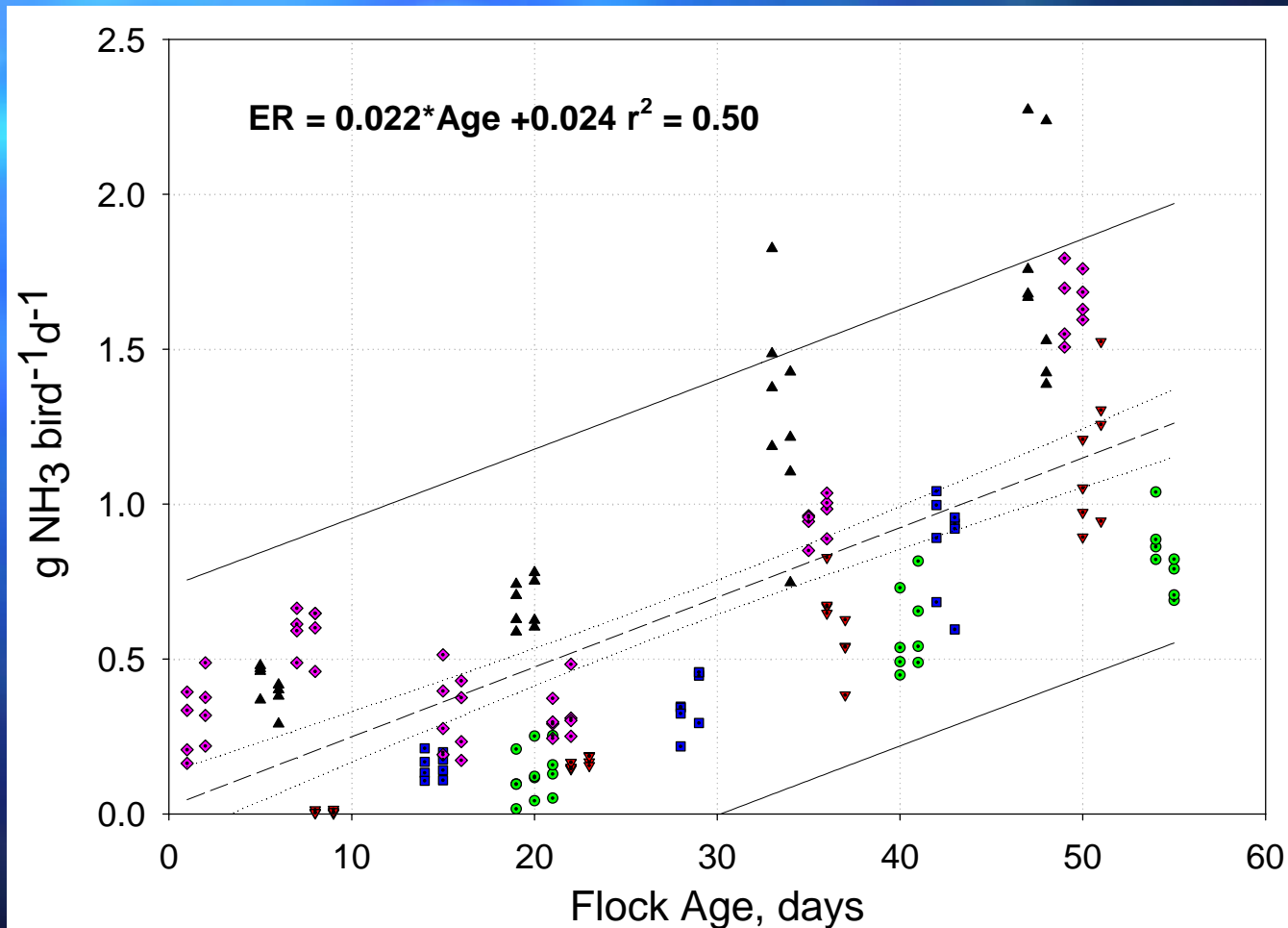
Housing	Season	g NH ₃ /(d-AU)	Reference
Belt Cage & Hi-Rise	All Year	311 (77- 578)	Xin et al. (2004) USA
Cage	Winter	192	Wathes et al. (1997) Europe
	Summer	300	
Belt Cage	Winter	14 - 223	Groot Koerkamp et al. (1998) Europe
Litter and Belt Cage	Spring	178 - 262	

Broiler Ammonia Emission New Litter Houses

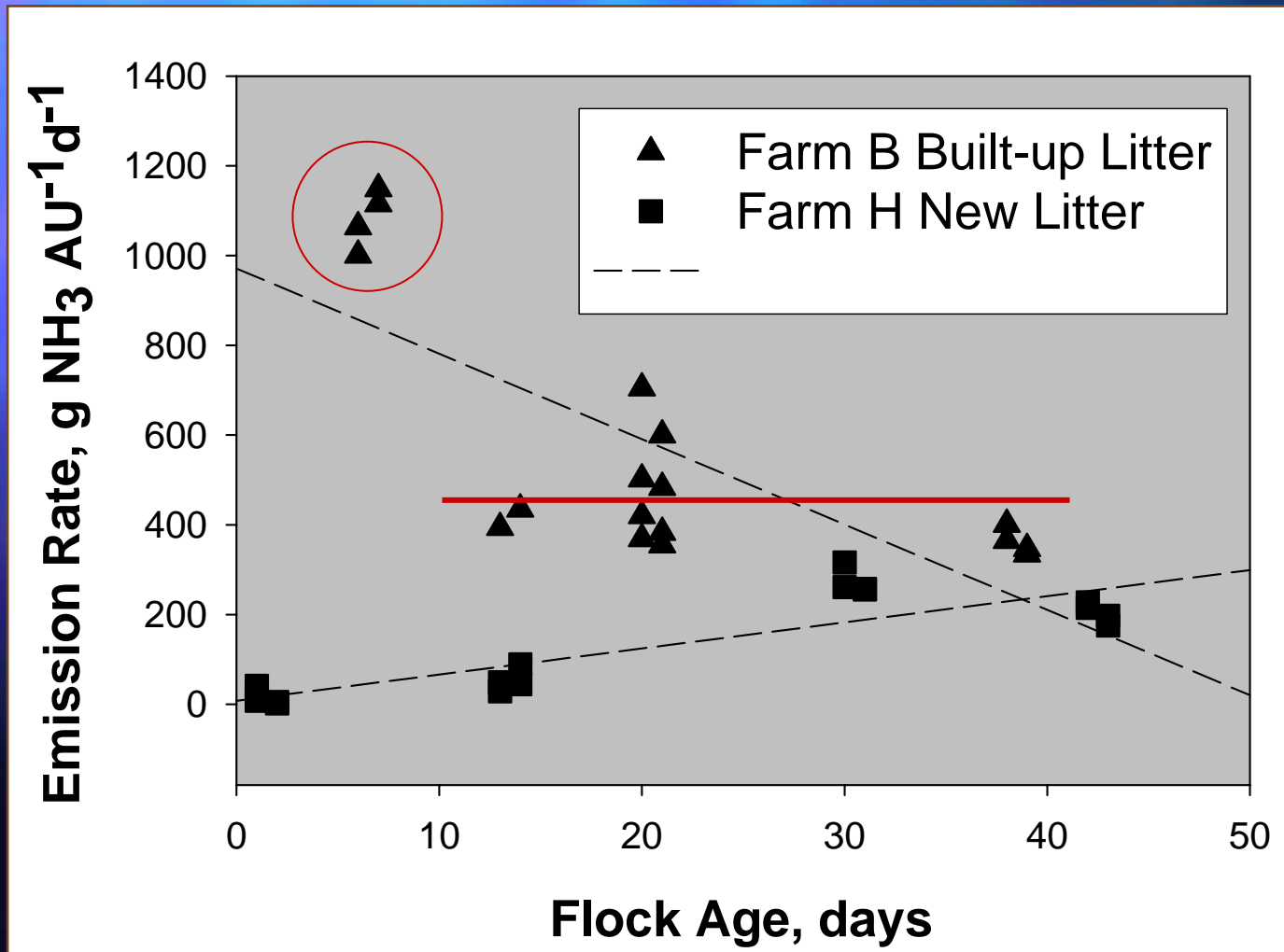


PA data

Broiler Ammonia Emission Built-Up Litter Houses



Broiler Ammonia Emission per Animal Unit



Animal Unit (AU)
= 500kg

Literature

Broiler Ammonia Emission Rates

Litter	Season	g NH ₃ /(d-AU)	Reference
Built up	All Year	100-700* *1000-2000 under 10 d old	Casey et al. 2004 USA
New	All Year	0-200	Wheeler et al. 2004 USA
Unreported	Winter	216	Wathes et al. (1997) Europe
	Summer	216	
Unreported	Litter	53 – 199	Groot Koerkamp et al. (1998) Europe

New Litter typical in Europe

Ammonia Conclusions

- Houses where manure is removed frequently, such as layer belt houses and broilers on new litter, emit much less ammonia than when manure is stored with birds.
- Manure storage contributes to whole farm emissions. Opportunity to manage aggressively and separately from bird environment.

Ammonia Conclusions

- Reduced protein layer diet reduced NH_3 emission (1% less protein + aa resulted in about 10% ammonia reduction).
- Broiler house emissions near CERCLA 100 lb/d reporting limit near end of production cycle.
- High-rise layer house of 100,000 birds will be over CERCLA limit most days. Belt house of 200,000 birds rarely over limit.

Summary

- Emission reduction requirements will challenge poultry industry to change production practices and manure management
- Whole farm and whole environment strategy will allow more effective nutrient management to reduce emissions.

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Meeting CERCLA Reporting

