

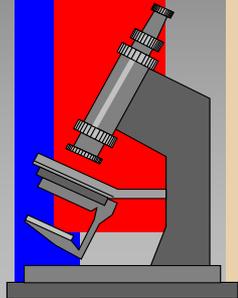
GHG Measurements at Livestock Farms

House Committee on Science and Technology

Albert J. Heber, Professor
heber@purdue.edu

www.AgAirQuality.com

*Purdue Agricultural Air
Quality Laboratory*



*Agricultural and
Biological Engineering*



Purdue University



Air Emissions from Livestock

- ***Odor***
- ***Ammonia***
- ***Hydrogen sulfide***
- ***Particulate matter (TSP, PM₁₀, PM_{2.5})***
- ***Greenhouse gases (CO₂, CH₄, N₂O)***
- ***Volatile organic compounds (VOC)***

GHG Sources from Animal Ag

➤ Methane

- *Enteric fermentation (beef 72% dairy 23% swine 2%)***
- *Anaerobic decomposition of manure.***

➤ Nitrous oxide

➤ *Direct:*

- *Nitrification/denitrification of organic N in manure***

➤ *Indirect:*

- *Ammonia and NOx volatilization and***
- *Runoff and leaching of nitrogen during treatment, storage and transportation.***

➤ Carbon dioxide

- *Anaerobic digestion of manure***
- *Animal respiration***

GHG Emissions from Animal Agriculture

- ***U.S. agriculture emits 6.4% of total US GHG emissions (FAO, 2006)***
- ***Animal agriculture emits 2.5% of total US GHG emissions (EPA, 2008)***

Potential GHG Mitigation by Animal Agriculture

- ***Improve production efficiency. For example, the average milk yield per cow increased from 2,074 kg/year in 1944 to 9,193 kg/yr in 2007 resulting in 1/3 lower carbon footprint***
- ***Methane utilization***
- ***Compost management***
- ***Apply manure to land agronomically***
- ***Diet modification***

Increasing Knowledge about Emissions

- **Laboratory studies**

- *Kinetics and process dynamics*
- *Controlled tests of abatement ideas*



- **Field studies**

- *Baseline source emission rates*
- *Emission characteristics*
- *Demonstrations of abatement methods*
- *Ambient downwind concentrations*



- **Scientific emission models**

- *Process-based*
- *Component emissions, e.g. barns, manure storage, etc.*
- *System models (show tradeoffs and consequences)*

- **Regulatory models**

- *Often shaped by untimely political and societal pressures*
- *Marked by simplicity, unfairness, arbitrariness, and inaccuracy!*
- *Can be influenced by scientific knowledge in a positive way.*

- **Multi-state and interdisciplinary research and education**

National Air Emission Monitoring Study

➤ Objectives

- Quantify air emissions from livestock production.
- Provide reliable data for developing and validating barn and lagoon emission models.
- Promote national consensus on methods of measuring, calculating, & reporting emissions.



Approach

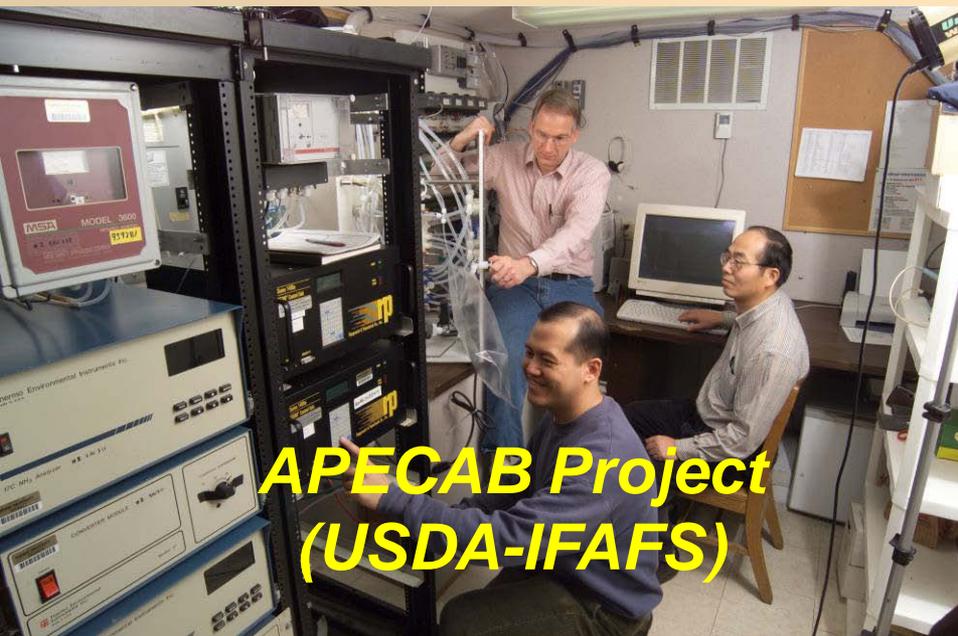
- **Barns (38) monitored continuously at 15 sites**
 - **Hydrogen sulfide (pulsed fluorescence)**
 - **Ammonia (photoacoustic spectroscopy)**
 - **Methane and non-methane HC (GC-FID) (2 sites)**
 - **Methane (photoacoustic spectroscopy) (5 sites)**
 - **Carbon dioxide (photoacoustic spectroscopy)**
 - **TSP, PM_{2.5}, PM₁₀ (TEOM)**
- **Open sources (9 lagoons and 1 corral) tested quarterly**
 - **Hydrogen sulfide (pulsed fluorescence with S-OP).**
 - **Ammonia (TDLAS, photoacoustic spectroscopy)**
 - **Methane (photoacoustic spectroscopy) 1/3 of time**

Control of Air Pollutant Emissions from Swine Housing CAPESH (funded by EPA and Premium Standard Farms)

Barn emission projects '01-'04



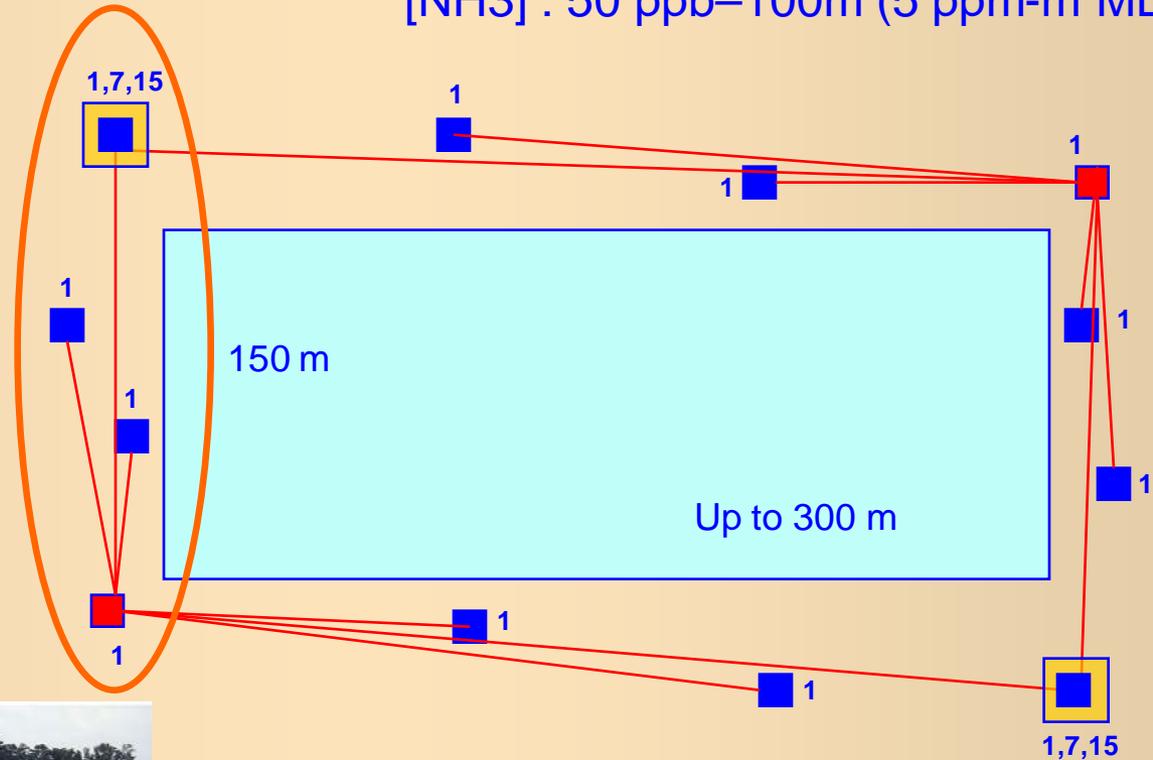
- Mechanically ventilated livestock buildings
- Continuous emission monitoring (source)
 - Multiple gas sampling points
 - Gases (NMHC, CH₄, NH₃, H₂S, traces)
 - PM₁₀, TSP, PM_{2.5}
- Grab samples (bags, traps, filters)
- Reliable emission measurements



NH₃ Measurements: TDLAS



[NH₃] : 50 ppb–100m (5 ppm-m MDL)

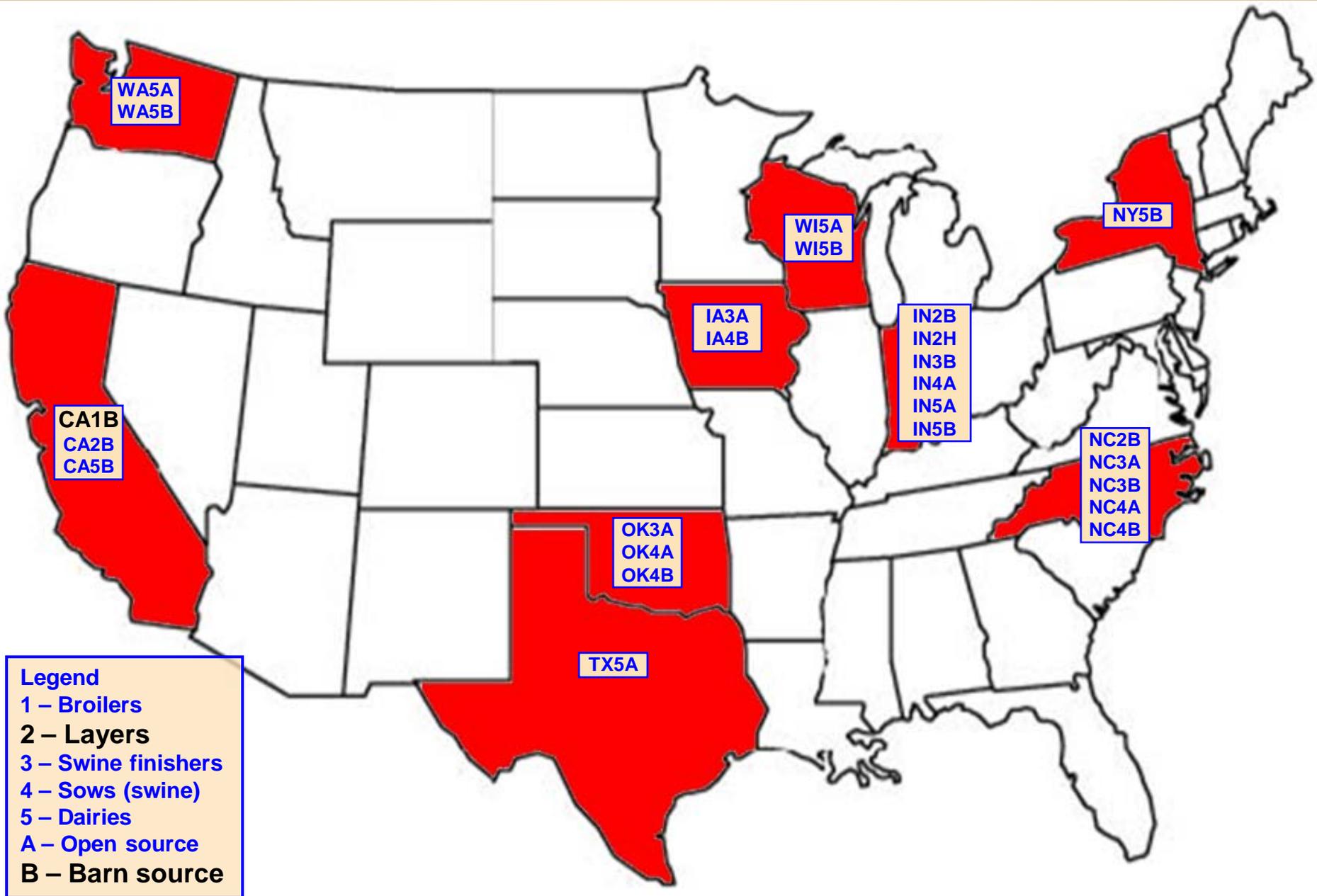


TDLAS reflector ■

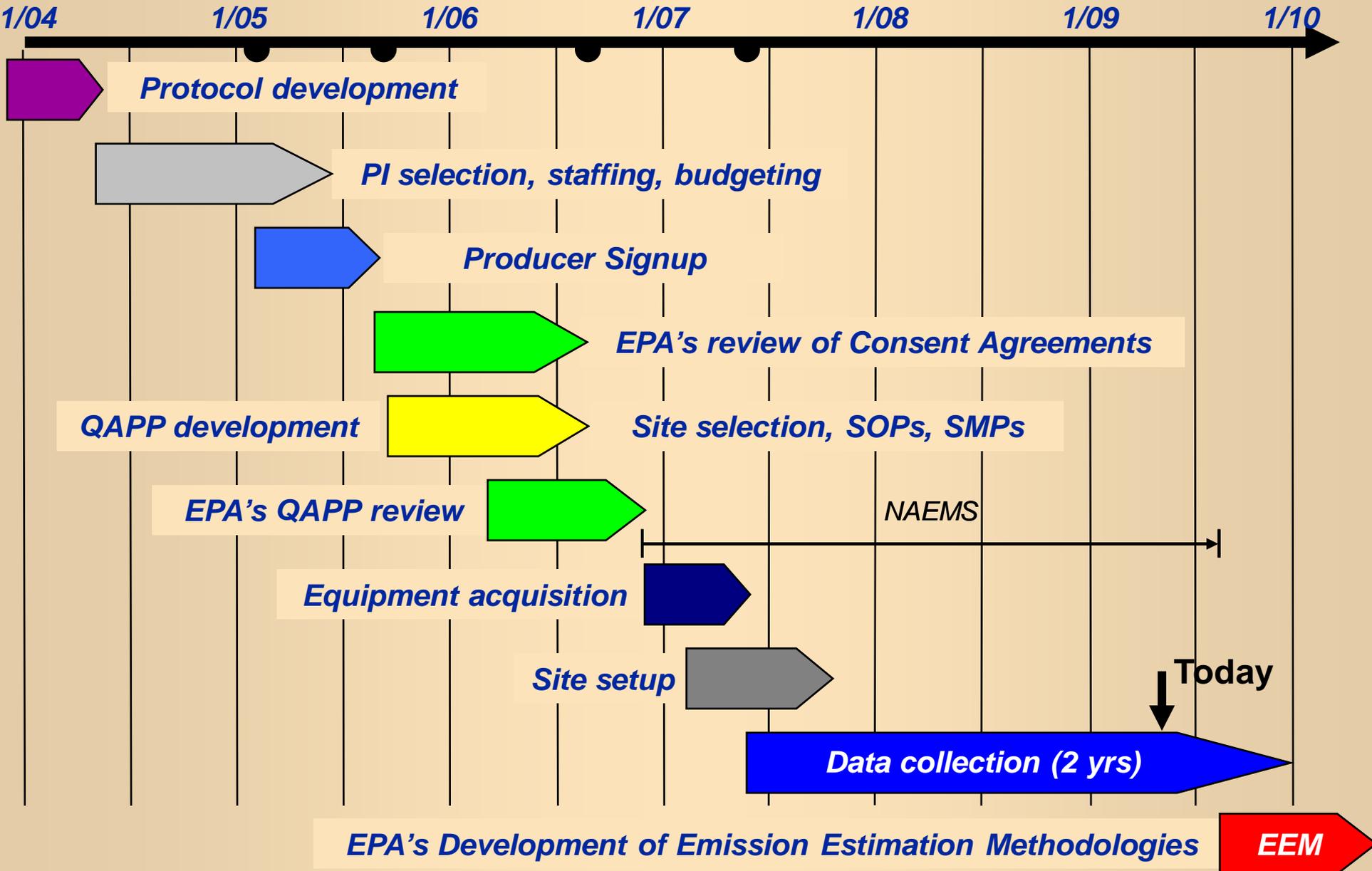
TDLAS ■

Source: Dr. Rich Grant, Purdue University, April, 2008

NAEMS Monitoring Sites



NAEMS Timeline



Using the NAEMS Infrastructure

- *Continue emission monitoring using NAEMS infrastructure and expertise.*
- *Refine GHG measurement methods.*
- *Validate of GHG emission models.*
- *Measure all sources on the farm.*
- *Test mitigation strategies.*

