Field Evaluation of DDGS Diet, Alum Manure Additives, and BMPs to Reduce Ammonia Emissions

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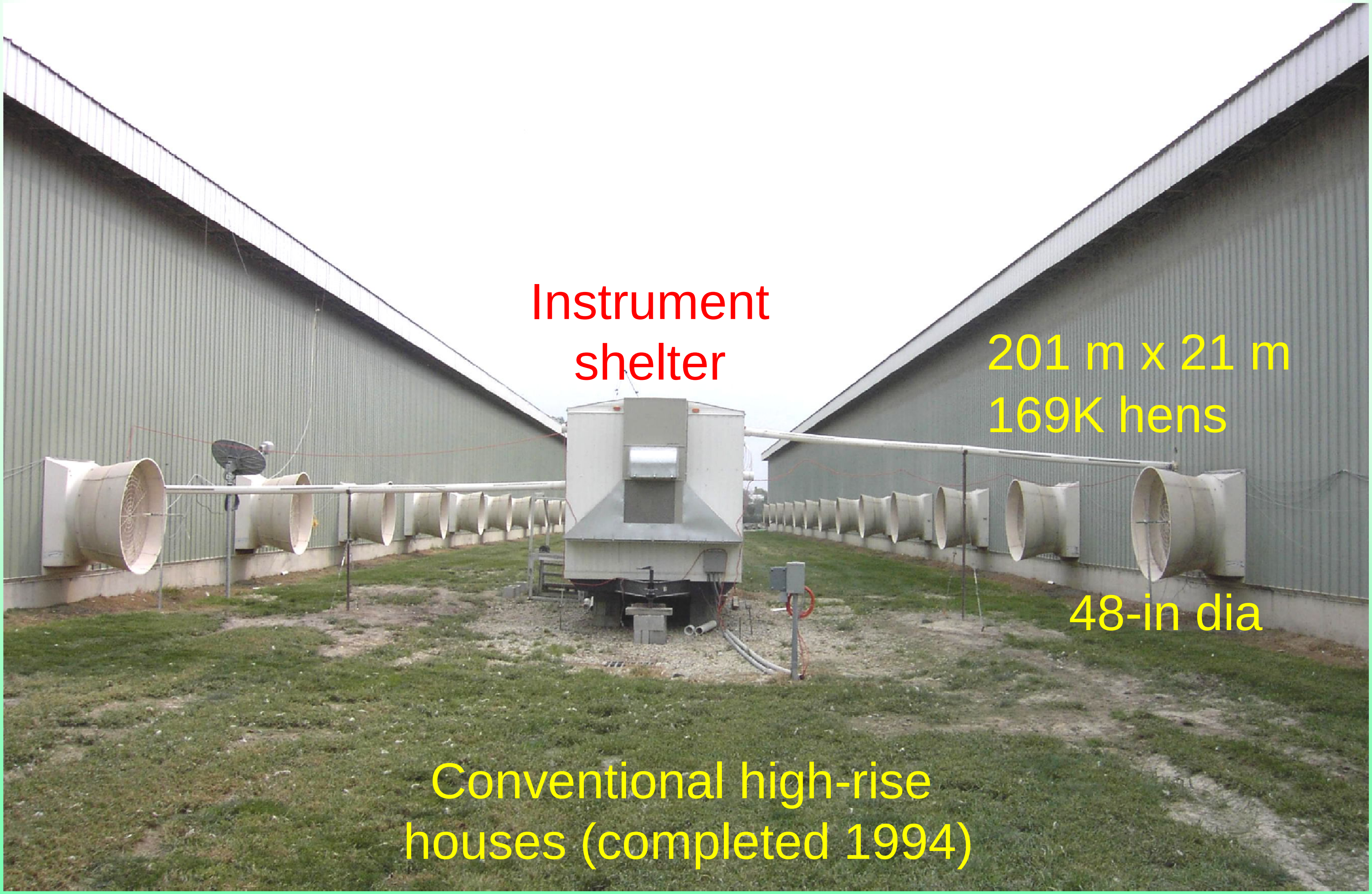
Overview

- **Test barns**
- **Effects of “Alum” and “Aluminum Chloride” applications.**
- **Effects of DDGS in the diet, combined with several best management practices.**
- **Effects of only BMPs.**

Field Test Site



High-Rise Layer Barns

- 169K hens, 8-rows, 4-tier crates.
- Sidewall fans spaced 7.3 m apart.
- 10 fan stages.
- "Turbo" ventilation system
- Manure scraped daily.
- Manure drying enhanced with 18, 918-mm dia. pit circulation fans.

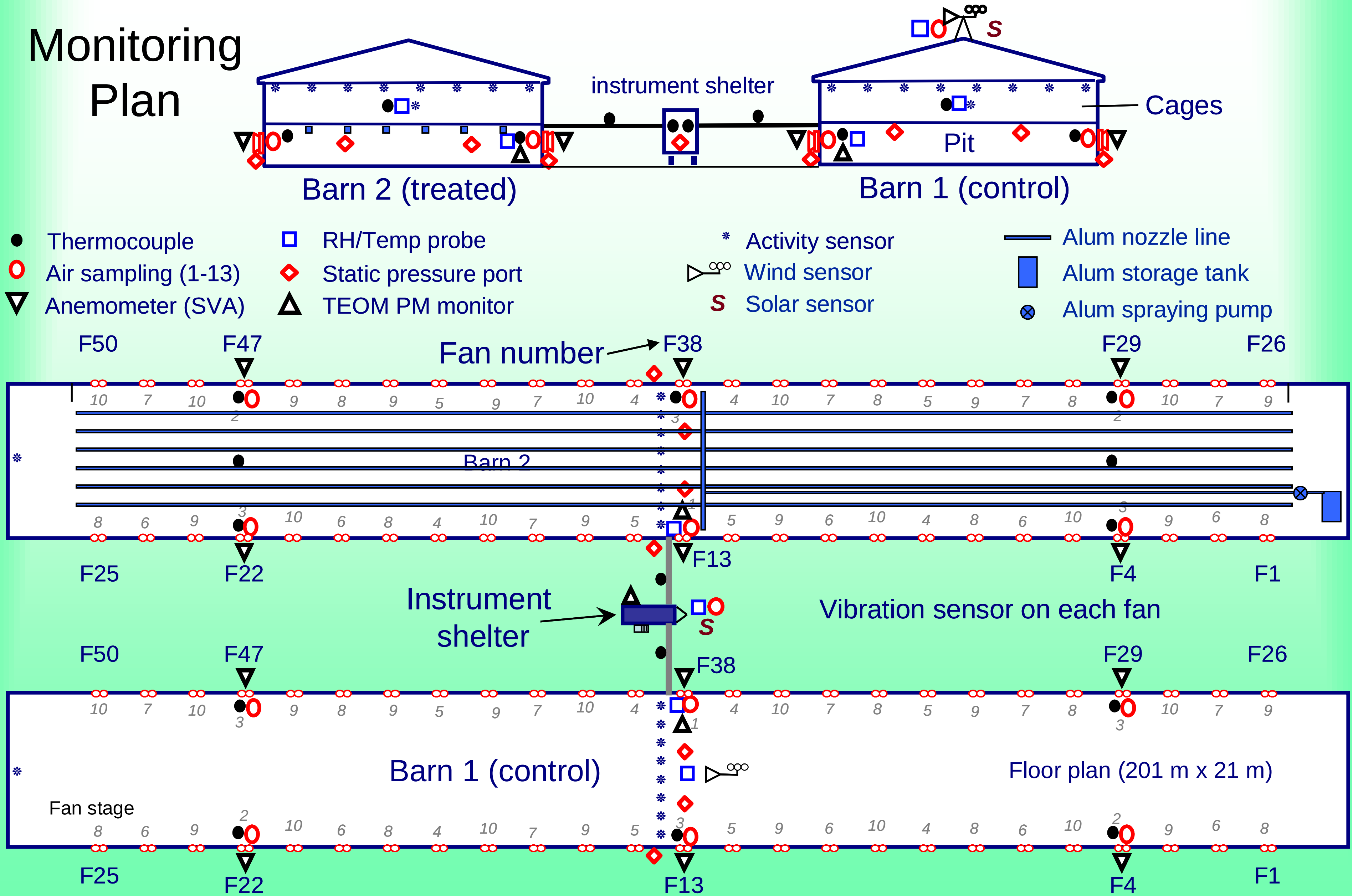
Alum and Aluminum Chloride Applications

- **Nitrogen is released as ammonium (NH_4+) under acidic or neutral conditions, or as NH_3 at higher pH. Acidifying agents reduce manure pH and decrease NH_3 volatilization**
- **The addition of alum to poultry litter:**
  - **reduces NH_3 volatilization.**
  - **increases total and soluble N and N/P ratios.**
  - **lowers in-house NH_3 concentrations.**

Alum Application System

- **A 3000-gal holding tank stored the chemical.**
- **1500 gal alum + 1500 gal water.**
- **Spray tubes and sprinkling nozzles were installed along the barn length.**
- **An air pump provided pressure for spraying, and the water pump filled the spray pipe with the solution.**
- **Solutions were sprayed for 4 s per hr.**

Monitoring Plan



Measurement Plan

- **Ammonia was measured with a chemiluminescence analyzer (Model 17C, Thermo Scientific), after conversion to nitric oxide.**
- **A photo-acoustic infrared monitor (Mine Safety Appliances) was collocated with the 17C.**
- **Fan operation & static pressure were monitored for barn ventilation rate.**
- **Temperature, humidity, wind speed, and direction.**

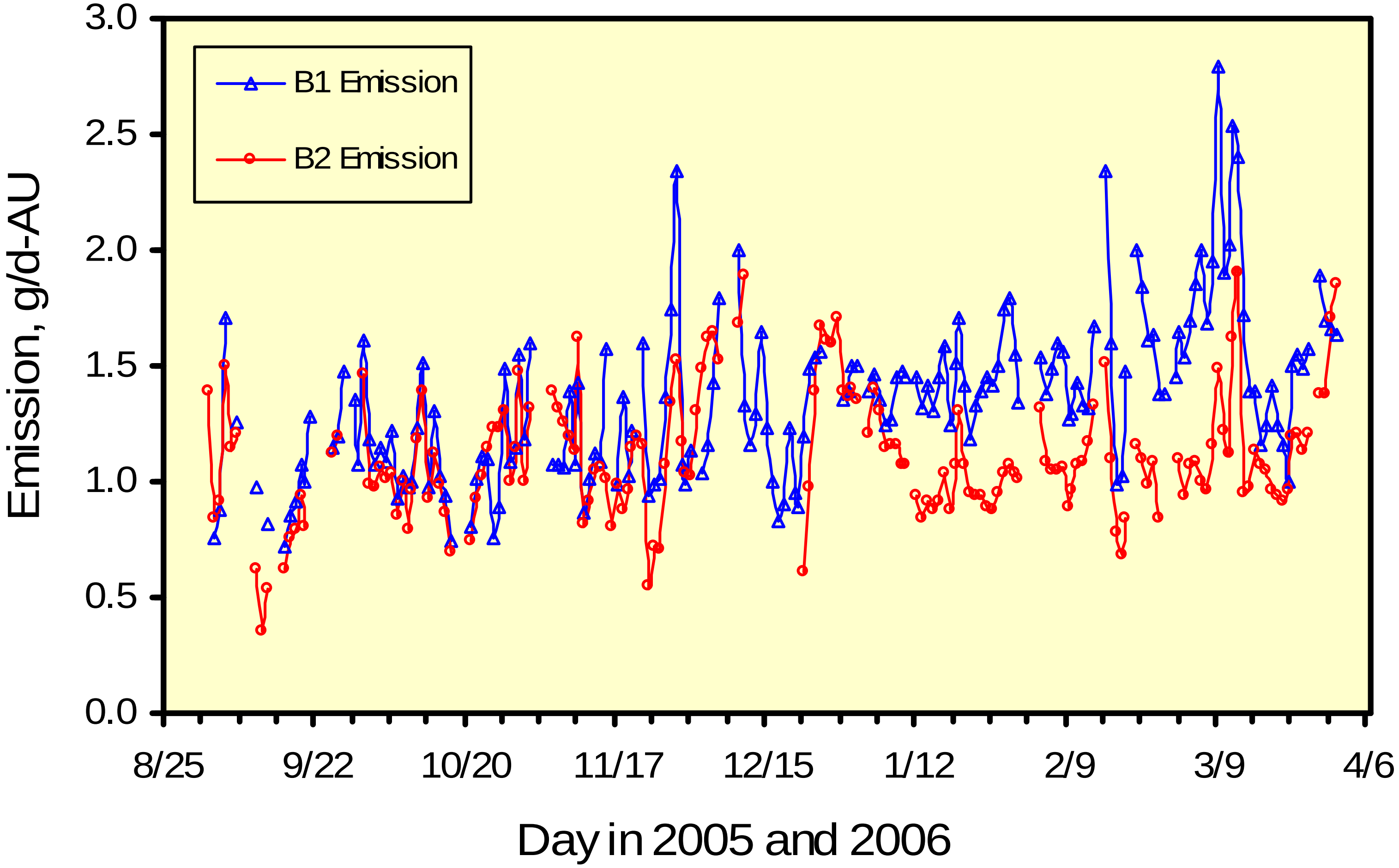
Alum Test Measurement Plan

Table 1. Tests conducted during study.

Test	Date	Description	Emission difference
1	9/1-9/10	ESCS	11%
2	9/11-9/20	Alum	29%
3	9/21-9/29	ESCS	12%
4a	9/30-11/4	ESCS + alum, some nozzles were clogged	16%
4b	11/5-12/12	ESCS + alum, nozzles were cleaned on 11/4	16%
4c	12/22-1/20	ESCS + alum, new hens in B2, nozzles cleaned (1/12)	17%
5	1/21-2/9	ESCS + alum (A7, single dose)	33%
6	2/10-2/15	ESCS + alum (A7, 1.5 dose)	23%
7	2/16-3/7	Alum (A7, 1.5 dose) + evening manure scraping*	40%
8	3/8-3/31	Aluminum chloride + evening manure scraping	27%

* ESCS operation was discontinued on March 4, 2006.

Alum Application NH_3 Emissions



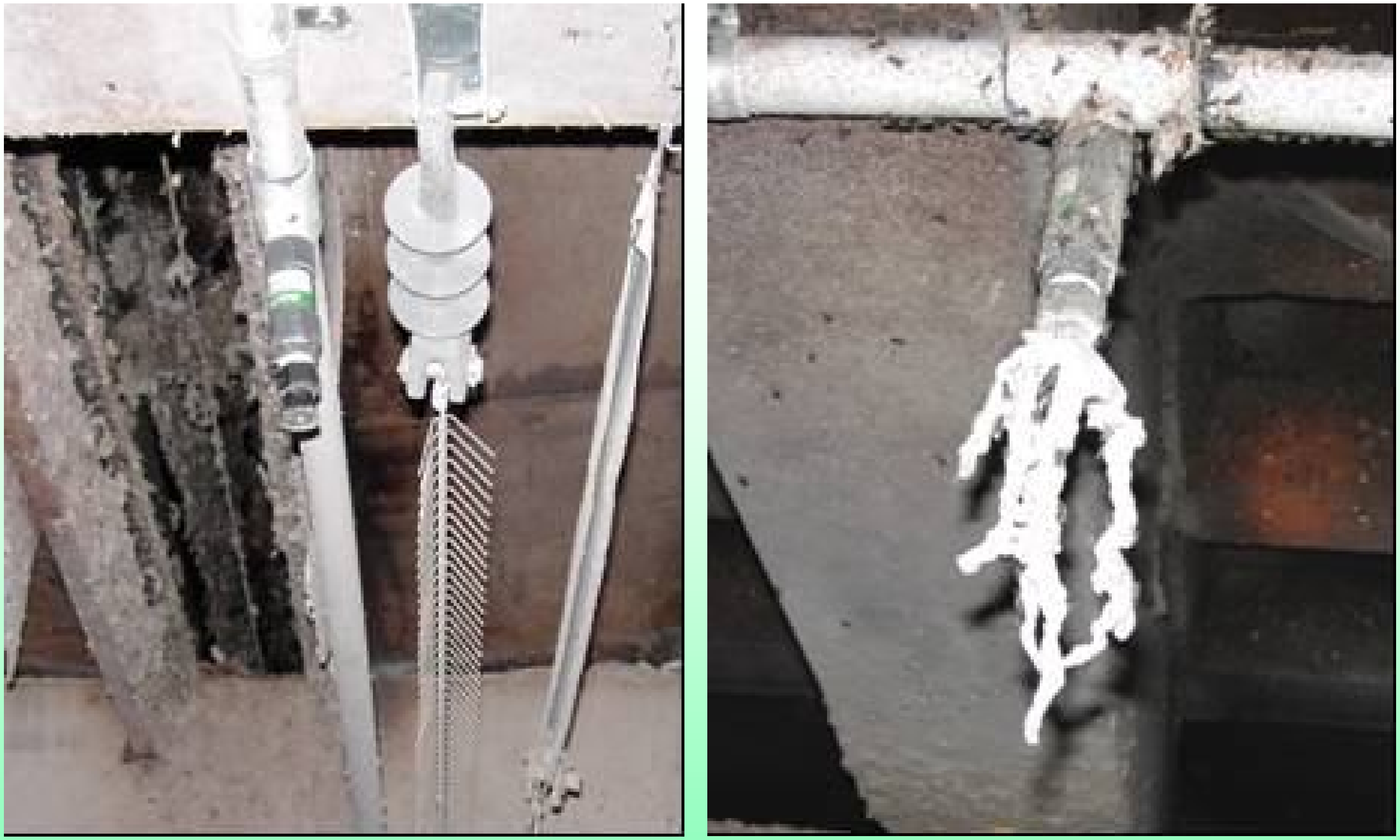
The mean untreated NH_3 emission rate was 480 g/d-AU (1.35 g/d-hen)

The alum and $AlCl_3$ applications reduced NH_3 emission by 23%

Alum Test Results

- **The highest paired NH_3 emission reductions were observed in Tests 5 (33%) and 7 (40%), which were probably due to the combined effects of well-functioning nozzles, evening manure scraping, and application of the A7 alum.**
- **Due to the lack of test replication and only one treated barn and one control barn, it is not known which factor contributed the most.**
- **The emission rate differences between the two barns averaged 32%, and ranged from -10% to 52% between January 21 and March 31.**

Alum Application Nozzle



A newly installed nozzle and lateral tube next to the ESCS system (left, picture was taken on September 8), and a clogged nozzle (right, picture was taken on November 1)

Limitations

- **Application of dry alum was not economically feasible.**
- **Manure moisture content (%) ranged from the upper 20s (warm months) to the upper 30s (cold months), thus limiting the amount of liquid alum that could be applied.**
- **The nozzles were easily clogged by salt accumulation.**
- **The chemicals were acidic and corrosive.**
- **The major limitation is related to the fact that manure on 2nd floor is untreated.**

Costs and Limitations

- Alum = $0.13/L, $AlCl_3$ = $0.14/L, without delivery charges.
- $44 per barn per day.
- The automatic spray controller cost about $3000, and the doubled-wall holding tank was $6500.
- The labor to maintain the controller, air and water pumps is about 3 hours per week per barn.

DDGS and BMPs Tests

- **To determine effectiveness and potential of DDGS and best management practices (BMPs) in mitigating NH_3 emissions from commercial high-rise layer houses.**
- **DDGS = fiber-enhanced diet.**
- **The BMPs included the operation of 36 manure drying fans in the manure pit, reduced crude protein in the feed, improved waterline leak management practices, and lower bird density.**

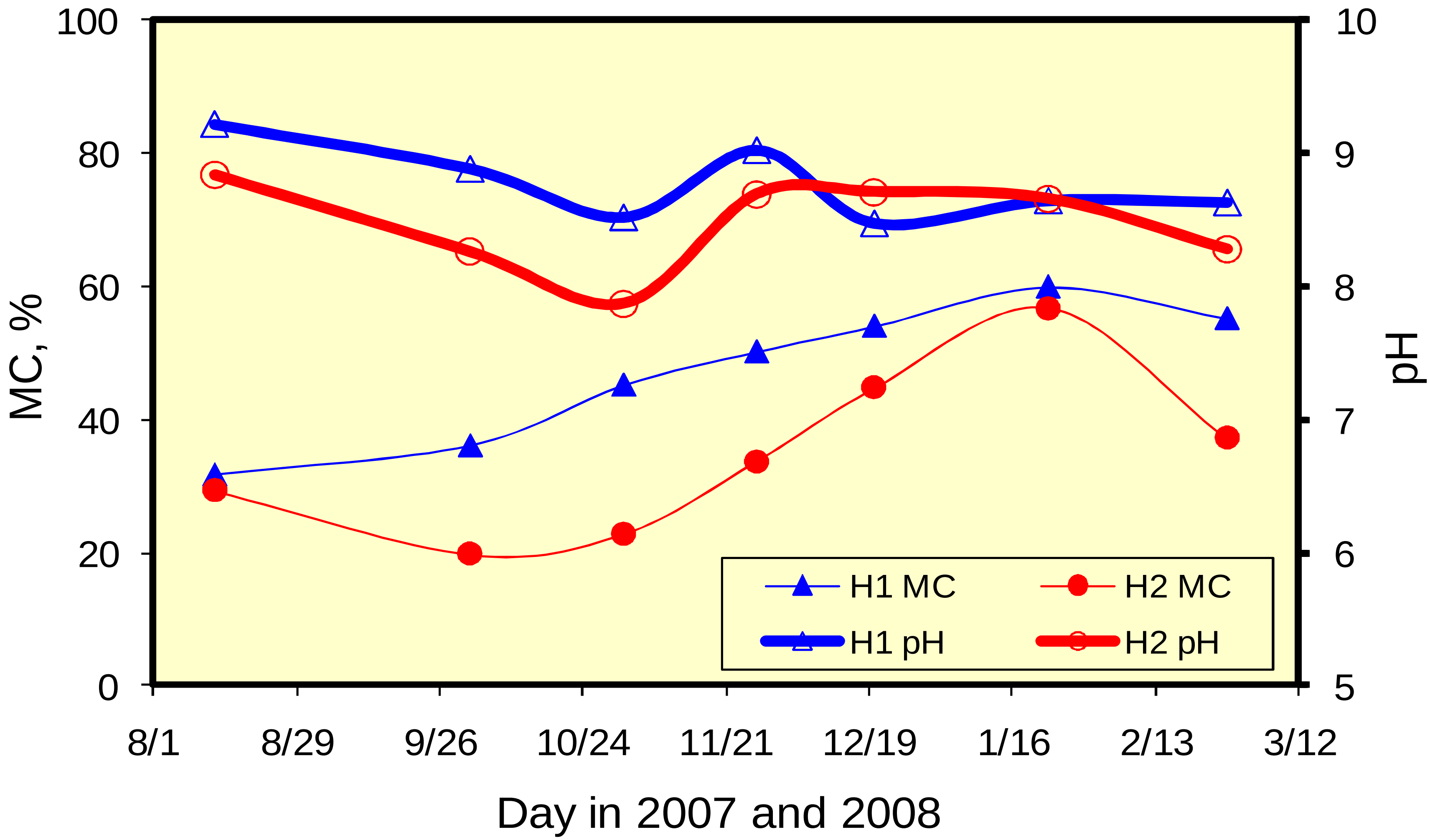
DDGS+BMPs Measurement Plan

Table 1. Tests conducted during study.

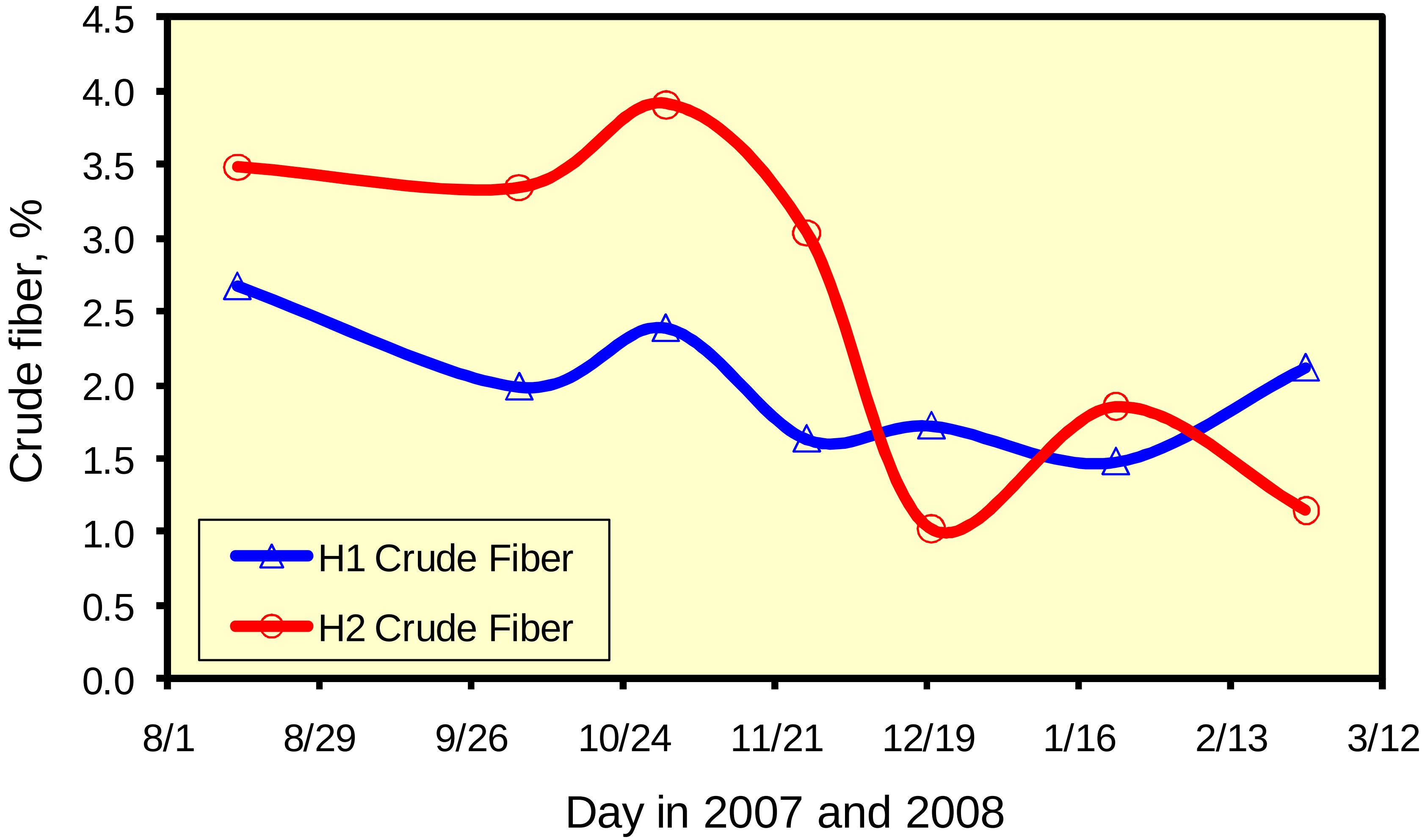
Test	Date	Description
1	8/1-8/6	Reduced bird density[1]
2	8/7-8/27	Stabilizing period[1]
3	8/28-12/10	DDGS + BMPs
4	12/11-1/14	BMPs only, old manure
5	1/15-2/18	Manure removal period[1]
6	2/19-3/17	BMPs only, new manure

1) Emission rate was not used to calculate effectiveness of tests

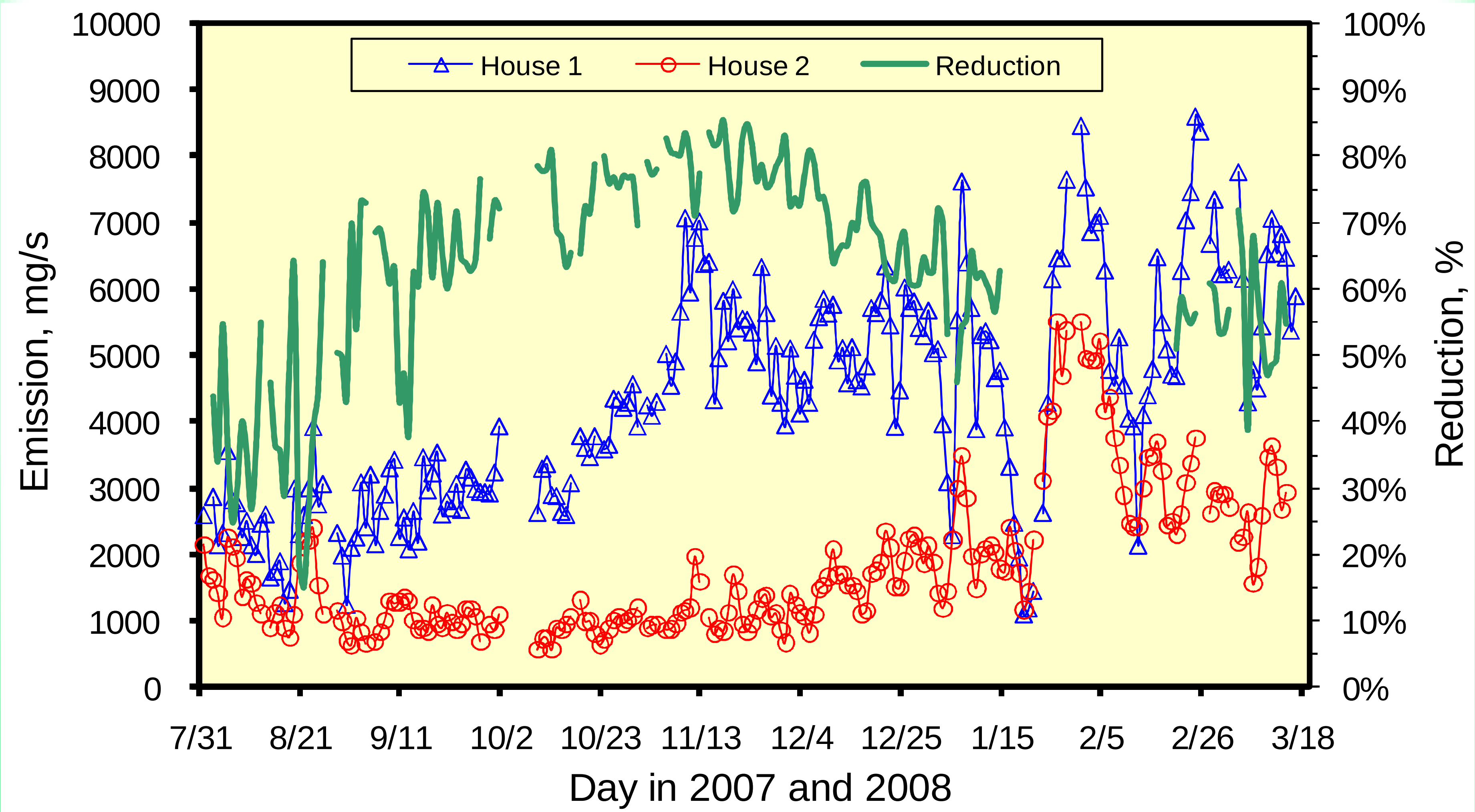
DDGS and BMPs Tests
Mean Manure MC and pH



DDGS and BMPs Tests Feed Fiber Contents



DDGS and BMPs: Emissions of H1 (untreated) and H2 (treated)

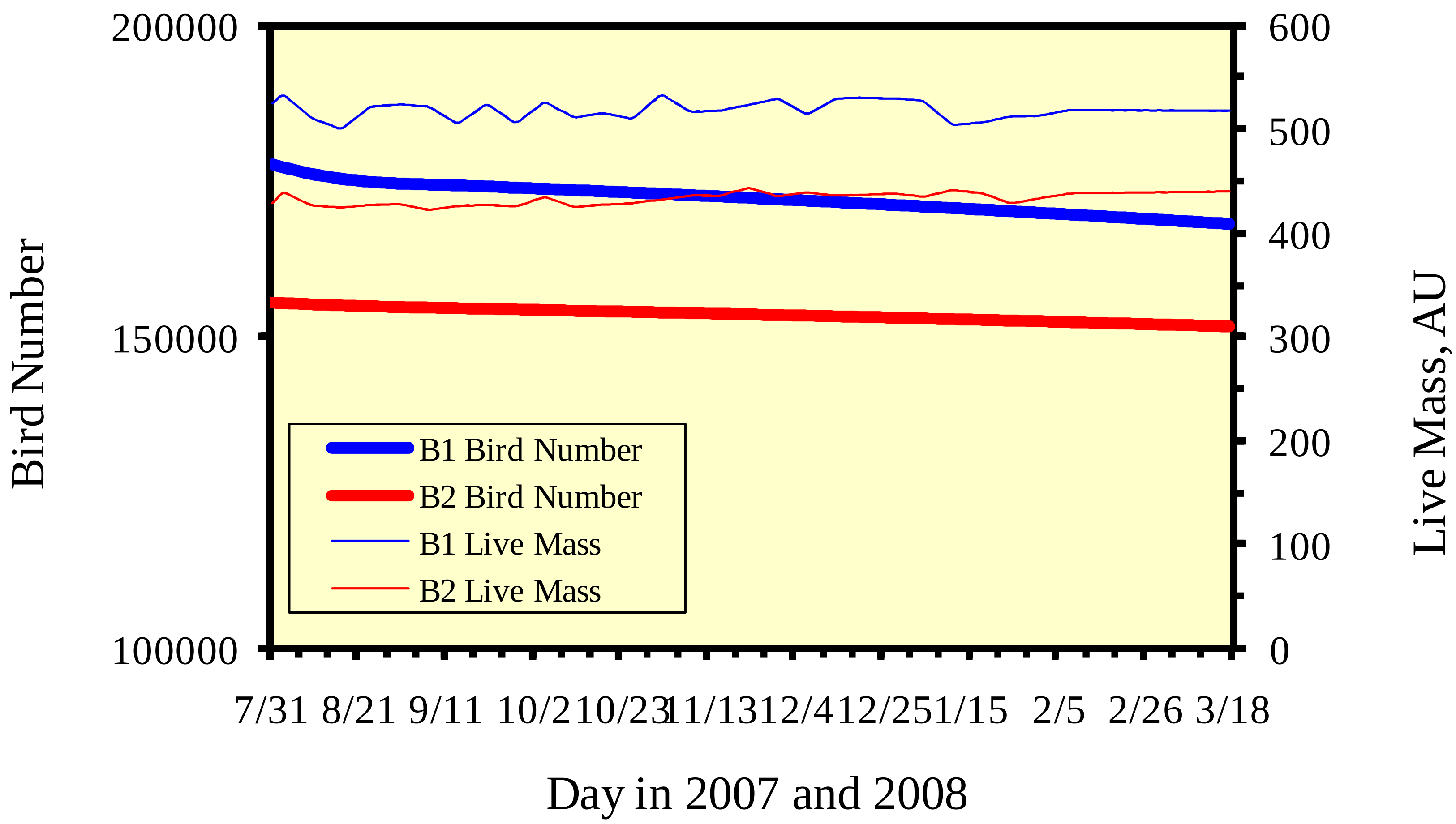


DDGS and BMPs Tests

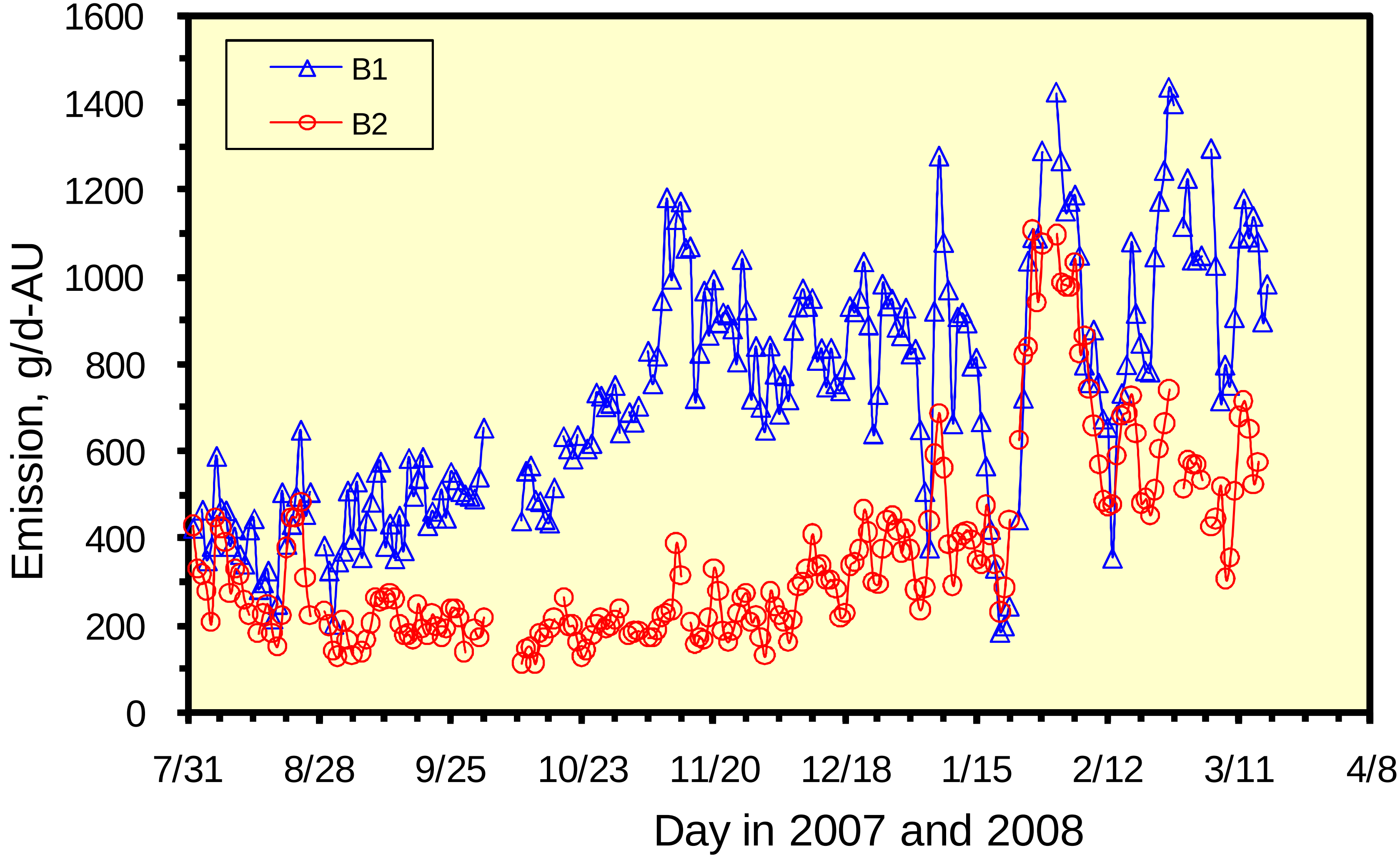
- **In test 1, reduction = 37%, caused by Lower bird density.**
- **For BMPs + DDGS, reduction = 72% (n=90 days).**
- **For BMPs only, reduction = 64%, but had residual manure from previous tests.**
- **After re-bedding, for BMPs only, reduction = 55%.**
- **Pit fans + leakage management successfully lowered the manure MC.**

That’s all. Thanks!

DDGS and BMPs: Bird Population and Live Mass



DDGS and BMPs: Emission per Live Mass Values



DDGS and BMPs: Emissions of H1 (untreated) and H2 (treated)