

Reduction of Ammonia Emission and Phosphorus Excretion in Laying Hen Manure Through Feed Manipulation

E. Carroll Hale III
Environmental Quality Control
Rose Acre Farms
Seymour, Indiana
2005 Texas Commercial Egg Clinic
April 2005, Bryan, TX

Aerosol Ammonia Regulatory Issues

- Ammonia emissions are currently regulated by the United States Environmental Protection Agency (USEPA) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Emergency Planning and Community Right-to-Know Act (EPCRA).
 - A facility that emits more than 100 lbs of ammonia in any 24-hour period must report the release to the appropriate authorities.
- Ammonia emissions may soon be regulated by the USEPA as a precursor material for particulate matter emissions pursuant to the Clean Air Act.

Aerosol Ammonia Regulatory Issues

- For regulatory permitting purposes, reducing the amount of ammonia emitted from manure via feed strategies is preferable to employing post-excretion methods of reducing ammonia emissions.
 - Feed manipulation to reduce ammonia emissions is considered source reduction.
 - Post-excretion treatment may be considered a control technology, and for regulatory purposes, emission rates without control technologies operating are the emission rates used for permitting, unless the control technology employed is an integral part of the process.

Aerosol Ammonia Regulatory Issues

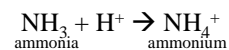
- The USEPA is under significant pressure to determine ammonia emission rates from animal feeding operations, and to bring those operations into compliance with applicable regulations. Ammonia emissions are a significant part of the study the USEPA is planning as part of the Consent Decree (a.k.a. the Safe Harbor Agreement).

Ammonia Emission from Manure

- Uric acid enzymatic conversion to ammonia begins almost immediately after excretion.
- Highest ammonia emissions occur in the first few days post-excretion.
- Low levels of ammonia emissions continue over time due to microbial degradation of protein.

Factors Affecting Ammonia Emission from Manure

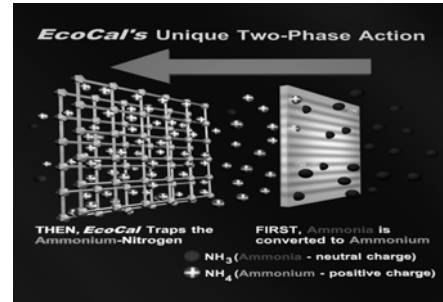
- Emission levels are dependent on manure moisture levels, air flow across manure, surface area of manure, and excreted nitrogen levels.
- pH is also a factor affecting ammonia emission rates. As manure pH is reduced, ammonia is increasingly ionized, forming ammonium cations which are less volatile than ammonia.



Feed Modification Strategies Explored to Create EcoCal

- Rose Acre Farms and EcoCal Products, LLC jointly entered into research to study the dietary effects of:
 - Alternative calcium sources.
 - Nitrogen binders.
 - Management of crude protein inputs.
- Combination/optimization of these dietary manipulation strategies resulted in the EcoCal diet.
 - A patent has been applied for this feed technology in the United States and abroad.

How EcoCal Works



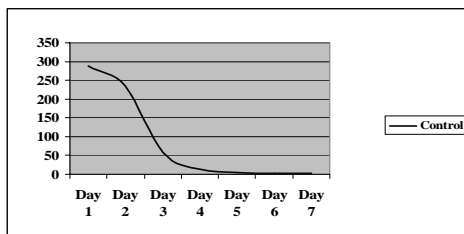
How to Use EcoCal

- EcoCal contains 18.5% calcium by weight, and replaces about 35% of the limestone used to formulate a typical layer diet.
- Because of the lower calcium content in EcoCal as compared to limestone, the weight of EcoCal added is twice the weight of limestone removed. The rest of the feed formula is adjusted as necessary.

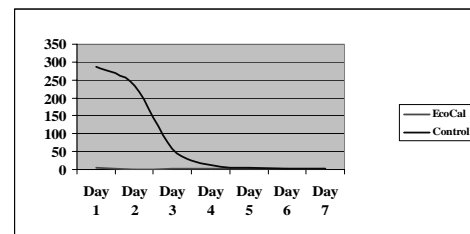
Test Procedures Used to Determine the Effectiveness of EcoCal

- Two testing regimens were used to illustrate the effectiveness of EcoCal.
 - Lab testing was performed to determine the relative reduction in ammonia emissions directly from the manure, as well as the effect of EcoCal on nitrogen retention and phosphorus excretion in fresh manure samples.
 - Long-term production scale testing was performed to determine relative reductions in ammonia levels observed at henhouse exhaust fans, effects on egg production, and effects on manure N:P:K ratios.

Lab Test: Manure Ammonia Emissions Without EcoCal, Reported in ppm



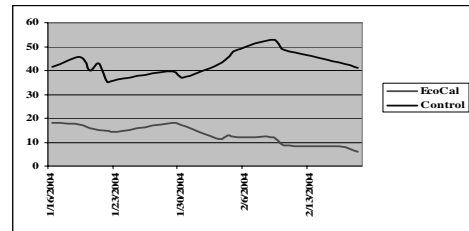
Lab Test: Manure Ammonia Emissions With EcoCal, Reported in ppm



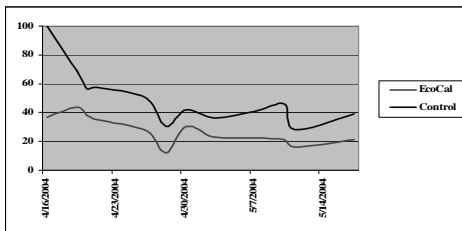
Lab Test: Results of EcoCal Use

- Using EcoCal in feed can reduce manure ammonia emissions up to 98% compared to industry standard feed.
 - As previously indicated, ammonia emissions are affected by manure moisture content, manure pile surface area, excess crude protein in feed, temperature, pH, drying rate, and the velocity of air flow in manure storage areas. EcoCal will minimize ammonia emissions, but specific manure handling practices have varying effects on ammonia emission rates.

Production Scale Test: Winter Ammonia Levels in ppm



Production Scale Test: Summer Ammonia Levels in ppm



Production Scale Test: Results of EcoCal Use

- Reductions higher when ventilation rates are lower and pit fans are not in operation.
 - Reductions from 54% to 86%, averaging 69% over this test. The level of reduction noted showed a significant trend toward higher reductions as time progressed.
- Reductions decrease when ventilation rates are high and pit fans are in operation.
 - Reductions from 27% to 64% noted, averaging 44% over this test.

Lab Test: EcoCal Effects on Manure Nitrogen Retention

- About 40% of dietary N is lost as ammonia emissions. (Patterson, et al, 1996, 1997, 1998)
- Decreases in ammonia emission should directly contribute to increased nitrogen retention in manure.

Lab Test: EcoCal Effects on Manure Nitrogen Retention

- The amount of nitrogen retained in fresh manure resulting from EcoCal-amended feed is approximately 50% higher than in manure resulting from the control diet. Results reported in lb/ton.

	Average	Std. Dev.
Std Diet N	75.3	4.7
EcoCal Feed N	112.6	4.1

Lab Test: EcoCal Effects on Manure Phosphorus Levels

- At equivalent bioavailable dietary phosphate levels, manure resulting from feeding EcoCal-amended feed exhibited lower total excreted phosphate levels than manure resulting from standard feed.
 - The reason is unclear.
- At equivalent bioavailable dietary phosphate levels, manure resulting from feeding EcoCal-amended feed exhibited lower soluble phosphate levels than manure resulting from standard feed.

Lab Test: EcoCal Diet Effects on Manure Phosphorus Levels

- Total and soluble phosphorus excretion in fresh manure was reduced by feeding EcoCal. Results reported in lb/ton.

	Average	Std. Dev.
Control Total P	13.5	2.6
EcoCal Total P	6.5	2.6
Control Soluble P	4.2	2.2
EcoCal Soluble P	1.6	0.8

Production Scale Test: EcoCal Effects on N:P:K Ratios

- Average manure N:P:K values presented in lbs/ton.
 - Manure was collected from the pit at varying depths and locations, in order to generate accurate whole-house average manure N, P, and K content for comparison purposes.

	Avg. N	Avg. P	Avg. K
EcoCal	76.6	15.4	20.6
Control	56.0	44.0	75.4

Production Scale Test: EcoCal Effects on Production

- A poorly performing house was chosen to determine whether production environment improvements due to using EcoCal would translate to improved performance.
 - Egg production was used as the basis to determine whether performance improved.
- Hy-Line W-36 hens were used, and actual production was compared to Hy-Line predicted production goals as published by Hy-Line in their W-36 Commercial Management Guide.

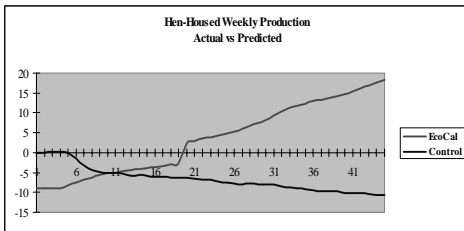
Production Scale Test: EcoCal Effects on Production

- The hens were fed an industry standard diet until first molt. After molt, the hens were fed a diet containing EcoCal.
- The length of each term of the study was 45 weeks.
- At the end of the first portion of the study, the production figures were 10 eggs/bird under predicted production goal.

Production Scale Test: EcoCal Effects on Production

- At the end of the second 45-week portion of the study (post-molt, EcoCal-amended feed), production increased to 18 eggs/bird over predicted production goal.
- The net production increase was 28 eggs/bird in a 45-week period.

**Production Scale Test:
EcoCal Effects on Production, Eggs/Bird**



**Production Scale Test:
EcoCal Effects on Production**

- EcoCal more than paid for itself in increased production in this test.

Added Feed Cost to use EcoCal	\$31,000
Production Gain in eggs/bird	28
Ending Hen Population	99,606
Total Production Gain, dozens	232,414
Value @ \$0.50/dozen	\$116,207
Profit (Value – Added Feed Cost)	\$85,207

Future Testing of EcoCal

- EcoCal has been continually tested in the 2 ½ years since it was invented. To date, EcoCal has been fed to approximately 2 million laying hens as part of ongoing studies to insure its effectiveness and safety.
- Different manure acidifiers are being tested so that EcoCal can be adapted to broilers and other poultry, as well as swine and cattle.
- Different nitrogen-binding additives are being tested to determine their effectiveness.