Air Quality on the Farm

Testing Strategies to Minimize Ammonia Release

Introduction

The work in this experiment was done because the number of chicken farms in rural areas is rapidly increasing. According to the Census of Agriculture 2022, 2022 was up 56% in commercial egg production compared to 2017. Also, according to the USDA, egg production for 2026 is projected to rise to 47.9 billion pounds, and that is projected to rise 11.5% for a total of 53.4 billion pounds by 2034. There have just been three chicken barns that have been built within a five-mile radius of my home. As broiler and egg production increase across the world, so does the manure production.

The problems with increased manure in barns can result in higher NH_3 (ammonia) levels, which **can lead to sickness and disease for the birds**. Because of the new chicken barns in my county, all of the fields around me are now being fertilized with chicken manure. Chicken manure is one of the best natural fertilizers, but it also has its downsides. **Chicken manure is notoriously known for smelling bad.** The reason for the smell is the high levels of ammonia that it contains. With chicken manure being spread all around, the outdoors always smells. But on top of this, having too high of ammonia levels can be dangerous for animals and people. It **can cause respiratory disease** and make people and chickens alike more susceptible to lung problems when exposed to high ammonia levels for a long time. Also, the **high ammonia levels deter people from choosing a natural fertilizer** to spread on their fields, even though it is better for the soil.

This problem led to **the purpose of my experiment**, to find the most economical solution to reduce ammonia in chicken manure. This project consisted of six variables and my control. Through this test, I can find which ingredients in the variables reduce the ammonia and result in a healthier, less smelly fertilizer to apply onto fields.

The **experiment's impact on agriculture** would make the barns a healthier environment for the chickens, which would improve bird health and increase egg and meat production. It will also encourage people to fertilize their fields with chicken manure since it would not have the bad smell caused by ammonia. This will have a great positive impact on the agricultural industry because, according to Llend (2025), chicken manure is better for soil health and leaves a lasting positive impact on the soil vs. the typical artificial fertilizers. Chicken manure has a slow release that results in the nutrients in the manure not being wasted when it is spread onto fields. Reducing ammonia levels in soil would also increase chicken health, reduce fatality rate caused by respiratory problems, improve smell to please neighbors, and it could even help sway the decision of governing boards to allow you to build a chicken barn if you reduce ammonia levels in the manure.

Literature Review

NH_3 is a gas composed of nitrogen and hydrogen. It has a very pungent smell that can cause sickness when exposed to high levels of NH_3 for eight or more hours. The common name for NH_3 is ammonia. It naturally occurs in chicken manure when urine or moisture combines with the undigested proteins in the manure. This results in NH_3(ammonia) and creates a pungent smell associated with chicken manure. However, many farmers will spread chicken manure on fields because of its high nitrogen, phosphorus, and potassium levels. This results in a lingering smell, on and around the fields for a week or longer. To reduce ammonia, you need some sort of absorbent that can get rid of the moisture to prevent it from encountering undigested proteins. You also need something that can reduce the PH levels in the manure.

In looking at the findings of others' earlier work, I found in (Howell 2019) that chicken runs should not exceed 25 ppm of ammonia, otherwise they will be highly susceptible to respiratory diseases. This means that if the ammonia levels get too high, the chickens can get sick. So, if I can eliminate the ammonia in the runs, then when it gets spread onto the fields, it will already have a low level of ammonia. Ammonia is the cause of chicken manure with high moisture levels. Ammonia is a measurement of the chemical in the air, but it also has a terrible smell.

This led me to **the general approach** of selecting six variables to test on chicken manure that will last a longer time, so that when the runs get cleaned and spread onto the fields, the ammonia levels stay down. But I also wanted a variable that can act fast enough in chicken coops so that the chickens don't have exposure to high ammonia levels. **The objective of this project** is to find which of the six variables would effectively eliminate ammonia and last for a long time from the moment that the variables are spread in the chicken runs. The winning variable will ultimately reduce the ammonia levels in the manure, which will result in a healthy living condition for the chickens, a better work environment for farm hands, happier neighbors, and an increased chance of building more chicken barns to increase meat and/or egg production.

Hypothesis

The 100% zeolite variable will decrease the ammonia the most compared to the control and maintain a level that is healthy for chickens and people.

Variable/Control

For this research, my six variable were Ammosorb, Coop Recuperate, Coop N Compost, Zeolite, Lime, and Ammonium Sulfate. My control was one pound of chicken manure.

Materials

The **materials used** to conduct this experiment begin with safety. Wearing proper Personal Protective Equipment (PPE) such as safety goggles, a mask, and gloves is very important while handling chicken manure and various materials. The next material needed is 21 pounds of fresh chicken manure. To contain the ammonia, put all the chicken manure into two 5-gallon buckets with airtight lids. Then, acquire the 6 variables which are Ammosorb, Coop Recuperate, Coop N Compost, Zeolite, Lime, and Ammonium Sulfate. To make sure the measurements are consistent, use a scale and a measuring cup. To contain 1 pound of manure for each trial, put the manure in small airtight containers. To test each variable, buy an NH_3 tester to get accurate measurements of the NH_3 levels. A pencil and paper are important to keep an accurate record of the data.

Methods

The **methods used to complete the experiment** begin with gathering all of the materials from home, local farmers, or Amazon. The intent is to conduct 3 trials for each variable and the control for a total of 21 trials. Before starting, make sure to wear gloves, safety glasses, and a proper mask. Start by marking the airtight containers with which variable will go into it and which trial it is, such as control trial 1, control trial 2, control trial3, variable 1 trial 1, etc. Next, weigh out 1 pound of chicken manure and pour it into each container. Quickly closed the lid of the container tightly to trap the ammonia. Then, by putting the tester in the container and closing the lid, test the starting ammonia levels of the chicken manure for all 21 trials and record this in the data notebook. Now, add half a cup of each variable to the respective containers by sprinkling it over the top of the manure and tightly put the lid back onto the container. After this, test the ammonia levels of every trial and control by putting the tester into the container and closing the lid at these exact time sequences: one hour, seven hours, twenty-four hours from the first test, two days, three days, four days, five days, six days, and seven days. All trials should be tested each day at the same time as the previous day, in the same order. This will show the effectiveness and time needed to reduce the ammonia for each variable. To test each variable and control, turn on the tester and set it to make sure it is testing for NH_3 and not anything else. Then, open the lid of the trial and quickly put the tester in the container and seal it shut. Repeat this each time for all the trials. It is important to keep the lid open for a minimal amount of time, as it will help keep the ammonia in the container. Do this every test for the entire week. Record all the data on the paper and analyze it after the completion of the tests.

Data

Table 1	Control in PPM						
Day	Trial 1	% change over start	Trial 2	% change over start	Trial 3	% change over start	Average % change over start
Start	164		143		173		
1 hour	100	-39%	108	-24%	105	-39%	-34%
7 hours	50	-70%	57	-60%	43	-75%	-68%
Day 2	62	-62%	50	-65%	62	-64%	-64%
Day 3	55	-66%	46	-68%	65	-62%	-66%
Day 4	60	-63%	62	-57%	73	-58%	-59%
Day 5	80	-51%	77	-46%	81	-53%	-50%
Day 6	120	-27%	116	-19%	142	-18%	-21%
Day 7	140	-15%	126	-12%	154	-11%	-13%

Table 2	Ammosorb in PPM							
Day	Trial 1	% change over start	Trial 2	% change over start	Trial 3	% change over start	Average % change over start	Variable vs. Control
Start	42		105		60			
1 hour	30	-29%	76	-28%	38	-37%	-31%	-3%
7 hours	42	0%	102	-3%	54	-10%	-4%	-64%
Day 2	55	31%	107	2%	62	3%	12%	-76%
Day 3	20	-52%	55	-48%	28	-53%	-51%	-14%
Day 4	13	-69%	30	-71%	20	-67%	-69%	10%
Day 5	12	-71%	23	-78%	17	-72%	-74%	24%
Day 6	43	2%	105	0%	59	-2%	0%	-21%
Day 7	32	-24%	87	-17%	50	-17%	-19%	7%

Table 3	Coop Recuperate in PPM							
Day	Trial 1	% change over start	Trial 2	% change over start	Trial 3	% change over start	Average % change over start	Variable vs. Control
Start	104		108		95			
1 hour	35	-66%	40	-63%	30	-68%	-66%	32%
7 hours	37	-64%	38	-65%	27	-72%	-67%	-1%
Day 2	35	-66%	31	-71%	24	-75%	-71%	7%
Day 3	18	-83%	24	-78%	17	-82%	-81%	15%
Day 4	12	-88%	20	-81%	13	-86%	-85%	26%
Day 5	20	-81%	26	-76%	14	-85%	-81%	30%
Day 6	80	-23%	88	-19%	73	-23%	-22%	0%
Day 7	63	-39%	74	-31%	79	-17%	-29%	17%

Table 4	Coop N Compost in PPM							
Day	Trial 1	% change over start	Trial 2	% change over start	Trial 3	% change over start	Average % change over start	Variable vs. Control
Start	84		93		98			
1 hour	23	-73%	29	-69%	63	-36%	-59%	25%
7 hours	30	-64%	31	-67%	28	-71%	-67%	-1%
Day 2	31	-63%	34	-63%	30	-69%	-65%	2%
Day 3	17	-80%	20	-78%	15	-85%	-81%	15%
Day 4	10	-88%	13	-86%	11	-89%	-88%	28%
Day 5	25	-70%	27	-71%	13	-87%	-76%	26%
Day 6	40	-52%	48	-48%	35	-64%	-55%	34%
Day 7	22	-74%	20	-78%	18	-82%	-78%	65%

Table 5	Zeolite in PPM							
Day	Trial 1	% change over start	Trial 2	% change over start	Trial 3	% change over start	Average % change over start	Variable vs. Control
Start	150		136		141			
1 hour	70	-53%	62	-54%	74	-48%	-52%	17%
7 hours	18	-88%	25	-82%	28	-80%	-83%	15%
Day 2	34	-77%	23	-83%	22	-84%	-82%	18%
Day 3	22	-85%	19	-86%	19	-87%	-86%	20%
Day 4	14	-91%	16	-88%	13	-91%	-90%	31%
Day 5	12	-92%	11	-92%	10	-93%	-92%	42%
Day 6	25	-83%	17	-88%	23	-84%	-85%	64%
Day 7	21	-86%	20	-85%	20	-86%	-86%	73%

Table 6	Lime in PPM							
Day	Trial 1	% change over start	Trial 2	% change over start	Trial 3	% change over start	Average % change over start	Variable vs. Control
Start	123		107		133			
1 hour	103	-16%	86	-20%	100	-25%	-20%	-14%
7 hours	60	-51%	66	-38%	73	-45%	-45%	-23%
Day 2	70	-43%	72	-33%	67	-50%	-42%	-22%
Day 3	78	-37%	81	-24%	79	-41%	-34%	-32%
Day 4	79	-36%	83	-22%	86	-35%	-31%	-28%
Day 5	102	-17%	96	-10%	100	-25%	-17%	-33%
Day 6	115	-7%	105	-2%	120	-10%	-6%	-15%
Day 7	117	-5%	113	6%	127	-5%	-1%	-11%

Table 7	Ammonium Sulfate in PPM							
Day	Trial 1	% change over start	Trial 2	% change over start	Trial 3	% change over start	Average % change over start	Variable vs. Control
Start	100		130		85			
1 hour	36	-64%	52	-60%	27	-68%	-64%	30%
7 hours	15	-85%	26	-80%	18	-79%	-81%	13%
Day 2	50	-50%	62	-52%	47	-45%	-49%	-15%
Day 3	94	-6%	105	-19%	119	40%	5%	-70%
Day 4	125	25%	132	2%	153	80%	36%	-95%
Day 5	150	50%	164	26%	189	122%	66%	-116%
Day 6	200	100%	199	53%	200	135%	96%	-117%
Day 7	200	100%	200	54%	200	135%	96%	-109%

Results

Table one shows the results of my control in Parts Per Million (PPM) of ammonia. The **trend** of this table is that the PPM of the NH_3 went down in each test for each trial until Day 2 of testing, when they started rising again.
Table two shows the results of variable one, Ammosorb, in Parts Per Million (PPM) of ammonia. The **trend** of this table showed a decrease in ammonia until Day 2, when it increased. However, it dropped again in Days 3, 4, and 5 with another elevation in ammonia through day 7. In relationship with the Control, Ammosorb had a worse change in percentage based on starting PPM, and we see this because of the 8 tests, 5 of them are below the change in percentage of the Control, as highlighted in red.

Table three shows the results of variable two, Coop Recuperate, in Parts Per Million (PPM) of ammonia. The **trend** of this table showed a decrease in ammonia in hour one. Then, in hour seven, it increased. However, it dropped again in Days 2, 3, 4, and 5, with another elevation in ammonia on day 6, but decreased the next day. In relationship with the Control, Coop Recuperate had a better chance in percentage based off starting PPM, and we see this because of the 8 tests, only 1 of them is below the change in percentage of the Control, as highlighted in red.

Table four shows the results of variable three, Coop N Compost, in Parts Per Million (PPM) of ammonia. The **trend** of this table showed a decrease in ammonia in hour one. Then, in hour seven, it increased. However, it dropped again and had a steady decrease till day eight. In relationship with the Control, Coop N Compost had a better change in percentage based off starting PPM, and we see this because of the 8 tests, only 1 of them are below the change in percentage of the Control, as highlighted in red.
Table five shows the results of variable four, zeolite, in Parts Per Million (PPM) of ammonia. The **trend** of this table showed an average decrease in ammonia since the start. In relationship with the Control, Zeolite had a better change in percentage based off starting PPM, and we see this because of the 8 tests, none of them are below the change in percentage of the Control, hence, all are highlighted in green.

Table six shows the results of variable five, Lime, in Parts Per Million (PPM) of ammonia. The **trend** of this table showed an average decrease in ammonia since the start. However, in relationship with the Control, Lime had a worse change in percentage based off starting PPM for all 8 tests as highlighted in red.

Table seven shows the results of variable six, Ammonium Sulfate, in Parts Per Million (PPM) of ammonia. The **trend** of this table showed a decrease in ammonia on hour one and hour seven. However, PPM of ammonia spiked in day 3 and continued until it maxed out the NH_3 reader on day 6. In relationship with the Control, Ammonium Sulfate had a worse change in percentage based off starting PPM, and we see this because of the 8 tests, 6 of them are below the change in percentage of the Control as highlighted in red.

Conclusion

In conclusion, my **hypothesis** was correct that Zeolite was the most effective at decreasing the NH_3 levels. Zeolite got the lowest PPM measurement of 10 PPM on day 5 in trial 3, as shown in Table 5. It was also the only one to have all positive results when compared to the Control. Zeolite came out on top because it is a great mineral that absorbs moisture but also absorbs the NH_3 in the air. When it takes in NH_3, it binds and collects it into its honeycomb structure, making lots of room for more NH_3 to be absorbed.

When reviewing the results, one can see that Coop Recuperate and Coop N Compost both only had one instance when it was red versus control. However, in further review of the data, you can see that Coop N Compost was effective at lowering the PPM of ammonia versus the control, but not as well as Zeolite, therefore making it a close second place. It had great results and would be a good option to use, but not for large amounts of manure since it can be so expensive. The main ingredient in this is zeolite, but it also has many other additives. This shows that all the added ingredients are unnecessary, and all you need to keep the ammonia down is Zeolite minerals. Coop Recuperate (Table 3) PPM's spiked on days six and seven, which placed it third in overall effectiveness. The main ingredient in this product is eucalyptus, which is a type of Yucca plant, as explained in the literature review.

The remaining variables ranked in effectiveness versus the control, as supported by the data and results of the experiment. Coming in fourth was Ammosorb, with the main ingredient being phosphoric acid. It is designed for cat litter but advertised to reduce ammonia. However, according to these results, it didn't do a very good job at reducing the ammonia. Next was the Control itself, as it performed better than the lime and ammonium sulfate. In fifth place was Lime. This is a common fertilizer that is spread in fields to increase acidity. But when this mixes with chicken manure, it causes it to rise in Ammonia on the later tests. When I compared this to Control, it had worse percentage changes, meaning it didn't decrease in ammonia as good as Control. In last place, Ammonium Sulfate. This variable started out good, for hours 1 and hour 7, but starting on day 3, the ammonia skyrocketed as seen in table 7. During day 6, it maxed out the NH_3 tester at 200 for 2 days straight. When compared to the Control, it achieved a 100% worse change in ammonia. Ammonium Sulfate is a fertilizer that is designed to lower the PH in fields and in water. If the soil is already very acidic, this fertilizer won't do anything. So, knowing this, I tested it to see if it would reduce ammonia. And at the beginning, it did, which may be because of my opening the lids to test, but the chicken manure was not already super acidic, so the Ammonium Sulfate raised its acidity. This fed the NH_3 and causes the ammonia levels to rise and increase by a lot.

Isaac Hefty – DeKalb FFA – Indiana
Environmental Services – Division three