

Litter Quality and Broiler Performance

Casey W. Ritz, Brian D. Fairchild, and Michael P. Lacy
Extension Poultry Scientists

Quality of chicks, feed and water are all of great concern to broiler producers; but quality of litter in broiler houses is seldom given sufficient emphasis. This is unfortunate because birds are in continuous contact with litter. Litter conditions significantly influence broiler performance and, ultimately, the profits of growers and integrators. Litter is defined as the combination of bedding material, excreta, feathers, wasted feed and wasted water.

Sources of Bedding Material

Bedding material serves a number of important functions. For example, it:

- absorbs excess moisture from the droppings and drinkers and promotes drying by increasing the surface area of the house floor.
- dilutes fecal material, thus reducing contact between birds and manure.
- insulates chicks from the cooling effects of the ground and provides a protective cushion between the birds and the floor.

An effective bedding material must be absorbent, lightweight, inexpensive and non-toxic. Ideal materials will have high moisture absorption and release qualities to minimize litter caking. In addition, a bedding material must be compatible as a fertilizer or soil amendment after it has served its purpose in the broiler house.

Many products have been used as bedding. The quality and quantity of bedding materials can vary greatly from one region to another. Table 1 (page 2) lists various materials that have been tried with at least some degree of success and briefly discusses

the advantages and disadvantages of particular litter sources. Periodically by-products of other industries have received interest as poultry bedding material. Efforts to use these materials are primarily driven by local recycling efforts and new market development. Pine shavings and coarse pine sawdust are currently the most popular bedding materials in Georgia; however, these two types of material are becoming more difficult to obtain with increasing frequency of periodic shortages and escalating costs. When supply and pricing become limiting factors, appropriate substitutions need to be considered.

Use caution when considering alternative bedding sources. Materials need to be evaluated based on their performance potential, downgrading potential, and potential for residues. The possibility of residues is the most serious consideration, whether it be compositional or accidental. If a chemical is in the bedding material, it has the possibility of ending up as a residue in broiler tissues.

Litter Quality and Performance

Broilers do not perform to their genetic potential in a poor environment. The quality of the in-house environment is highly dependent upon litter quality. The litter environment is ideal for bacterial proliferation and ammonia production. The two factors that influence litter conditions most are manure and moisture. The manure portion is largely out of a grower's control; however, growers can and must control litter moisture.

Excess moisture in the litter increases the incidence of breast blisters, skin burns, scabby areas, bruising, condemnations and downgrades. The



wetter the litter, the more likely it will promote the proliferation of pathogenic bacteria and molds. Wet litter is also the primary cause of ammonia emissions, one of the most serious performance and environmental factors affecting broiler production today. Controlling litter moisture is the most important step in avoiding ammonia problems.

Many producers underestimate the detrimental effects of ammonia. The human nose is able to detect ammonia levels near 15 parts per million (ppm) but will lose even this level of sensitivity with long-term exposure. Ammonia concentrations of 50 to 110 ppm can cause the human eye to burn and tear and induce possible health risks to farm workers. EPA has set human exposure standards that should not exceed 25 ppm per 8 hours or 35ppm per 15 minutes of exposure. Chickens are also sensitive to ammonia. Prolonged exposure to high levels (50 to 100 ppm) can result in keratoconjunctivitis (blindness). Obvi-

ously, when ammonia levels are high enough to blind birds, production is seriously affected; however, ammonia levels of just 25 ppm have been found to depress growth and increase feed conversion in broilers. In addition, a greater incidence of airsacculitis, viral infections and condemnations have been linked to ammonia levels at this concentration. Ammonia volatilization from poultry litter can also cause air pollution and lowered fertilizer value of litter due to nitrogen loss.

Litter that is too dry and dusty can also lead to problems such as dehydration of new chicks, respiratory disease and increased condemnations. Ideally, litter moisture should be maintained between 20 to 25 percent. A good rule of thumb in estimating litter moisture content is to squeeze a handful of litter. If it adheres tightly and remains in a ball, it is too wet. If it adheres slightly, it has the proper moisture content. If it will not adhere at all, it may be too dry.

Table 1. Advantages and disadvantages of various litter material.

Pine shavings and sawdust	Preferred litter material but becoming limited in supply and expensive in areas.
Hardwood shavings and sawdust	Often high in moisture and susceptible to dangerous mold growth if stored improperly prior to use.
Pine or hardwood chips	Used successfully but may cause increased incidence of breast blisters if allowed to become too wet.
Pine or hardwood bark	Similar to chips or shavings in moisture absorption capacity. Medium-sized particles preferred.
Rice hulls	A good litter material where available at a competitive price. Young chicks may be prone to litter-eating (not a serious problem).
Peanut hulls	An inexpensive litter material in peanut-producing areas. Tends to cake and crust but can be managed. Susceptible to mold growth and increased incidence of aspergillosis. Some problems with pesticides have been noted in the past.
Sand	Field trials show comparable performance to pine shavings. Long-term reuse potential with de-caking. More difficult to maintain suitable floor temperatures during cold weather brooding. Need ample time and ventilation prior to brooding to assure dryness.
Crushed corn cobs	Limited availability. May be associated with increased breast blisters.
Chopped straw, hay or corn stover	Considerable tendency toward caking. Mold growth can also be a disadvantage.
Processed paper	Various forms of processed paper have proven to be good litter material in research and commercial situations. Tendency to cake with increased particle size. Top dressing paper base with shavings may minimize this problem. Careful management essential.

As time passes, used litter can become seeded with pathogens that affect bird performance. High humidity, warm temperatures and high pH favor the proliferation of pathogens in the litter. Avian influenza, laryngotracheitis, gangrenous dermatitis, gumboro, reovirus, bronchitis and botulism are several of the more serious viral and bacterial diseases known to spread easily in contaminated litter. In addition, fungi that produce mycoses or mycotoxicoses have been isolated in broiler litter, and there is some evidence that these may cause increased mortality when flocks are reared on reused litter.

Parasites, such as round worms, tapeworms and coccidia, are also a potential problem in reused litter. Wet litter further aggravates coccidiosis by providing the proper environment for oocysts to sporulate, thereby increasing challenge levels to which birds are exposed.

Management Practices to Improve Litter Quality

Many factors affect litter moisture. For instance, if new litter is not stored properly and becomes damp before it is spread in the broiler house, wet litter problems would likely be unavoidable. Nutrition also influences litter quality. Certain dietary ingredients (especially salt), when fed in excess, cause broilers to consume and excrete large amounts of water and result in wet litter conditions. Some drugs also stimulate excess water consumption and excretion.

Environmental conditions such as wet and humid weather, condensation or very cold temperatures can cause wet litter if the broiler house ventilation system is not able to eliminate moisture effectively. Drinker lines, foggers and evaporative cooling pads, if not managed and maintained carefully, can contribute greatly to wet litter problems.

Here are some key points to consider concerning litter management:

- Proper house preparation to release ammonia trapped in the litter is necessary to minimize ammonia release from the litter during brooding. Heating and ventilating the house 24-48 hours prior to chick placement will help to accomplish this.
- It may be necessary to increase minimum ventilation during the first few weeks of growout if ammonia levels become too high. Begin with at least 1 minute out of 5 on your timer and decrease the ratio as needed.
- Use circulation fans to move air within the house. The fans help litter dry by moving warm air (which can hold more moisture) off the ceiling and down to the floor.
- In negative pressure power-ventilated houses, use air inlets to bring fresh air into the house. When fans are on, static pressure should be maintained at .05 to .10 inches of water, so air velocity through the inlets stays within the range of 600 to 1,200 feet per minute. This keeps cold air from dropping to the floor as it enters the house and promotes good air mixing.
- Do not be afraid to add heat to the house to facilitate moisture removal. As air is warmed, its ability to hold moisture increases. The combination of heating and ventilating will remove considerable moisture from the house.
- Check and manage watering systems to prevent leaks that will increase litter moisture. Adjust drinker height and water pressure as birds grow to avoid excessive water wastage into the litter.
- If leaks or spills occur and wet spots develop, the affected litter should be removed from the house promptly and replaced with clean, dry bedding.
- Remove cake with a housekeeping machine between flocks (rototilling is not recommended). Cake removal gets excessive moisture and manure out of the house, which, if left in the house, can contribute to elevated ammonia release from the litter in the ensuing flock. In most cases, these de-caking machines are more expensive than one grower can afford; however, several growers could share the equipment and reduce costs to a reasonable level. Take extreme care to completely disinfect such equipment before moving it from farm to farm.
- Make sure no moisture is getting in from the outside. Check grading and drainage around the building to ensure that storm water is being diverted away and not causing a seepage issue under the pad.

Built-Up Litter Management

As a result of the availability and expense of pine shavings and sawdust, and the difficulty of handling and disposing of used litter, many poultry companies and broiler producers have adopted the practice of reusing litter for one, two or even more years of production. This practice has become a standard in the industry.

De-caking the house of crusted litter, preheating and ventilating the house prior to each flock is necessary to help purge the house of ammonia before chick placement. Field experience shows that good performance can be achieved by leaving the litter in the house through several flocks and top-dressing the old litter with a light layer of new litter between flocks. This good performance may be facilitated when the old litter serves as a reservoir for “good bacteria” that acts by competitive exclusion to suppress pathogens. Additionally, old litter typically keeps the floors warmer during brooding.

Some growers do not top-dress between flocks and have found birds do as well on used litter as when top-dressed. Available machines can rework the litter, pick up the cake, stir the litter pack, and apply top-dress bedding. Annual savings estimates from use of a housekeeping machine range from \$700 to \$2500 per house in litter and cleanout costs.

The practice of growing broilers on built-up litter provides considerable management challenges. The potential for problems with ammonia, disease and condemnations increases each time another flock is grown on the same litter and intensifies the challenge of maintaining optimal in-house environment. Controlling darkling beetles can also be a challenge in built-up litter houses.

Controlling litter moisture and ammonia emission are primary areas of concern with built-up litter. The use of nipple drinker systems, however, has made the reuse of litter possible by reducing the moisture content of the litter. The use of litter amendments, coupled with moisture control have made the reuse of litter in poultry houses a common practice.

Litter Amendments

As the practice of growing birds on built-up litter has increased, considerable effort has been made toward controlling the level of ammonia generated

within the poultry house. Numerous chemical and biological litter amendments have been developed to aid in addressing ammonia production from built-up litter. The main premise of these products is the suppression of ammonia volatilization from the litter. Use of these products has become a common practice to enhance quality of litter, both in the house and as a plant fertilizer.

These treatment products fall into three categories: 1) acidifying agents that lower litter pH and thereby inhibit the bacteria that transforms manure nitrogen into ammonia, 2) clay-based products that absorb odors and reduce ammonia release by absorbing moisture, and 3) products that act by inhibiting microbial growth and enzyme production through competitive exclusion and enzyme inhibition. Litter accumulation, litter moisture, bird type, brooding temperature program and disease challenge are among a number of variables that influence selection of treatment, efficacy and return on investment.

Currently, the most effective products seem to be those that react chemically to lower the pH of the litter. The low pH creates an unfavorable environment for most bacteria, including those responsible for ammonia volatilization. Take care to ensure a sufficient and timely application, adequate moisture for activation, and appropriate ventilation. Failure to meet these standards will lead to ineffectual treatment and possible bird and human health safety issues.

While the use of litter treatments has been effective to a degree in controlling ammonia, their overall use has met with varying levels of success. Most of the chemical treatment products are only effective less than three weeks during brooding and may have limited long term impact on ammonia concentrations, especially during later stages of production.

High litter moisture can reduce the effective life of the products even more. Applying the product over the equipment can leave a portion of the litter untreated and can damage equipment over time. It is extremely important to emphasize that litter treatments are not a substitution for good ventilation. Some producers mistakenly believe that the use of litter treatments can reduce minimum ventilation levels. Providing inadequate minimum ventilation can potentially lead to more ammonia volatilization with the amendments than without their use. Proper house preparation, amendment application and litter

management are essential factors that need to be met to maximize the effectiveness of litter treatment products.

The potential benefits of litter treatment products will continue to expand beyond improving bird performance. Litter amendments are increasingly viewed as products that can also address environmental related concerns such as enhancing the composition of litter for end-user markets, limiting the emissions of ammonia and odor from poultry houses, and reducing water-soluble phosphorus concentrations in litter. Products that reduce ammonia volatilization, enhance composition of the litter for fertilizer value, and reduce foodborne pathogens will continue to be improved and their use will likely expand.

Poultry flocks and litter at times suffer from conditions that may warrant the use of a drying agent to improve the in-house environment. Historically, using lime as a drying agent has been a common practice in agricultural buildings. However, chemically speaking, lime is highly basic. Ammonia-producing microorganisms flourish in a more neutral or basic environment. When applied to poultry litter or the floor of a poultry house, lime will raise the pH, thereby facilitating the generation and release of ammonia from the litter and floor soil. As a general rule, lime products are not recommended for use in poultry houses.

A better alternative to using lime as a drying agent in poultry houses is the use of absorbent clays. Absorbent clay products have an increased water holding capacity 5-10 times greater than lime due to smaller, more numerous pores. Clay-based drying agents, either with or without ammonia-reducing

chemical additives, are an excellent material to treat wet floors and spill areas.

Litter Quality and the Bottom Line

The costs of poor litter conditions to broiler producers are estimated in Table 2 on page 6. (These estimates are based on one flock in a single broiler house with a capacity of 20,000 birds.) Obviously, these costs are rough approximations, but they have been made very conservative to avoid overestimation. Actual losses are likely to be much greater.

Growers and integrators share the economic losses outlined in the table. No attempt has been made to separate the costs between the two.

Summary

In the broiler house, litter serves to absorb moisture, dilute fecal material, and provide insulation and cushion between the birds and the floor. Because birds are in constant contact with litter, litter conditions will significantly influence bird performance and ultimately profits of producers and integrators.

The practice of built-up litter requires a higher degree of management to be successful. Growers need to be alert to changes in litter quality and take actions to maintain an appropriate in-house environment for optimal bird performance. Controlling litter moisture coupled with the use of litter amendments can help growers manage litter quality. Proper litter management helps to improve in-house air quality. Any investment growers and integrators make in maintaining ideal environmental conditions for their broilers will potentially return a significant dividend.

Table 2. Estimated costs associated with poor litter conditions, for a flock of 20,000 birds.

Factor and Cost	Rationale for Costs
Ammonia (\$430)	When litter conditions deteriorate, ammonia is always a problem. Research has shown that, if ammonia levels are allowed to reach and remain at 50 ppm or above, feed conversion can be increased by 8 points and final body weight decreased by 0.25 lbs.
Disease (\$120)	Admittedly, this is difficult to estimate, but it is potentially the most costly. One serious disease outbreak can cause economic disaster. It is estimated that disease costs the U.S. broiler industry nearly \$500 million/year in mortality, morbidity and medication. A very conservative estimate would be that poor litter conditions are responsible for only 10 percent of these losses.
Parasites (\$140)	Anticoccidial drugs cost the U.S. poultry industry an estimated \$125 million/year. Anthelmintics (de-wormers) cost another \$35 million. Considering that initial parasitic loads in built-up litter may increase the likelihood of serious infections, and that wet litter promotes oocyst sporulation, the cost of poor litter conditions is considerable.
Condemns & Downgrades (260)	Several studies have reported that litter conditions significantly affect condemns and grade. Cleaning out has been shown to reduce condemns by as much as 50 percent. Breast blisters have been shown to be highly correlated with poor litter conditions.
Total (\$950)	Adding up these estimated losses, we find that poor litter conditions cost producers at least \$950 per 20,000 birds produced. Remember, this is a very conservative estimate; actual losses could likely be much greater.

* A brief explanation of how these cost figures were calculated is provided at the end of this publication (p. 7)

Poor Litter Condition Cost Computations

From Table 2:

Ammonia:	.08	(8-point increase in feed conversion)
	x 5 lbs.	(live weight of broilers)
	x 20,000	birds
	<u>x \$160/ton</u>	(feed cost)
	\$560	
	.25 lbs.	(weight loss per bird)
	x 20,000	birds
	<u>x \$0.06</u>	(lost profit)
	\$300	
	Total \$860	

(To be conservative, 50 percent [\$430] of the total was used.)

Disease:	\$500 million	(cost to U.S. industry annually)
	÷ 8.5 billion	(broilers produced in U.S. annually)
	<u>x 20,000</u>	birds
	\$1176	

(To be conservative, only 10 percent [\$118] of the total was used to estimate the cost of litter-released diseases.)

Parasites:	\$300 million	(cost of anticoccidials and antihelminthics in U.S. annually)
	÷ 8.5 billion	(broilers produced in U.S. annually)
	<u>x 20,000</u>	birds
	\$705	

(To be conservative, only 20 percent [\$140] of the total was used to estimate the cost of litter-released parasitic diseases.)

Condemns & Downgrades	.01	(percent of field condemnations)
	x 20,000	birds
	x 5 lbs.	(live weight of broilers)
	x .75	(yield)
	<u>x \$0.40</u>	(cost/lb. to produce)
	\$300	
	.45	(percent downgrades)
	x 20,000	birds
	x 5 lbs.	(live weight of broilers)
	x .75	(yield)
	x \$0.04	(estimated loss per lb. due to lower grade, trim loss)
	\$1080	

(Fifty percent [\$150] of the total cost of condemnations was considered to be related to litter conditions, and, to be conservative, only 10 percent [\$108] of downgrade costs was used.)

Note: All costs were rounded to the nearest \$10 for use in Table 2.

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Josef M. Broder, Interim Dean and Director