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Dale Bumpers College of Agricultural, Food, and Life Sciences (University of Arkansas, Fayetteville). Center of Excellence for Poultry Science

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AVIAN

Advice

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UNIVERSITY OF ARKANSAS
DIVISION OF AGRICULTURE
Cooperative Extension ServiceFertility and Embryonic
Mortality in Breeders

by R. Keith Bramwell, Extension Reproductive Physiologist

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Coming Events

Introduction

Broiler breeder fertility is, somewhat indirectly, of utmost importance to the overall success of the poultry industry. Through many years of intense genetic selection and improved nutritional management, there has been a steady and rapid increase in the growth rate of broilers produced for the meat market. A natural result of this is that the present day breeders also have the propensity for extremely rapid growth which usually has detrimental effects on reproduction. Consequently, a few years ago some people believed that in order to maintain acceptable fertility levels, artificial insemination would find its place in the broiler industry much like it has in modern turkey breeding programs. However, artificial insemination is not commonly accepted by the broiler industry and it is not likely to be accepted as a necessary alternative for the production of fertile eggs in the near future. Therefore, the broiler industry will continue to use natural mating systems as the primary means of reproduction of broilers destined for the meat market.

Observations in Figure 1 were reported by The University of Georgia and support the importance of fertility and its negative influence on hatchability. Obviously, these data indicate that fertility is the primary factor resulting in fewer chicks hatched per hen housed since even the best incubators and hatchery management procedures can not produce chicks from infertile eggs! In addition, losses in hatch due to early dead embryos often occur concurrently with a reduction in fertility. Thus, in order to more effectively manage flock fertility, it is beneficial to have a better understanding of the series of events which occur prior to and at the site of fertilization in the avian egg.

Fertilization

Successful fertilization in birds occurs following a culmination of a series of events between properly grown breeder males and females. These events, in order, are: the physical act of mating, sperm storage within the hen, sperm transport within the oviduct, recognition of and penetration through the wall of the ovum, and the successful joining of the male and female gamete.

Under natural mating conditions, the physical act of mating is often preceded by courtship which is sometimes very brief. Nevertheless, the physical act of mating, or copulation, is the first actual step in the fertilization process. A necessary component to successfully completed matings is maintaining male breeders which have the desire, or libido, to continue to mate throughout the life of the flock. When the mating process occurs normally, semen is deposited by the male in the hen's cloaca at the rate of approximately 100 to 200 million sperm per ejaculation. Mating must occur frequently enough to ensure that relatively fresh and viable sperm are available to the hen at the time she ovulates. However, avian sperm do have an extended fertilizable life span due to the presence of sperm storage glands located in the hen's oviduct. This allows for stored sperm to travel from these storage tubules to the infundibulum (the site of ovulation and fertilization) at the appropriate time. Although the ability for sperm to be maintained in these storage sites eliminates the need for fertilization on a daily basis, frequent matings insure the availability of fresh, high quality semen in the fertilization process.



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... helping ensure the efficient production of top quality poultry products in Arkansas and beyond.





After the sperm cell has arrived at the site of fertilization, the male gamete, or sperm cell, must recognize the appropriate sites on the outer surface of the ovum prior to its passage through this outer wall. After recognizing the appropriate sites on the ovum, through enzymatic action (called an acrosome reaction) the sperm cell creates a hole, or pathway, through which it passes into the ovum (this process is referred to as sperm penetration). If the sperm cell passes through the outer layer of the ovum in the germinal disc region, it gains access to the female genetic material, or pronuclei. After gaining entrance into the egg, syngamy, or joining of the male and female gametes, can occur. Following these steps, the avian egg has been successfully fertilized; and, given the proper incubational conditions, embryonic development may begin.

Assessing Reproduction in Breeder Flocks

There are several common methods for assessing the reproductive characteristic of breeder flocks. Reproduction in breeders is usually evaluated in the hatchery as part of an egg candling and egg breakout program. Results of an egg candling and breakout program reveal flock by flock patterns and fluctuations in embryonic mortality, embryo abnormalities, fertility, hatchability, hatch of fertiles, and contamination. Other programs can reveal egg shell quality, and egg pack qualities such as percent small end up, dirty eggs, off size or misshaped eggs, farm cracks, etc. On farm egg breakouts can also be used to immediately assess flock fertility without incubation in certain situations. However, the results of all this information must be tabulated and evaluated in order to improve flock performance.

There are generalities associated with some of these data. There is a relationship between the condition of hatching eggs brought into the hatchery and breeder house conditions. Poor egg pack can be attributed to on farm house conditions, frequency of egg collection, as well as time and care taken during on farm egg grading. Fertility is understandably related directly to the current status of the breeder flock and/or a result of lingering conditions related to the grow out phase of pullet and cockerel production. Although the breeder flock itself can affect hatch of fertiles, hatch of fertiles is often determined by the conditions the eggs are subjected after lay as well as during the storage, transportation and incubation processes.

Fertility & Embryonic Mortality

Most individuals involved in reproduction of animals are familiar with the common conception that "it only takes one sperm to fertilize an egg." While this is true in mammals, it is only partly true in the avian world. While it may be true that a single sperm is all that is necessary to *fertilize* an avian egg, the conditions which cause low sperm numbers or single sperm activity at the site of fertilization can cause reductions in the actual number of chicks hatched. When few sperm are available to fertilize an egg in broiler breeders there is an associated reduction in fertility as well as an increase in early embryonic mortality. This is a common occurrence in flocks of older breeder hens or any other flock experiencing infrequent mating activity.

As previously mentioned, during natural mating, approximately 100 to 200 million sperm are deposited in the oviduct of the hen. Using the technique of counting the holes in the ovum caused by sperm penetration, a study was conducted in which hens were artificial inseminated with either 400, 200, 100, or 50 million sperm. In this study, eggs were collected and evaluated each day following a single insemination until sperm penetration activity ceased. The intent was to determine how rapidly the sperms' ability to fertilize eggs decreased following insemination.

As shown in Table 1, sperm penetration in the germinal disc region decreased rapidly with time and sperm concentration. In the groups of hens inseminated with what may be considered a *normal dose* of semen (100 or 200 million sperm), 8 to 10 days following insemination average sperm activity dropped below 10 holes or sperm penetration sites. Two weeks following insemination, both groups averaged less than 5 holes created by this sperm activity. In situations in which more than normal numbers of sperm are deposited in the hens (400 million sperm dose), 12 to 14 days must elapse between matings before numbers under 10 sperm penetration sites are observed. Consequently, under normal conditions it may be understood that anything less than 10 sperm holes indicates a situation where infrequent mating has occurred. In short, few sperm available to fertilize an egg is a result of less frequent mating activity.

Table 1. Sperm Penetration Activity in the Germinal Disc Region

Sperm Number	Days After Insemination									
	2	4	6	8	10	12	14	16	18	20
400	109.5	62.1	31.8	21.4	13.6	9.3	7.8	4.5	3.1	1.8
200	69.2	50.6	18.9	14.1	10.5	8.7	7.0	3.6	2.3	1.1
100	35.9	20.4	10.5	8.8	7.3	4.8	3.7	2.5	1.2	0.9
50	24.6	14.1	7.8	6.2	5.0	3.6	2.0	0.7	0.4	0.1

Previous research has indicated that old, stale sperm in the oviduct is associated with poor chick quality and early embryonic mortality. Old, stale sperm is sperm that has been inseminated in the hen and stored in the storage tubules of the hen's oviduct for an extended period of time and not to old sperm at the time of insemination or sperm from old males. As part of the previously mentioned study, the relationship between the decrease in fertility due to days post insemination and early embryonic mortality of fertile eggs was examined. In this experiment, hens were inseminated with one of two *normal doses* of semen, either 100 or 200 million sperm. Fertility, and early embryonic mortality (0 to 3 days) was measured until the cessation of fertility at 22 days following insemination. As can be seen in Table 2, as fertility decreased in succeeding days following insemination, early embryonic mortality of fertile eggs increased in both groups of hens beginning 12 days after the initial insemination. This is not due to few sperm, but, as has been seen in similar trials, to sperm residing within the hen's storage tubules for an extended period of time. Thus, time causes both a decrease in the number of sperm available to fertilize, and an increased occurrence of in embryo death.

Table 2. Fertility and Embryonic Mortality

Parameter/ Sperm Dose	2	4	6	8	10	12	14	16	18	20	22
Fertility (100 mil sperm)	94.2	88.7	89.3	87.8	63.0	50.0	23.4	15.7	7.0	0	0
Fertility (200 mil sperm)	97.5	94.7	94.7	94.7	81.3	52.9	48.1	21.4	17.5	4.7	0
% embryo mortality (100)	2.4	0.9	2.2	5.2	2.4	4.7	5.1	4.9	6.5	0	0
% embryo mortality (200)	2.1	1.1	1.6	3.6	2.7	4.1	8.2	7.7	6.9	3.3	0
% mortality of fertile (100)	2.5	1.0	2.5	5.9	3.3	10.0	17.9	33.3	93.8	0	0
% mortality of fertile (200)	2.2	1.1	1.7	3.8	3.3	8.0	16.9	32.5	36.7	60.0	0

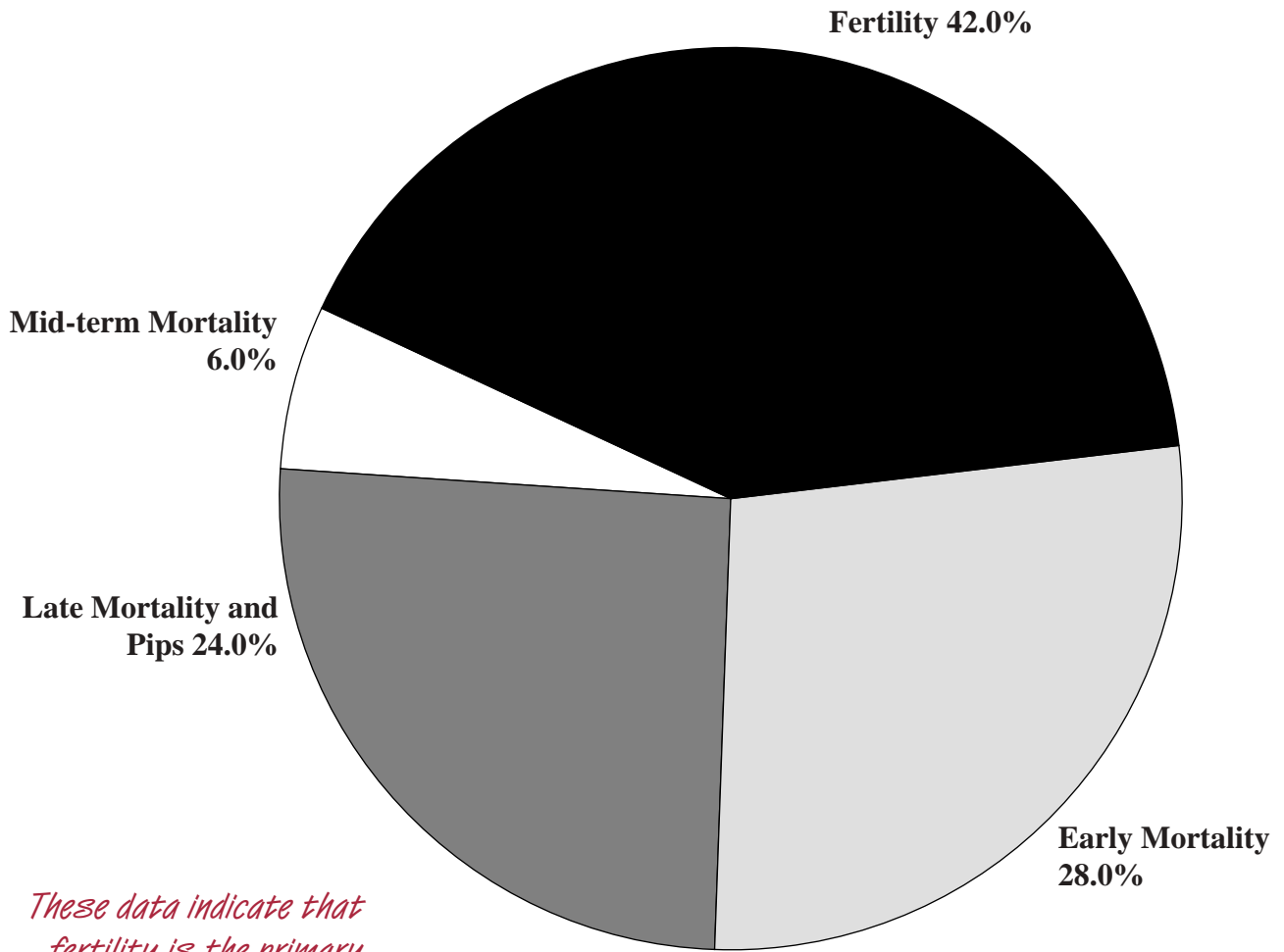
Essentially, 12 days after mating, early embryo mortality begins to rise with up to 10 percent of the fertile eggs dying during the first three days of development. The situation gets worse 16 to 18 days after mating when as much as 93 % of eggs fertilized at this point die during the first three days of development. Interestingly, actual embryo mortality does not increase as drastically because there are fewer developing embryos due to lower fertility. So does it take more than one sperm to fertilize an egg? Not necessarily. Does it take more than one sperm to ensure an egg has the potential to produce a viable quality chick? Yes, absolutely.

Summary

Understanding the relationship between fertility and early embryonic mortality as it relates to the production of quality chicks is important when trying to improve hatchability. As flocks age, mating frequency decreases, fertility decreases, and embryonic mortality increases. Part of the increase in embryonic mortality and decrease in hatch in older hens is undoubtedly due to reduced shell quality and other associated factors. Often times the declining egg production and other flock conditions cause a reduction in interest and attention from the grower. As conditions deteriorate in the flock due to age, attention to detail often subsides and additional hatching egg quality problems result. Problems such as unidentified farm cracks which affect moisture loss in the incubating egg, poor sanitation resulting in contaminated hatching eggs, or simply poor egg handling resulting in weak embryos. However, in addition to the conditions previously mentioned, frequent mating activity must be maintained in breeders throughout the life of the flock as infrequent mating not only results in poor fertility, but reduced hatch of fertiles due to losses from early embryo mortality. Although these factors are very commonly seen in flocks as they age, it is much more costly when these problems arise while the flocks are near peak production or shortly thereafter.

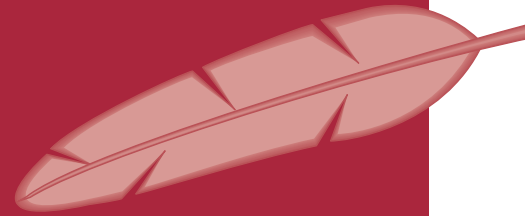
FERTILITY - continued on page 4

Figure 1. Causes for Losses in Hatchability



These data indicate that fertility is the primary factor resulting in fewer chicks hatched per hen housed since even the best incubators and hatchery management procedures can not produce chicks from infertile eggs!





Infectious Laryngotracheitis

Introduction

Infectious Laryngotracheitis (LT) was described almost 70 years ago and has been identified in most countries of the world. In spite of the long history with the industry, the availability of vaccines and Biosecurity procedures, LT breaks still occur. In fact, LT remains one of the most economically important diseases facing poultry producers.

The Virus

The causative agent of LT is a herpes virus. Although only one serotype of the LT virus has been recognized, field strains vary in virulence. Field infections may cause mild inapparent infections or produce high mortality depending on the strain.

Susceptible Avian Species

LT is primarily a disease of chickens, and can affect any age chicken. The disease has also been reported as being isolated from pheasants, peafowl, and pheasant-chicken hybrids. Although LT is not thought to cause disease in other poultry, common domestic birds such as turkeys, ducks, geese, pigeons and quail may spread it. Usually the disease causes the characteristic symptoms and lesions in adult chickens.

Symptoms and Lesions

Once infected, a chicken will generally show symptoms (become sick) in one to two weeks. The symptoms of the disease vary with the virus virulence. In the mild form, symptoms are barely distinguishable from other respiratory problems. Symptoms that have been associated with infections from mild LT strains, vaccine reactions, and other respiratory irritation (from ammonia, dust, or mycoplasmosis) include mild rales, nasal discharge, watery eyes, conjunctivitis, coughing, and possibly a small decline in egg production. Dual infections of LT and bacteria (such as *E. coli*) can produce severe symptoms and mortality. In infections involving more virulent LT strains, the clinical symptoms may include moist rales, nasal discharge, coughing and sneezing followed by gasping for air, severe depression and death due to asphyxiation. Some birds will have extreme difficulty breathing and will cough up blood stained mucus. Birds exhibiting characteristic symptoms and sounds are often referred to as “caller birds.” The percentage of affected birds in a flock can range up to 100 percent, with death usually occurs in 5 to 30percent of the flock. Lesions associated with the disease are usually seen in the trachea and larynx. The lesions can vary with virus virulence and may include excess mucus, hemorrhages, tracheal inflammation, inflammation of the conjunctiva of the eye, and formation of a tracheal plug (consisting of dead epithelial cells, mucus, and blood). As with other herpes viruses, LT is capable of establishing latency in birds by migrating from the trachea to the brain, where it can remain indefinitely. This latent or carrier state complicates preventative measures and control programs, since current techniques cannot detect it. This carrier state means that birds that appear to be perfectly healthy can be the vehicles through which many other birds become infected. Stress often brings out the disease since it causes carrier birds to shed the virus. Stress may also cause carrier birds to exhibit LT symptoms. Social stress, poor ventilation, inadequate space, lack of feed or water, drastic changes in temperature, and many other factors may be associated with LT breaks.

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Transmission

LT is a highly contagious disease. The virus is easily spread through droplets associated with sneezing, coughing, and/or direct touching. The virus easily gains entry into the bird via the respiratory tract or eye. People, animals, litter or equipment that has been in contact with infected chickens can also spread the virus mechanically.

Prevention and Control

The best method of control would be to have an entire industry that is free of LT. However, this appears to be an unlikely possibility. Thus, it is important to ensure that the disease does not spread from infected birds to uninfected birds. This can be accomplished by controlling the flow of humans, animals, equipment, materials and supplies entering the farm, wearing appropriate protective equipment, as well as proper cleaning and disinfection following an infected flock. Service personnel should always service infected flocks on a last-stop basis. While immunization methods generally yield satisfactory resistance to the disease symptoms, vaccination is generally done only in LT endemic areas or when the disease is present in the immediate area. Flocks in low risk areas are usually not vaccinated for LT. In fact, it is illegal to vaccinate for LT in some states. The disease is also listed as a reportable disease in many states. ■



Susan E. Watkins, Extension Poultry Specialist
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Fascinate, then Educate

Allowing children to be fascinated by the incubation process... is a golden opportunity to help kids better understand what is involved in the production of their food supply.

Fascinate then educate is really a simple concept that is difficult to implement when the audience is a roomful of first graders with little idea about where their chicken nuggets really come from. What started a few years earlier as a request from my own childrens’ teachers has progressed into a demonstration that captures the attention of city kids from kindergarten to fifth grade, teaches them biology, a little physics and most important of all, that the poultry industry is taking good care of the birds they raise.

Allowing children to be fascinated by the incubation process and giving them the opportunity to hatch eggs right in the classroom is a golden opportunity to help kids with very little background about animal husbandry have a better understanding of what is involved in the production of their food supply. There are hundreds of websites extolling the evils of factory farming and how cruel the industry is to the animals they raise for meat. Unfortunately there are few places where kids can go to learn positive information about how the poultry industry raises birds for meat and how the industry works every day to produce a safe, wholesome and inexpensive protein source.

The demonstration starts when I smile and hold up a perfectly shaped brown egg and ask casually, “Who wants to turn this into a baby chick?” Squeals of delight ripple across the room as all hands shoot to the sky. “Well good,” I say, “I’ve come to the right classroom. First though, there are a few rules we need to learn about the incubation process.” I cup the egg and then look surprised. “Oh my goodness, I feel the chick wiggling in the egg, he is getting ready to come out.”

From that moment on, all eyes are glued on the egg, me and a computer generated presentation. In less than twenty-five minutes, the students learn about what is necessary for the incubation process to be successful. They learn that in 21 days a chick goes from being the size of a pin head to a forty-five gram chick and that the egg contains everything the chick needs to hatch normally. Even a short physics lesson is thrown in when I talk about how gravity impacts the growth in the egg, making it necessary to turn the egg daily. To emphasize the miracle of the 21-day incubation cycle, I show pictures of the developing embryo throughout the cycle. And at the end of the cycle are pictures of a fluffy chick, a shell with nothing inside and what looks like a submarine hatch for an opening. The last few minutes are devoted to pictures of chickens and turkeys in commercial production facilities. I show the children where the birds get their food and water and how they keep warm. Most importantly, I ask the students if it looks like these birds are being mistreated. No! They reply in unison. "That's right because the industry does their very best to take care of the birds they raise because sick, mistreated birds don't grow very well and it is important to the industry to raise the best birds that they can."

Maybe it doesn't seem like much of plug for a billion dollar industry. But when less than 2 percent of the population is directly involved with food production and even less are involved in the production of food animals, it is a positive step towards making the next generation of consumers feel good about what they eat. ■



Dr. Watkins solicits questions from second graders after presenting her "Fun with Incubation" presentation...



Dr. Watkins responds with a smile and laugh to one of the more "interesting" questions asked by the children...



Dr. Watkins explains how things really work. As is typical in her presentations, the children in this class were fascinated by the entire process.



Litter Management: In and Outside the Poultry House

Introduction

Growers must now be concerned not only with how their litter management is affecting the in-house environment, but also with how their litter management practices are affecting the outside environment when litter is removed. This situation will only warrant increasing attention as more concern is focused on the environment. With this perspective in mind, let's review some of the important issues in poultry litter management both inside and outside the poultry house.

Preventing in house wet litter

If litter moisture averages above 35 percent moisture, poor and unsanitary growing conditions may result. These conditions could include offensive odors, harmful gases (including ammonia), insect problems (particularly flies), soiled feathers, footpad lesions, breast bruises and breast blisters. Litter moisture that averages between 25 and 35 percent moisture in the broiler house can be reused over numerous flocks, unless serious disease problems occur which warrant a total cleanout (Butcher and Miles, 1995). However, it is important to assure the new flock is started on loose, friable material.

For each pound of feed consumed, chickens produce approximately 1-lb. of fresh manure containing about 75 percent moisture. Turkeys produce similar amounts of manure (Vest et al., 1994). While the moisture in manure tends to evaporate, litter will remain wet if excess moisture is not removed from the house. Temperature and ventilation rate must be managed properly to remove moisture from the house. Improper management will result in poor litter and environmental conditions leading to increased stress levels and decreased bird performance. It may come as a surprise to some growers that ammonia levels of just 25 ppm have been found to decrease growth rate by 4 to 8 percent and increase feed conversion by 3 to 6 percent. This level of ammonia has been linked to increased incidence of air sacculitis, viral infections and condemnations. Even low levels (5 ppm) have been shown to injure the protective systems of the chick's respiratory system, causing chicks to be more susceptible to respiratory diseases (Lacy, 2002)

Improper management of waterers may result in elevated litter moisture levels leading to excessive amounts of "caked" litter. Caked litter is litter that is or has been saturated with water. Newly formed caked litter exposes birds to a continually damp, slippery and sticky surface (Butcher and Miles, 1995). When caked litter begins to dry it forms a crusted area that prevents the litter beneath from drying and provides cover for insects. Caked litter is more common in cooler weather when temperatures and ventilation rates are low, but can also be a problem in warmer weather. Caked litter is most often found under water lines. Therefore, management of both water line pressure and height are important to prevent cake formation and buildup. In addition, it is important to promptly replace leaky nipples to keep litter moisture as low as possible. Collins Jr. (1996) indicated that reducing water spillage will:

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REDUCING WATER SPILLAGE CAN:

1. save water
2. improve bird quality
3. improve production environment
4. reduce ammonia release from litter
5. reduce volume of wet cake
6. extend time between litter cleanouts

Excessive litter moistures can also be caused by factors other than improper management. High intake of minerals such as potassium, sodium, magnesium, sulfate or chloride can lead to excessive water consumption and wet droppings (Butcher and Miles, 1995). These minerals could be delivered in the feed or present in the water supply. This means that growers should periodically have their water checked for mineral concentrations and also bacterial loads. The consumption of moldy feed can mean that birds are exposed to mycotoxins, which may also result in wet droppings. Growers should periodically clean their storage bins and feed hoppers to ensure that caked or moldy feed is removed. Numerous diseases cause poultry to excrete wet droppings, either through alimentary canal damage or by birds going off feed but maintaining water consumption (Butcher and Miles, 1995). The type and amount of bedding material can also have an impact on litter quality. While soft wood shavings may be the product of choice, many times it is unavailable or too expensive leading to use of other, less absorbent materials (rice hulls, straw, etc.). A lack of bedding material on the floor may also lead to wet houses. A depth of 4-6 inches is usually recommended to assure adequate moisture absorption and cushioning capabilities.

Management of litter after removal from the house

Proper management of litter in the house will reduce the need to move excessive amounts of litter between flocks and will aid in developing a cleanout schedule that allows direct application of manure to forage or crop land without intermediate storage (Collins Jr., 1996). This direct application is more efficient because it decreases handling costs (moving litter once versus twice) and nitrogen will be more efficiently utilized.

Tabler (2000) estimated that 105 tons of litter are produced annually in 40 by 400 broiler houses. Caked litter accounted for 28 percent of this total with the remaining 72 percent being dry litter. Thus, approximately 13 lbs of litter are produced per square foot of house. Vest et al. (1994) estimated annual manure production at 2.5 lbs. of manure per broiler, 40 lbs. per commercial layer, 44 lbs. per broiler breeder, 8 lbs. per replacement pullet and 31 lbs. per turkey. While differences exist in these estimates, the volume of litter produced has made litter management an important issue for both the poultry industry and farmers.

As a fertilizer, compared to mineral salts, organic amendments such as poultry litter offer several advantages (Table 1). Although poultry litter contains significant amounts of plant nutrients such as nitrogen, phosphorus, and potassium, other essential nutrients are also included in poultry litter in trace amounts. Experience has shown the nutrients in poultry litter become available for plant uptake when applied to soil. Unfortunately this availability of nutrients in litters, as compared to commercial fertilizers, is unpredictable. Phosphorus and potassium become most readily available in soil, while nitrogen has the slowest release rate of the three major nutrients (Dick et al., 1998). In order to create a balance of nutrients in their soils, farmers must plan a method of fertilization according to these differing release properties. Dick et al. (1998) indicated two possible strategies were (1) apply litter so as to receive the desired amounts of phosphorus and then add commercial potassium and nitrogen fertilizers to make up the deficit in these nutrients or (2) apply enough litter so as to insure a proper amount of nitrogen will be released into the soil. The danger with the second method is that it greatly increases the risk that phosphorus and potassium will be oversupplied, thereby adversely affecting soil and water quality.

Litter nutrient concentration depends on type of bedding used, feed source, type of poultry being raised, number of flocks between house cleanouts and management practices. This results in a wide range of nutrient values (Table 2). While calcium supplement for egg layers increases the

calcium carbonate concentration in the litter, it also results in an increased pH in the litter which, in turn, increases the potential for nitrogen to be lost as ammonia gas (Dick et al., 1998). Tables 3 and 4 list average nutrient content of broiler and hen manures (Table 3) and turkey manure (Table 4).

Timing of litter application to forage or crop land can be extremely important in influencing the amount of nutrients released, and the rate at which they are released.

Timing litter application and use of Best Management Practices (BMPs)

Time of litter application to forage or crop land can be extremely important in influencing the amount of nutrients released and the rate at which they are released. Fall application allows maximum time for litter to decompose and release nutrients for next year's crop. However, this also offers the greatest potential for soluble nutrients to be lost by leaching and for nitrogen to be lost by denitrification. Spring litter application will usually conserve more nutrients, but may also interfere with other types of farm operations that must be accomplished in a timely manner (Dick et al., 1998).

Most of the nitrogen in poultry litter is available the first year after it is applied. The amount of nitrogen available two years after application is difficult to predict because it is dependent on climatic conditions during the previous year and the crop produced. The amount of nitrogen carry over will also vary depending on the number of years litter has been applied to the location. A soil treated with litter only once will carry over almost no nitrogen whereas a soil treated annually for five or more years may carry over 5 to 10 percent of the applied nitrogen (Dick et al., 1998).

Litter applied in sufficient quantity to meet nitrogen needs of a healthy growing crop results in more phosphorus added to the soil than plants can utilize. Phosphorus utilization by plants during the year following litter application will range from 20 to 80 percent of the total applied depending on soil types and other factors (Mississippi State University, 2001). Until the early 1990s, it was thought soils had an infinite capacity to store the unused phosphorus (Mississippi State University, 2001). However, recent research has revealed that increasing the phosphorus level above that needed for crop production increases the potential for phosphorus in the runoff water from the field (VanDevender et al., 2000). Since phosphorus is usually the limiting nutrient in low-fertility clearwater lakes and streams, a slight increase can result in unwanted algae blooms and other aquatic vegetation (VanDevender et al., 2000). The following Best Management Practices (BMPs) are recommended by VanDevender et al. (2000) for proper litter management. The objectives of the following BMPs are to maximize the value of poultry litter, protect the environment and maintain good relationships with neighbors.

- Develop and follow a Comprehensive Nutrient Management Plan (CNMP) for your operation. This plan will be tailored to fit the conditions of your farm and provide management guidelines that are more specific to your farm than the BMPs listed below.
- Have the soils in the application fields tested (see the local county Extension office for assistance). If soil test phosphorus is a concern, consider reducing litter application rates and supplementing with commercial fertilizer.
- Spread litter uniformly over the application site. Unless specified by a CNMP, apply no more than 2 tons per acre for each application, with an annual application of no more than 4 tons per year.
- Do not apply poultry litter on land when the soil is saturated, frozen, covered with snow, during rainy weather or when precipitation is in the immediate forecast.
- Do not apply litter on slopes with a grade of more than 15 percent or in any way that allows manure to enter water sources.
- Do not apply litter within 100 feet of streams, ponds, lakes, springs, sinkholes, wells, water supplies and dwellings. Do not apply within 25 feet of rock outcroppings.
- Keep records of dates, amounts and litter application sites. If you sell litter, keep a record of who buys the litter and the dates and amounts sold.

- Cover or tarp vehicles when transporting litter on public roads.
- Develop a good relationship with the surrounding community. Avoid spreading litter when it would be objectionable to your neighbors.

Make it a habit to develop and then stay on a regular soil testing program. “You can’t manage what you can’t measure” is a phrase heard quite often these days and with good reason. You must know what you have before you can know your next step. Soil testing is inexpensive, simple, and is a powerful tool for farm management. You will learn not only the nutrient levels in your soils, but also the pH and lime requirements. Mississippi State University (2001) research has indicated that in most soils litter applications tend to increase pH levels and decrease lime requirements over time. Thus, when litter is land applied, it has a liming effect. Increasing the pH by meeting recommended lime requirements provides the extra benefit of increasing availability of native nutrients in the soil.

Mukhtar et al. (2001) recommends the following common sense approaches for applying litter to land:

- Before scheduling an application, talk with neighbors to make sure the application is not made on a day when they have planned outdoor activities.
- Do not apply litter on weekends or holidays.
- Apply litter early in the morning when the typical airflow patterns will lift odors high into the air.
- Select a day when the wind is blowing away from neighbors.
- Do not apply litter on hot, still afternoons when there is little air movement and odors are concentrated.
- Avoid extremely dry, windy days when application is likely to generate a lot of dust and rainy periods or when rain is in the immediate forecast.

Summary

Poultry growers should strive to maintain an in-house environment which will allow the birds to perform up to their genetic potential. This means paying special attention to the ventilation, heating, water and feed systems. Proper temperature and air flow must be maintained to prevent moist, humid conditions from developing in the house leading to wet, caked litter and increased ammonia problems. Dry litter can be used for numerous growouts reducing cleanout and bedding costs and improving the nutrient content of the litter thereby increasing its fertilizer value.

Poultry litter is a natural soil amendment that adds nutrients and organic matter to increase soil fertility. However, significant potential for pollution exists if Best Management Practices are ignored. All farmers should have a Comprehensive Nutrient Management Plan (CNMP) in place for their farm and follow it. Timing land application of litter is important in influencing the amount of nutrients released and the rate at which they are released. Following BMPs and having a CNMP in place will help assure that litter is spread when and where and in the proper amount to prevent potential pollution problems. Contact your local county extension office or Natural Resources and Conservation Service offices for assistance with a CNMP and to learn more about BMPs.

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Table 1: Comparisons of organic amendments and mineral salts as fertilizers.¹

Material	Advantages	Disadvantages
Mineral Fertilizers	<ul style="list-style-type: none"> • Convenient • Transport and handling cost lower • Quick Crop Response 	<ul style="list-style-type: none"> • Some easily leached • Nutrient availability is tied to application time and is not sustained
Organic Fertilizers	<ul style="list-style-type: none"> • Improves soil structure • Controls erosion • Supplied wide range of nutrients • Improves water holding capacity 	<ul style="list-style-type: none"> • Dilute nutrient source • High transport cost • May be difficult to apply evenly • High C/N ratios may rob N from soil

¹ Source: Dick et al., (1998)

Table 2: pH, organic carbon content, and nutrient composition of poultry litter.¹

Parameter	Sample Type	
	Eggs layer litter	Broiler litter
Organic C (%)	15.3 (4.7)²	32.5
pH	8.1	6.4
Salts (dS/m)	7.2	7.0
Macronutrients		
Nitrogen, %	3.3	4.1
Phosphorus, %	2.9	2.1
Potassium, %	3.6	2.7
Sulfur, %	1.0	0.73
Calcium, %	17.9	4.0
Magnesium, %	0.8	0.7
Micronutrients		
Boron, ppm	42.7	33.5
Copper, ppm	163	163
Iron, ppm	2040	3254
Manganese, ppm	647	444
Molybdenum, ppm	10.7	6.2
Zinc, ppm	403	383

¹ Source: Dick et al., (1998)

² Value in parenthesis is inorganic C as calcium carbonate

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Table 3: Average amount of plant nutrients in broiler and hen manures on an as-is basis.¹

Manure Type	Total N ² Present	N ² as NH ₄	Phos. ² as P ₂ O ₅	Pot. ² as K ₂ O
	-----lbs./ton-----			
Broiler house litter ³	66	10	50	40
Roaster house litter ³	68	11	53	41
Breeder house litter ⁴	31	7	40	35
Stockpiled litter	36	85	5	35

¹ Source: Vest et al., (1994)

² N=Nitrogen, Phos.=Phosphorus, Pot.=Potassium

³ Assumes a moisture content of 23%

⁴ Assumes a moisture content of 40%

Table 4: Average nutrient content of turkey manures.¹

Manure Type	Total N ² Present	N ² as NH ₄	Phos. ² as P ₂ O ₅	Pot. ² as K ₂ O
	-----NH ₄ lbs./ton P ₂ O ₅ -----			
Brooder house litter ³	45	9	52	32
Grower house litter ⁴	57	16	72	40
Stockpiled litter ⁵	36	8	72	33

¹ Source: Vest et al., (1994)

² N=Nitrogen, Phos.=Phosphorus, Pot.=Potassium

³ Based on cleanout after each flock

⁴ Based on annual cleanout after full production

⁵ Based on annual house accumulation removed to uncovered stockpile to be spread within six months

Coming Events

Here's what to look forward to this summer:

Poultry Festival
June 7-8, 2002
Hot Springs, Arkansas
Contact: The Poultry Federation
Phone: (501) 375-8131

Poultry Science Youth Conference
July 9-12, 2002
University of Arkansas, Fayetteville
Center of Excellence for Poultry Science
Contact: Gary Davis
Phone: (479) 575-7526

Poultry Science Association
August 11-14, 2002
Annual Meeting at University of Delaware, Newark, DE
Contact: Poultry Science Association
Phone: (217) 356-3182

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