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INSIDE

Beat the Heat!

Be Prepared for Summer Flocks

by Susan Watkins, Extension Poultry Specialist

Hot or cold, which is worse?

What's worse for your birds, being too hot or too cold? You may be surprised to know that heat stress is more detrimental to bird performance than cold stress. The effects of being too hot begin with the breeder birds that fail to eat adequately and produce smaller chicks and poults. Then place these birds in a hot environment. Not only do they not want to eat properly, but they also use valuable feed energy to get rid of heat instead of growing. Heat stressed birds experience poor feed conversion and weight gains as well as higher mortality and morbidity. Heat stress can begin at 80°F for turkeys and 85 – 90°F for broilers (depending on age). If birds are panting, they are hot and not productively using feed.

Minimize the impact of heat stress by maximizing air movement over birds and using foggers or fogging pads to reduce the air temperature sensed by the birds. Most poultry houses are equipped to handle heat. The key is to make sure ALL equipment is ready for that sudden spike in temperature.

Optimize air movement

The most effective air movement is at bird level. Lower circulation fans so that they move air directly over birds. Even a light breeze of 4 miles/hour can help reduce the temperature sensed by the birds as much as 10 to 15°F. In conventional houses, place 36 inch circulation fans every 40 to 50 feet blowing in the same direction. If circulation fans won't lower, then use baffles to direct air-flow downward. Position circulation fans so that they blow with prevailing winds. Turn fan thermostats to 74°F during the day so that fans will continue to run in early evening and help get birds cooled down more quickly.

Don't allow fan thermostats to get wet from foggers. A wet thermostat will sense a lower temperature than what the air really is. Wet thermostats may also cause electrical shorts. A 2-liter plastic beverage bottle can be modified into a protective umbrella for thermostats. Cut the bottom out of the bottle, remove the thermostat and slide the bottle over the wire. Reattach the thermostat and then seal the top of the bottle around the wire with electrical tape.

If you are paying the utility bill for fan motors to run, make sure you are getting the most for your money. Inspect all belt-driven fans and replace old or worn belts. Worn belts reduce fan efficiency by 10%. Keep fan belts tight because loose belts are 30% less efficient. Clean shutters, blades, housing and screens on a regular basis. This will improve fan efficiency by 20-30%. Fans motors should also be on a regular maintenance and service schedule that includes properly lubricating the bearings. Avoid disasters by having spare fan belts, motors and circuit breakers.

Don't allow weeds grass, bushes to block air flow into poultry houses. Utilize herbicides to control vegetation growth around houses. Warning: Do not spray herbicides when birds could be exposed and be certain that your company approves of the herbicide you are using.

HEAT - continued on page 2

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

HEAT - continued from page 1

Fogger system maintenance.

Make sure all nozzles work. Clean or replace nozzles that are clogged or several years old. Remember fogging can provide birds with some heat relief because humidity during the hottest part of the day is the lowest. This hot air can hold more water and by saturating the air with moisture, the more heat the air will absorb before it rises in temperature. The end result ca be a reduction in temperature by 10 to 15°F. It is important to note that the cleaner used should be compatible with the fogger nozzle material to prevent damage to the nozzles.

Water System Check

Conduct a water system inventory to assure that every drinker is working properly. Birds double water consumption when hot which means they spend twice as much time drinking. If even a few drinkers are not working then competition for water causes bird stress. And if birds are really hot, they may completely give up if their closest water source fails to quench their thirst. Insulate water lines as well as flush water lines 2 to 3 times a day to reduce water temperature. Birds will not drink hot water. Increased water consumption and low levels of water in wells may also result in water filters becoming dirty and clogged more frequently. Have extra filters on hand to prevent water flow problems. Don't let your guard down with your water sanitation program which includes cleaning lines with a sanitizer once a week and cleaning plassons every day. Warm water can support tremendous explosions in bacterial growth.

Other tips, work birds before 9:00 a.m. Encourage birds to consume feed during the coolest parts of the day such as midnight to early morning. If foggers and fans aren't providing adequate heat relief then use soaker hoses on roof.

In conclusion, being prepared for hot weather can provide relief for the most detrimental stress mother nature can give a flock. Making sure equipment is ready and back up supplies are on hand can prevent disasters and keep flocks profitable. ■

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Caring for Hatching Eggs Prior to Incubation

Introduction

There are many factors which affect chick quality and percent hatchability from hatching eggs. As a general rule, other than fertility, conditions in the hatchery are considered to be more important to successfully hatching quality chicks than conditions on the farm. However, providing the proper temperature and environmental conditions for hatching eggs prior to incubation can be nearly as important as during incubation. As midday summer temperatures continue to rise both in, and around breeder houses, it then becomes even more critical to handle hatching eggs properly. To maximize the number of quality chicks hatched from these eggs, it is helpful to understand how the avian embryo develops and why maintaining a proper storage temperature of hatching eggs is so critical.

EGGS - continued on next page

Sperm storage in the hen

The avian reproductive system is somewhat unusual in that it allows the hen to store sperm in specialized sperm storage sites within the oviduct. After successful mating and insemination by the male, sperm cells deposited in the hen accumulate in these storage sites called sperm storage tubules, in the oviduct. These primary, long term sperm storage tubules are located in the lower portions of the oviduct, while additional short term storage sites are located in the upper portions of the oviduct closer to the site of fertilization. The domestic chicken hen can store viable sperm for 20 days or longer after a single insemination. Reports indicate that turkey hens have the ability to maintain viable sperm within their storage tubules for as long as 40 days. However, while these stored sperm cells may maintain their ability to fertilize an egg, eggs fertilized from sperm stored in the hen for longer than 12-14 days have increased incidences of early embryonic mortality (particularly in days 1-3 of incubation).

Fertilization and Embryo Development

Twenty to thirty minutes after a hen lays an egg, the next ovum (or yolk) is ovulated and this is the egg that will be laid the following day. The ovum that has just been ovulated must be fertilized within the first 5-10 minutes after it is released from the ovary. The addition of egg albumen around the yolk begins within these first few minutes following ovulation and will prevent fertilization from occurring. The addition of the egg albumen renders the sperm cells incapable of penetrating the outer layer of the ova thus preventing fertilization of the egg. As the yolk, or ova, moves down the reproductive tract, additional albumen is laid around the yolk, egg membranes are laid around the albumen then a shell is formed on the membranes to surround the entire package. This process requires approximately 24-26 hours from the time of ovulation to the time the egg is laid.

While the egg progresses down the oviduct, it is maintained at the hens body temperature of between 104° and 106° F (40° to 41.1℃). Although the ideal incubation temperature is near 100° F (~37.8℃), following fertilization of the avian egg, any temperature greater than 70℉ (21.1℃) can allow for embryonic development. Obviously, the hen's body temperature of 104-106℉ is sufficient to allow for embryonic development in the 24-26 hours after fertilization and before the egg is laid. Therefore, at the time the egg is laid, the chicken embryo is composed of approximately 20,000 to 40,000 cells. What this really means is that from fertilization to hatching it requires approximately 22 days to complete development in the chicken egg and about 29 days for turkeys, with about 4.5% (in chickens) of this time occurring prior to the egg being laid.

Arresting Embryo Development

After the egg is laid, further development of the embryo can be carefully interrupted by lowering the temperature of the egg. This is natures way of allowing a hen to accumulate enough fertile eggs to form her clutch, which she will incubate and hatch. By bringing the internal temperature of the egg below the physiological temperature of 70° F, further development of the embryo stops. The longer the egg remains above approximately 70° F, the greater the potential for embryonic development to occur. If the embryo undergoes too much pre-incubational development prior to being cooled, the chick can hatch early and will dehydrate and weaken by the time the entire hatch is pulled out of the hatchers.

Additionally, if the internal temperature of the egg is allowed to oscillate above and below a 70 to 80 ° temperature range, the embryo may continue to start and stop development. It is not uncommon to see producers remove partial buggies of hatching eggs from the cool room to fill the remainder of the rack. This situation allows the eggs to oscillate above and below the physiological temperature of 70° F. When this happens, the embryo becomes weakened and there is a greater chance for the embryo to die in the first few days of development inside the setters. Obviously, when this happens there will be a decrease in the overall hatch of the eggs as well as a subsequent reduction in chick quality.

Egg storage prior to incubation

To maximize the chance of fertile eggs developing properly into healthy chicks, hatching eggs should be handled with care. Hatching eggs should be removed from the hen house as often as possible and placed in the cool egg storage rooms to avoid unnecessary pre-incubation development. Frequent gathering of eggs becomes more and more important as the midday summer temperatures continue to rise. Houses equipped with mechanical nests provide an opportunity to remove eggs from the houses more frequently and more rapidly as compared to conventionally equipped houses. Houses which rely completely on manual egg collection generally expose the hatching eggs to elevated temperatures for extended periods of time

. Once the eggs are removed from the breeder house, they should be stored between 50-70° F (65 - 68° F recommended) with a relative humidity of 75% if possible for no more than seven days. This temperature will safely arrest embryo development and the humidity will prevent excessive egg moisture loss from the eggs. Storage of eggs for longer than seven days will result in significant reductions in hatchability. Turning eggs during storage is generally not necessary when stored for less than seven days, but if done, won't hinder normal embryonic development. When eggs have been placed in the cool egg storage environment, they should not be allowed to warm up above the physiological temperature until they are ready to be placed in the incubator. Pre-warming of eggs is gaining popularity and is beneficial as a method to slowly bring the arrested embryo back into active development. Remember, eggs already contain a live developing embryo and any added stress negatively effects their development and reduces the number of quality chicks hatched.

Summary

During the hot days of the summer, increase frequency of egg collections times, particularly in the afternoon hours. This should be done in an effort to get hatching eggs into the cool room as soon as possible. This is much more important in older houses not equipped with many of the modern environmental control systems. Once eggs have been placed in the egg storage room, do not remove them unnecessarily. Once embryo development is arrested, it should not be allowed to proceed until the eggs are ready to be placed in the setters. Remember that poor egg handling on the breeder farm can reduce both overall egg hatchability and chick quality.

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Mad Cow and You

Background on TSEs

BSE or **B**ovine **S**pongiform **E**ncephalopathy is also known as mad cow disease. BSE is a central nervous system disease of cattle. The disease is progressive in it's effects and is always fatal. BSE is characterized by the appearance of vacuoles (clear holes) in the tissue of the brain. These vacuoles give the brain the appearance of a sponge, thus, the term spongiform.

BSE belongs to an unusual group of progressive, neurological diseases known as **T**ransmissible **S**pongiform **E**ncephalopathies (TSEs). TSEs are characterized by a long incubation period (several years), during which there are no visible sign of the disease. When symptoms appear there is a gradual impairment of the central nervous system that is invariably fatal. There is no known treatment or cure for TSEs.

No one really knows what causes TSEs. However, the current theory is that TSEs are caused by small proteins called prions (pronounced pree-ons). Prions are abnormal variants of proteins that normally occur in brain cells. When prions enter the body they are able to convert their normal counterparts to abnormal forms. Although enzymes easily degrade normal proteins within the brain when they are not needed, prions are folded in such a way as to prevent their degradation. Thus, prions accumulate in brain and spinal cord tissue and tend to link together causing abnormal central nervous system function and eventually death. No one really knows how many prions are required to cause the disease. However, most experts believe that very few prions required to cause TSEs. While prions are not completely understood, they are resistant to the effects of cooking or rendering, but are known to be sensitive to solvents, oxidizing agents and extremely high temperatures.

While we are on the subject, a TSE disease called Chronic Wasting Disease (CWD) occurs in a small number of American elk and deer in certain parts of the country, particularly Colorado and Wyoming. The Food and Drug Administration (FDA) is working with other government agencies and public health officials to address CWD in wild animals. Wildlife officials in Colorado and Wyoming have advised individuals not to harvest, handle or consume any wild deer or elk, especially in Colorado or Wyoming, that appear to be sick, regardless of the causes.

When symptoms appear there is a gradual impairment of the central nervous system that is invariably fatal. There is no known treatment or cure for TSEs.

A Very Short History of Mad Cow Disease

BSE was first recognized in cattle in the United Kingdom (UK) in 1986 and had apparently not occurred before then. It is believed that BSE originated from the scrapie organism. Scrapie is a disease of sheep which was present in the UK for nearly 200 years. It is presumed that the scrapie agent changed species and adapted to cattle. The initial spread of BSE was through rendered animal products (such as meat and bone meal) made from scrapie infected sheep. BSE then spread in epidemic proportions via rendered animal products made from affected cattle. Interestingly, in the UK fat was extracted from rendered animal products using solvents prior to 1980. The extraction with solvent apparently destroyed the BSE agent. However, after 1980 the solvent fat extraction process was not used, allowing the BSE agent to survive and spread. Approximately 95% of all BSE cases in the world have been found in the UK.

Variant Creutzfeldt-Jakob Disease

Variant Creutzfeldt-Jakob Disease (vCJD) in humans is a TSE disease that is linked to BSE. There have been a total of 92 cases of vCJD worldwide and there is a genetic component of vCJD (i.e. it tends to run in families) which accounts for about 10% of cases. However, the incubation period for BSE appears to be 6 to 7 years in cattle and the incubation period for vCJD may be equally long or longer.

MAD COW - continued on next page

Keeping BSE from U.S. meats

BSE has **NEVER** been found in meats produced in the U.S. However, regulatory officials remain cautious and have been aggressive in strategies to prevent BSE from entering the country. In 1989 imports of live ruminants and many ruminant products were banned from countries where BSE had been found. In 1997 the import of live ruminants and most ruminant products from all the countries of Europe were banned. In 1998 a survey of downer cows for BSE was intensified. Federal regulators have also been very aggressive in efforts to prevent the spread of BSE in the unlikely event that it does enter the country. For example, as early as 1997 the FDA banned the use of mammalian proteins (e.g. meat and bone meal) in ruminant feeds. The importation of rendered proteins or rendering wastes from Europe was also banned in 2000.

In addition to governmental actions, beef packers and retail operations established certification programs this spring to insure that they **are not** receiving cattle that have been fed ruminant derived protein materials. Packers participating in the certification program **will not** purchase **any** cattle from producers who have **not** signed a statement certifying that **none** of their cattle or other ruminant animals have been fed any feed containing protein derived from ruminant tissues and / or that none of their livestock have illegal levels of drug residues

How BSE can affect you.

Poultry are apparently not affected by TSEs or BSE but, an estimated 75% of poultry rations contain ruminant products. Those feeds that do not contain ruminant products have been produced in feed mills where such products are in inventory. Since the FDA declared the feeding of mammalian products to ruminants illegal in 1997 and most poultry feeds contain mammalian products, **the feeding of poultry feeds to cattle is illegal and can not be defended.** In addition, feeding poultry feeds to cattle would result in filing a false certification at the sale barn. A false certification would mean that **the producer is vulnerable to civil suits by packers and retail operations.**

IF BSE or mad cow disease were ever discovered in the U.S. this issue would likely become "big news" to the news media. Investigative reporters would likely attack such a story vigorously. These reporters would try to tie the story to everything they felt they could. There could also be panic created among consumers, leading to reduced meat consumption. Any tie of BSE to the poultry industry could mean that poultry products become suspect in the mind of the consumer.

In view of this situation, it is **imperative** that poultry growers keep cattle from eating **any** poultry feed. Not only is feeding poultry feed to cattle unwise, it is illegal. In addition, feeding poultry feed to cattle can mean that poultry products would be implicated in any BSE "news event."

BOTTOM LINE: DO NOT FEED ANY POULTRY FEED TO CATTLE.

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Should My Old Broiler Houses be Remodeled?

Introduction

Last winter we all struggled through the coldest temperatures in memory and the highest gas prices we ever endured. Many growers were unprepared and some growers were forced by the high gas prices not to place birds for an extended period. The prospect of a long, hot summer now looms ahead. Last winter's gas prices and increasing electrical costs have forced many growers with older houses to seriously evaluate their houses and decide whether or not they will continue to grow poultry. Some houses that may still be useful to their owners as hay barns or implement sheds, but should soon be retired as broiler houses. Yet, there are many more older

REMODEL - continued on page 6

REMODEL - continued from page 5

broiler houses that, with some investment, can be profitable operations for several years to come. However, before investing in house renovation growers should take a hard, honest look at where they can get the most return for their investment.

Most new broiler houses being built today have dropped ceilings, are well insulated, tunnel ventilated, evaporatively cooled and have automatic electronic controllers. Many houses also have static-pressure controlled sidewall or ceiling air inlets. Most older houses do not have this advanced technology and it will be harder and harder for these houses to compete with modern facilities. Options should be carefully weighed before deciding to retrofit, but what should you be looking for?

Where to Start

One of the first things to consider is the integrity of the house structure itself. If the house will not last long enough to recoup an investment in advanced technology, then it should be gradually phased out of production. Take a long, hard look at your houses. How old is the house in question? Does it have center posts? Is it leaning? Does it have a dropped ceiling? In what shape is the ceiling or insulation? Does the roof leak? (Donald *et al.*, 2001).

If renovation is a viable option, before spending any money, visit with your live production personnel and be certain of their future direction in broiler operations. Also, ask questions and get information from extension poultry specialists and agricultural engineers.
Consult local equipment dealers for price quotes and to take a look at manufacturers' literature. In most cases, if an older house is judged worthy of reworking, the items with the most significant payoff possibilities are (Donald *et al.*,2001):

1. Improving house tightness and insulation
2. Converting to tunnel ventilation
3. Adding static-pressure controlled air inlets
4. Adding pad-type evaporative cooling
5. Installing an automatic electronic controller

Improving House Tightness and Insulation

Loose houses use much more fuel, have poor litter quality and poor temperature control than do tight houses. Having a tight house makes it easier in cold weather to keep fuel costs down, while maintaining adequate temperature and litter conditions. During hot weather in a pad cooled house, birds receive maximum cooling, since all air enters through the pads and not through unwanted cracks and leaks. This results in less heat buildup from the inlet end to the fan end of the house. Tightening up the house should be first on the list of where to spend money on an older house to get the most return (Donald *et al.*, 1999b).

To test the tightness of your house you will need a static-pressure meter. You will also need to be sure that your fans are rated at about 20,000 cubic feet per minute (cfm) at 0.05 inches of static pressure. With all the inlets and doors closed, turn on one 48-inch fan or two 36-inch fans and test the static pressure. A tight house should show a reading of 0.12 to 0.15 inches. However, many older houses may test out at 0.05 inches or less, indicating they have at least 14 square feet of leakage. Consider that a continuous uncaulked 1/8-inch crack under a sill plate that runs along both sidewalls of a 500-foot house adds up to a 10 square foot (sq ft) opening. So it doesn't take much before a tight house becomes a loose house (Donald *et al.* 2001).

The condition of insulation should also be checked when checking for tightness. Since loose insulation tends to settle and lose insulating value over time, older houses with drop ceilings should be checked and insulation added if needed to reach an R19. In open truss houses, R-10 should be considered the minimum under-roof insulation. Adequate insulation will not only will save fuel costs in winter, but it will protect birds in summer from solar heat re-radiated from an un-insulated roof (Donald *et al.* 2001).

Converting to Tunnel Ventilation

Most new houses now being built are tunnel ventilated. While the benefits of tunnel ventilation are well documented for all sizes of birds, the larger the bird being grown, the more valuable tunnel ventilation is and the greater the importance of high wind speed. Many companies today consider 500 feet per minute air velocity to be the minimum required fan capacity. In some cases where broilers are being grown to very large sizes, some companies are designing for 600 feet per minute. Yet older tunnel houses may not have enough fans, enough pad space, or a combination of the two to provide adequate wind speed. However, before purchasing new fans growers should decide about the drive type, electrical efficiency and cfm delivery under static pressure.

Direct drive fans tend to cost less and require less maintenance than belt driven fans. However, direct drive fans are less efficient, move less air and are louder than belt driven fans. The drive type decision will depend on the size of the fan and how it is to be used. Direct drive fans might make sense as mixing or minimum ventilation fans since these fans are normally 36 inch fans which do not run constantly, but should be reliable and long lasting. Belt-drive fans are generally preferred for 48 inch tunnel ventilation because they generally move more air at less cost than direct-drive fans. (Donald, 1997).

Fan efficiency is usually measured by the number of cfm's per watt of power expended (cfm/watt). The higher the cfm/watt the greater the fan efficiency. For instance, if fan number 1 is a 20,000 cfm fan rated at 20 cfm/watt, while fan number 2 is a 20,000 cfm fan rated at 18 cfm/watt that means that fan number 2 will require 10% more electricity than fan number 1 to move the same amount of air. If this 10% difference in efficiency is multiplied by 8 to 10 fans, the added electrical costs can be substantial. Exhaust fans are commonly rated on an efficiency scale from 0 to 5. Fans with an energy efficiency of 16 cfm/watt or less are rated 0, while fans at 24 cfm/watt or greater are rated 5. The efficiency rating increases by one for every 1.6 cfm/watt increase (Czarick and Lacy, 1999a). Fans with a high efficiency ratings are important today, and may be even more important in the future, since electricity rates are likely to continue to rise.

REMODEL - continued on next page

Fans are usually advertised for a given cfm capacity at 0.05 inches static pressure, but fans used in tunnel ventilation will usually be operating at 0.10 inches or higher (Czarick and Lacy, 1999b). As the static pressure increases, the amount of air any fan moves is decreased. This decreased movement of air means that it is harder for fans to draw air into the house and the amount of air moved by the fan decreases. This diminished fan output can result in decreased air speeds and lower air exchange rates, which can lead to increased environmental problems within the house. How much does a fan's output decrease? That decrease varies dramatically from fan to fan and is generally measured by the air flow ratio. The air flow ratio is determined by dividing the amount of air moved at a static pressure of 0.20 inches by the amount moved at a static pressure of 0.05 inches. Fans that moved the same amount of air at 0.20 and 0.05 would have an air flow rating of 1, while fans that moved half as much air at 0.20 as at 0.05 would have a rating of 0.5. Fans air flow ratios can range from 0.85 to 0.40. This means that when fans are put under static pressure outputs can decrease between 15 and 60% depending on the fan. (Czarick and Lacy 1999a). While fan selection is crucial to the efficient performance of a tunnel ventilated house, the location of inlet openings is equally important.

Static Pressure Controlled Air Inlets

In less than ideal weather many older houses allow ventilation air into the house by lowering the curtain on the south side slightly, but this system is by far the least efficient system available. Heat escapes through the crack whenever the fans are not running and it is a challenge to keep the crack width uniform the entire length of the house. When the fans do run, it is difficult to maintain a high enough static pressure to jet the air across the house instead of having it fall to the floor just inside the south wall. This situation results in two different environmental conditions inside the house, neither of which are desirable. The birds along the south wall are usually always chilled as cold outside air comes over the lip of the curtain and immediately drops to the floor and birds along the north wall never have the benefit of fresh air mixing and diluting the contaminated air (ammonia, dust, high humidity) inside the house. A much improved system is a specific number of air inlets based on the size of your house. It is vital that you have the right number, type and distribution of air inlet within the house so that in-house conditions can be properly managed. There are a variety of inlet systems available today. These may be cable- or static-pressure controlled. If the inlets are not cable-controlled, you should be able to open and close individual inlets to obtain the desired static pressure depending on weather conditions and your situation (brooding, power vent mode, etc.). Air inlets allow us to bring air into the house when we don't need to be in tunnel mode and don't want outside air flowing directly on our birds. The inlet should be mounted high enough and angled in such a way that the jet of air they provide when the fans run will shoot along ceiling or roof line of your house and mix with the hot air in place before falling to the floor. Inlets allow air to come into the house based on the static pressure. During very cold weather, static pressures of 0.08 to 0.10 inches should be maintained so that air will move rapidly into the house allowing maximum mixing before dropping. During milder weather, static pressures of about 0.05 should allow adequate mixing. How many inlets are required? The answer to that question will vary with the system involved. However, one good rule of thumb is to equip your houses with 15 sq ft of inlet space for each 10,000 cfm of fan capacity (Donald *et al.*, 2000a). For example, if you have ten 48" fans each rated at 23,800 cfm, your total fan capacity is (10 x 23,800 =) 238,000 cfm and you would need (15 sq ft/10,000 cfm x 238,000 =) 357 sq ft of inlet area. Your integrator, equipment dealers and/or extension personnel can assist you in determining the exact number of inlets needed in your house.

Pad Type Evaporative Cooling

While most older houses use in-house fogging to cool birds, pad cooling is becoming the standard on new house construction. The difficulty with in-house fogging is that if more water is put into the air than it can absorb, water drops onto the birds and litter. Fogging systems must be managed such that just the right amount of water is fogged into the air to get maximum cooling, without wetting the house. Many older houses will have a very difficult time providing just the right amount of water since the water applied in fog is controlled only by a thermostat, and not by a timer. Although, properly designed and operated in-house fogging with tunnel ventilation can be both efficient and effective. Evaporative cooling is becoming much more common in conjunction with tunnel ventilation, in part because wind-chill effects begin to fall off as temperatures approach 100°F (Donald *et al.*, 2001).

Even though evaporative cooling is becoming the standard, there are some important areas you must address before retrofitting your house to pad cooling. It is important to remember to balance air velocity and pad area. It is the **combination** of tunnel air flow and evaporative cooling that provides the most advantageous results in the hot summer months. The air flow provides the wind chill effect and removes bird heat while evaporative cooling provides cool air during sweltering temperatures (Donald *et al.*, 2000b). The most common mistake made in designing pad systems is not having enough pad area. You want to achieve the desired cooling efficiency with the least pad area possible, while keeping the static pressure below 0.10 inches. As static pressure increased, fan efficiency decreases, so if you do not have enough pad area, static pressure will reduce the output of the fans and lower cooling efficiency (Donald *et al.*, 2001). To determine the total sq ft of pad area required, divide the installed fan capacity (cfm) by the recommended air velocity through the pads in feet per minute (fpm) (Donald et al. 2000b). For instance, if your house has a total fan capacity of 190,000 cfm and the designed air velocity through the pad you are considering is 350 fpm the total pad area needed would be (190,000/350 =) 542 sq ft. However, remember that a higher **volume** of air through a wet pad is more desirable than a higher **velocity** of air. The lower the air velocity through a wet pad, the higher the cooling efficiency.

A second major area you must address is to design the pad installation in such a way that the air flow into the house through the pad will not greatly increase the static pressure. A direct sidewall mount system (as opposed to a dog house

REMODEL - continued on page 8

REMODEL - continued from page 7

system) may be more appropriate for an older house. Many new houses now use a dog-house room attached to the side of the broiler house with a 6-inch recirculating pad system. This is an expensive system and can be difficult to install in a retrofit. However, you should evaluate your needs, ask questions and compare prices of direct mount vs dog house style pad cooling systems if your cooling system is on your remodel list. Before making drastic changes to your cooling system, you should also verify that your water source can supply the quantity and quality a new cooling system will demand. A typical cooling system will use about 8 gallons per minute per house (Donald *et al.*, 2001)

Electronic Controller

New houses now come equipped with electronic controllers and if you are planning to retrofit an older house, you should seriously consider one on your list of improvements. It cannot take the place of you being in the chicken house, but it can help you save and manage your time more efficiently. Controllers can be intimidating at first if you are not familiar with all the lights, screens and buttons, but they are much simpler than they look. The installers can usually explain the system (don't let them drive away until they do) and most of the instruction manuals are very helpful and user friendly. A good system will be fairly easy to learn, having a good display screen and being menu driven. Manufacturers want growers to be able to understand and use their products so they try to keep them as non-complicated as possible. Controllers should be capable of keeping heating and cooling systems from working against each other, and be able to automatically move the house from heating to minimum ventilation to transitional (or natural) to tunnel to evaporative cooling (and back). A controller should also have built in protection against power line surges or spikes that are common in many rural areas and it should have enough capacity (channels) to operate everything you want. The capability to handle area in your house as zones is an additional important feature in controllers. This zone capacity will allow you to place several temperature sensors in various locations of the house and set the controller to read and control each zone independent of other zones. More advanced controllers allow growers to look at data on house conditions over the past few days or weeks. Remote monitoring which allows growers to check house conditions from any personal computer (PC) and to quickly respond to problems is also possible in advanced systems. The ability to interface with an off-site PC will likely become more important in the future. In fact, if remote monitoring allows integrators to oversee house conditions, controller features such as these could become a required capability.

What Will It All Cost?

So far we have addressed some of the major changes involved in a retrofit, but what about the rest of the equipment in your house? What is the condition of your feed system, water system, and heating system? If these are 12, 15, 18 years old or older, are they in need of repair or replacement? If so, what will it cost to do all this work? Table 1 contains cost estimates I gathered from two Arkansas poultry equipment dealers on the building adaptations and equipment necessary to remodel an older broiler house. Please remember that these estimates are just that **estimates.** Prices will vary depending on the contractor, the size of the job and where your farm is located. However, the numbers in Table 1 should provide an idea of the investment involved to retrofit a 40' x 400' conventional ventilation.

Summary

It is increasingly difficult for growers with older houses to compete with growers with newer more well equipped houses. Improvements such as tighter houses, better insulation, tunnel ventilation, static pressure air inlets, evaporative cooling, and integrated controllers are paying dividends in new house construction. These improvements can be incorporated into older houses with adequate structural integrity. However, before embarking on such a project, each grower should carefully consider the costs involved, payback time required and possible returns in the future. **Do not make such a decision on your own!!** Consult with your poultry integrator about their plans for the future. **Ask questions!!** Get opinions from several different individuals including: your integrator representatives, contractors or equipment dealers, extension personnel and, if possible, other growers that may have retrofitted an older house. In some cases, an older house may simply not justify the expense of a retrofit, but in those cases where an older house has sound structural integrity and the grower plans on raising broilers for several more years, retrofitting may be a viable option.

Table 1. Cost Estimates to Retrofit 40' x 400' Conventional Broiler House

	Cost Estimate $	
Item	**Firm A**	**Firm B**
Building Adaptation and Electrical Work	3000	4100
Electronic Controller	2700	3400
New Curtain	1200	1200
Recirculating Cool Cell System	6000	7200
New Fans	5200	5300
New Heaters	3300	3500
New Brooders	3000	3300
New Nipple Water System	6000	6000
New Feed System (w/o feed bins)	6800	7000
Total	37,200	41,000

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Newcastle Disease Virus
Source: Stewart McNulty, Veterinary Services, Queens University, Belfast.

Exotic Newcastle Disease and Other Foreign Animal Diseases

Avian Influenza (see Avian Advice vol. 2, no 1, Fall, 2000) and Exotic Newcastle Disease are two of the Foreign Animal Diseases (FAD's) that can cause devastating losses in the poultry industry. Exotic Newcastle Disease can affect many species of domesticated, wild, or exotic birds and was first seen in 1926 in Great Britain, Java, and Korea. The name Newcastle comes from the location where the disease occurred in Great Britain (Newcastle-on-Tyne). The disease is still present endemically in many areas of Africa, Asia and Latin America.

The disease was first reported in the United States in 1944 with other outbreaks reported in 1946 and 1951. However, Exotic Newcastle Disease was quickly eradicated from the United States. The most serious recent outbreak in the United States occurred in southern California in 1971 and cost almost 56 million dollars to eradicate.

The causative agent of Exotic Newcastle Disease is a Rubulavirus in the family Paramyxoviridae. The virus can persist in feces for long periods of time and some bird species (parrots and some wild birds) may be asymptomatic carriers of the virus. Outbreaks of the disease can cause severe losses in a short period of time. The incubation period for the disease varies from 2-15 days with the incubation period in chickens being 2-6 days. Clinical symptoms include gasping for air, green watery diarrhea, coughing, depression, loss of appetite, thin shell misshapen eggs, droopy wings, twisting of the head and neck, and spasms. Mortality varies with the viral strain and species infected; but may be high at the initial onset. Lesions observed with the disease include: swelling in the neck tissues around the trachea, hemorrhages on the tracheal mucosal surface, small pinpoint hemorrhages on the inside lining of the proventriculus, hemorrhage and necrosis of the lymphoid tissue in the intestines, and hemorrhages in the vent.

The best method for control of Exotic Newcastle Disease is prevention.

A presumptive diagnosis of suspicious for Exotic Newcastle Disease can be made based upon the symptoms and lesions. However, since there are no symptoms or lesions exclusive for Exotic Newcastle Disease the disease must be differentiated from similar diseases such as Avian Influenza and fowl cholera. A definitive diagnosis is based upon virus isolation and identification.

The best method for control of Exotic Newcastle Disease is prevention. This is accomplished via Biosecurity protocols (Avian Advice vol.1, no. 1, Fall, 1999) and vigilance for FAD's to prevent entry into the United States. Exotic Newcastle Disease could be devastating to the poultry industry if an outbreak occurred. Currently, there is an Emergency Poultry Diseases Technical Poultry committee that is determining how to handle an outbreak of Exotic Newcastle Disease if an outbreak were to occur Arkansas. This group organized and conducted a Tabletop Exercise in December 2000 and plans another scenario for October 2001. The purpose of these exercises is to help in the development of plans and procedures for handling outbreaks if the disease were introduced into the United States. These plans are very necessary considering that in 1999 outbreaks of Exotic Newcastle Disease occurred in Argentina, Brazil, Venezuela, Canada, and New South Wales, Australia. In 2000 there were outbreaks in Russia and Italy with 231 outbreaks in Italy alone. Vigilance, common sense, and Biosecurity protocols all can help in the prevention of this disease, other Foreign Animal Diseases as well as more common, less devastating diseases.

DISEASES - continued on page 10

DISEASES - continued from page 9

Foot and Mouth Disease and Other Foreign Animal Diseases

The last few months there has been tremendous news coverage of the outbreaks of Foot and Mouth disease in the United Kingdom. In addition to the outbreaks in the United Kingdom, there are currently other Foot and Mouth Disease outbreaks in Argentina, Uruguay, Kuwait, Saudi Arabia, and the Netherlands. Foot and Mouth Disease is a viral disease that affects cattle, goats, sheep, swine, deer and other cloven footed animals. **The disease does affects not affect poultry, but an outbreak in the United States would affect the poultry industry because of restrictions on movement of animals, supplies, and people in and out of quarantined areas.** The reasons for the restrictions on movement would be to prevent spread of the disease so it could be more easily contained and eliminated.

Foot and Mouth Disease and some other diseases are considered by the United States Department of Agriculture Animal and Plant Inspection Service (USDA - APHIS) to be Foreign Animal diseases (FADs). FADs are those diseases which have either never occurred in the United States or have been eradicated from the United States. Examples of some FADs are: Hog Cholera, African Swine Fever, Dourine, Glanders, African Horse Sickness, Heartwater Disease, Screwworms, Rinderpest, Avian Influenza, and Exotic Newcastle Disease (END). There is continued surveillance and vigilance by the USDA - APHIS, private veterinary practitioners, and Foreign Animal Disease Diagnosticians (FADDs) to prevent these diseases from entering or re-entering the United States.

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Litter Conditioning for a Healthy Flock

Introduction

The high cost of clean out, litter disposal and new bedding makes it economical for broiler producers to re-utilize bedding material for one, two, three or even more years of production. However, this practice makes proper litter conditioning an essential tool of good management for keeping flocks healthy and profitable. Conditioning litter between flocks addresses where the birds live, which is the most crucial aspect of the poultry house environment. Litter quality impacts bird health, skin and footpad quality and even the bacteria levels on the final product. While occasionally a good flock is produced on poor litter, the odds are far more likely that a flock will have a lower average weight, poor feed conversion, higher condemnation rates with a loss in profit when litter quality is allowed to deteriorate.

Critical Factors in Litter Quality: Moisture, Temperature and pH.

Moisture is the key factor which influences litter quality. Litter moisture is linked to the survival of harmful organisms (pathogens) such as *Salmonella, E. coli, Clostridium,* viruses, coccidiosis and mold that can impact both bird and human health. The wetter litter is, the more

LITTER - continued on next page

likely bacteria will survive for extended periods of time. Bacteria can survive for weeks in wet litter versus days or hours in dry litter. It has recently been documented that by lowering the moisture level of litter through increased air flow, it is possible to reduce the litter *Salmonella* levels, which can help to reduce the contamination entering the processing plant. The key was dry litter. Friability is a physical property of litter that directly impacts litter available water. Friability is a measure of how easily the litter will crumble or break up. Practically speaking the more friable the litter, the easier it is to break up and less likely to mat and hold water on the surface.

In addition, litter moisture helps support the bacteria which converts litter nitrogen or uric acid (a key component of bird's manure) into ammonia. High levels of ammonia cause blindness, damage trachea or lungs and depress appetite. Once the bird's trachea is damaged, dust, bacteria and viruses can easily enter the birds system making it very susceptible to air sacculitis infections.

Temperature will also contribute to ammonia production. The warmer the litter, the more active the bacteria will be in converting uric acid to ammonia. Thus, while raising the temperature is critical for brooding young birds, it results in a release of ammonia from the litter.

Litter pH is another critical factor affecting quality. The pH of litter is alkaline or basic and typically ranges from 7.5-8.5. Within three flocks litter pH can be well above 8.0. Most bacteria, including the ammonia-producing bacteria, grow best at pH values above 7.0, while few grow below 4.0. Also yeast and mold growth is slowed at low pH's. Reducing litter pH as a means to control microorganisms requires reducing and maintaining the litter pH at 4.0 or below.

Ideal Litter Conditions

In order to understand how litter can be managed to provide an optimum environment, it is first important to have litter quality goals. Ideal litter has the following characteristics:

- Loose and not caked over
- Not too dry or too wet (20-30 % moisture is ideal)
- Low level of ammonia (less than 20 parts per million)
- Uniform particle size (No large clumps)
- Minimum insect load

Addressing Litter Quality

The best time to address litter quality is immediately after the last flock has been removed. Litter should be decaked by removing or pulverizing the material that has become saturated with moisture and is severely clumped together. Allowing litter cake to remain in a facility can create a protective seal keeping moisture trapped in the litter. Litter cake creates a microenvironment where bacteria can remain living even when birds are absent and the house temperature is cold. The moisture trapped in caked litter will also contribute to a substantial ammonia release once the house is closed and re-warmed for the next flock.

After decaking, when possible, stirring litter or raking the litter will help the release of moisture. Many turkey producers deep stacking litter down the center of the house and allow it to go through a heat cycle for 10 to 14 days to destroy bacteria and lose moisture. The litter is then re-spread in the house.

Litter Amendments and How to Use Them

An additional way to enhance litter quality is through the use of litter amendments. The three most commonly used amendments are all chemicals that acidify the litter. These contain either sulfate or sulfuric acid. The sulfate when combined with air or litter moisture converts to sulfuric acid, which as a strong acid that will acidify the litter. When used at the manufacturers recommendations of 50 to 100 pounds per 1000 square feet, the treatments will drop the litter surface pH to below 4 and in some cases, such as newer litter, as low as 2. The low litter pH then results in an unfavorable environment for most bacterial growth including the bacteria responsible for creating ammonia. Properly adding litter treatments prior to the placement of a new flock will reduce ammonia during the brooding cycle, which allows producers to run fans for minimum ventilation instead of over ventilating to remove high atmospheric ammonia levels. Litter treatments also reduce bacterial exposure for young birds. Yet as new manure and moisture are added to the litter, the litter treatments will become neutralized and lose their ability to control ammonia production and bacteria growth. Litter treatments usually control ammonia for two to three weeks. The less treatment used, the shorter the time of ammonia control.

Each litter treatment is unique in the way that it works. The aluminum sulfate (or alum) based treatment, commonly called Al+ Clear must be worked or tilled into the litter to be most effective. While this litter treatment will give some ammonia control if not worked into the litter, the producer will not get the most effective use from the product. The AL+ Clear product works best if applied 7 days before chick placement if the litter is dry and 3 days before chick placement if the litter is moist. The other two commonly used amendments, sodium bisulfate (PLT) and a clay product acidified with sulfuric acid (Poultry Guard) work best when top-dressed on the surface of the litter. The sodium bisulfate product (PLT) works best when applied as close to chick placement as possible. This product will actually pull moisture from the air and combine with ammonia. Poultry Guard works best if applied 3 days or less before chick placement. A trend that has recently started is the use of two treatments in a facility. For example, blending the Al+ Clear with one of the other products. One suggestion is to apply 50 pounds/1000 square feet of Al+ Clear and then apply 50 pounds/1000 square feet of a second product.

All of the common litter treatment products can easily be applied with standard equipment such as a rotary disk spreader. However, before amendments are applied, it is crucial that the litter be properly prepared through decaking, tilling or pulverizing. The longer litter is maintained in a house, the more important good decaking or litter pulverizing is before amendment applications. It is also important to level the litter surface as a final step before application to ensure uniformity of application so that ammonia and bacteria can be

LITTER - continued on page 12

LITTER - continued from page 11

controlled through out the house. Since litter treatments are acids, they will corrode metal over time, so it is important to keep them away from footings and equipment.. Remember to follow all listed safety precautions when handling the products. Protective eye gear is especially important.

Another amazing benefit from the use of litter treatments is a reduction in darkling beetle population. Since beetles will eat anything, they also consume these products. The products turn into strong acids in their digestive tracts and the beetle is destroyed. Facilities which consistently use litter treatments have fewer beetles. In addition, insecticides last longer under acid conditions versus alkaline conditions. Thus, litter treatments may increase the residual killing power of insecticides. Therefore, by applying liquid insecticides before litter treatment application and dry insecticides after litter treatment application, extended effectiveness of the insecticide can be obtained. Make sure that liquid insecticides have had time to dry before litter treatment application.

Choosing the right litter treatment should include information on cost, availability and other factors such as nutrient best management practices.

Choosing the right litter treatment should include information on cost, availability and other factors such as nutrient best management practices. The aluminum sulfate product will tie up the phosphorus in litter and prevent it from becoming a runoff hazard when the litter is spread on pasture or crop land. This has become an accepted tool by the Arkansas Natural Resource Conservation Service, which might allow producers who regularly use alum to spread litter on soil that has a high phosphorus level. To get optimum phosphorus binding, it is necessary to use the higher levels of alum (200 pounds/1000 ft^2) and to use it every flock. See your local conservation district water quality technician to obtain more details on how this practice could be utilized in your operation.

The utilization of the aluminum sulfate product for extended periods does make the litter less desirable as a feed stuff for cattle. The key reason is the aluminum imparts a bitter, metallic taste to the litter. It is recommended that if litter is fed to cattle, it should not be treated with aluminum sulfate. Remember that cattle have a maximum recommended sulfur intake of 0.4%. The sulfur content of poultry litter ranges from 0.2 to 0.8% sulfur without added litter treatments. The use of any of the litter treatments could raise the litter sulfur to levels that are toxic for cattle. One symptom of sulfur toxicity in cattle is reduced feed consumption. Check with your county extension agent for information on us of litter for cattle feed.

A final word of caution, follow the manufacturers' recommendations when using litter treatments. Utilizing levels below recommendations may drop litter pH to a level that is close to 7. This reduced amount of litter treatment can enhance bacterial growth instead of depressing it. Table 1 shows results of a trial where three-flock old litter was autoclaved and inoculated with known levels of *Salmonella*. Litter was then treated with either Poultry Guard or PLT (Poultry Litter Treatment) at different levels and sterile drag swabs were used to collect *Salmonella* samples. The results showed that using low levels such as 25 pounds of treatment/1000 square feet of litter resulted in higher levels of *Salmonella* as compared to the untreated litter. The pH of the low level application litter was high enough to support the growth of the *Salmonella*. It took utilizing 100 pounds/1000 square feet to drop the *Salmonella* to levels which were much lower than what was found in the untreated litter.

Table 1. Affects of litter amendments on autoclaved litter inoculated with *Salmonella*.

Litter Treatment	Application Rate (Pounds/1000 ft^2)	**Salmonella** Count/Sponge [1]	Litter pH[1]	Litter Moisture (%)
Untreated Litter	0	589_{abc}	8.300_{a}	23.60
Poultry Guard	25	2723_{a}	5.825_{bc}	25.40
	50	697_{abc}	4.425_{d}	24.30
	75	191_{bcd}	3.550_{e}	23.75
	100	53_{d}	2.675_{f}	23.80
PLT	25	1026_{ab}	6.233_{b}	23.27
	50	123_{cd}	5.475_{c}	23.33
	75	146_{cd}	4.425_{d}	25.60
	100	30_{d}	3.475_{e}	24.98
	SEM	2.29	.272	.813
	P-value	.0075	.0001	.7610

[1] Means followed by a different letter in the same column are significantly different.

LITTER - continued from page 12

Conclusion

In conclusion, managing litter is a crucial step in promoting flock health and well being. Conditioning litter between flocks can help keep the environment productive and the operation profitable. Controlling litter moisture and utilizing litter amendments at the proper rates can maintain litter quality maintained for extended periods of time. ■

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Heat Stress, Evaporative Cooling and Tunnel Ventilation

Introduction

Today's broiler and turkey are among the fastest growing and most efficient birds ever. However, this tremendous potential comes with a greater susceptibility to many different types of stress. Commercial birds are particularly susceptible to heat stress because metabolic heat production increases with growth rate, while the capacity to dissipate heat does not (Teeter et al., 1996). With summer soon upon us, it's time to review some of the effects of heat stress on broilers and methods which can be used to partially alleviate the detrimental effects of heat stress. We will also look at ways of getting the most benefit from evaporative cooling and tunnel ventilation.

Understanding and Managing Heat Stress

Broilers that are subjected to elevated environmental temperatures will reduce their activity level and rest more during periods of heat stress. Some birds will stand quietly in place while others will sit throughout the house. In most cases, they will have their wings spread away from their body to promote cooling by reducing body insulation. Blood flow is diverted from the internal organs to dilated blood vessels near the surface of the skin to facilitate heat loss (Butcher and Miles, 1990). Skin which is normally pink will turn dark as blood circulation is shifted to the body surface to dissipate heat (Donald, 1999). However, it is impossible for increased peripheral blood flow to completely dissipate body heat when birds are exposed to high environmental temperatures. As temperatures increase birds will begin panting, which allows them to utilize evaporative cooling for heat loss. In fact, broilers dissipate more than 80% of their heat production by evaporative cooling (panting) (Teeter et al., 1996).

Panting is accompanied by an increase of water loss from the lungs. This water must be replaced to prevent birds from dehydrating. However, birds will often avoid drinking warm or

HEAT STRESS - continued on page 14

HEAT STRESS - continued from page 13

hot water. Cool drinking water stimulates water intake and consuming water lower than body temperature absorbs heat, reducing heat stress. Water can be kept cooler by, avoiding placing pipes near the ceiling where it is extra hot. In addition, lines with warm water in them can be drained to allow cooler water to reach the waterers. The importance of providing birds with an adequate supply of cool drinking water during heat stress can not be over emphasized (Anderson and Carter, 1993).

Normally, panting starts when at temperatures is near 86°F (30°C), and will increase as the temperature rises. As the bird pants, there is a corresponding decrease in the levels of blood carbon dioxide, which causes an increase in blood pH. This decrease in blood pH causes the kidneys to excrete excessive amounts of potassium and other minerals (electrolytes), which alters the bird's electrolyte balance. As the pH shift occurs, feed intake is increasingly depressed (Anderson and Carter, 1993).

This decrease in feed consumption occurs because the bird does not feel like eating and because the process of digestion generates heat. In fact, it has been estimated that approximately 60% of the metabolizable energy consumed by the bird will be lost as heat (Teeter et al., 1996). While the reduction in feed intake results in lower daily nutrient intake, fewer nutrients to metabolize means less heat produced by the body. Growth rate is slowed, but research has demonstrated that as feed intake increases during heat stress fewer birds survive (Butcher and Miles, 1990). Yet, studies have demonstrated that low phosphorous consumption can contribute to increased heat prostration losses (Kutlu and Forbes, 1993). Thus, it is important that birds consume some feed during hot weather.

Cool drinking water stimulates water intake and consuming water lower than body temperature absorbs heat, reducing stress.

Growers seem to have a natural tendency to encourage birds to eat. However, management techniques which promote feed consumption during peak hot periods must be used cautiously. During hot weather most integrators usually formulate feeds with increased levels of protein, energy and fat to compensate for decreased consumption levels. Vitamin and mineral concentrations may also be increased (Butcher and Miles, 1990). Hot weather normally means that birds consume the greatest amount of feed at dawn or just after the lights come on. Feed consumption will then decrease as ambient temperature increases, but will then increase dramatically just before the lights go out (Anderson and Carter, 1993). To safely encourage feed consumption, growers should encourage consumption just after dawn or lights on and just before lights out. Growers may also encourage feed consumption by cooling birds as much as possible during the evening hours. Birds tend to build up heat in their body during the hot parts of the day, but cooling birds can dissipate the heat, and encourage feed consumption during

HEAT STRESS - continued on next page

early morning (Teeter et al., 1996). Some integrators recommend fasting broilers during hot periods of the day to lessen the heat load, but fasting requires additional management skills.

Fasted birds will survive heat better than full fed birds, but fasting reduces weight gain (Kutlu and Forbes, 1993). Fasting has a calming effect and reduces the heat of digestion, but the timing and length of the fast is critical to success (Butcher and Miles, 1990). In order for fasting to be effective the bird's digestive tract must be nearly clear during heat stress. However, it is often difficult to predict when temperatures will rise to critical levels and time is required for the digestive tract to clear. In addition, it is not uncommon for fasted birds to "rush the feeder" when feed becomes available (Teeter et al., 1996). This "rush" can cause injuries within the flock and could hamper feed withdrawal times since birds will tend to gorge themselves. Check with your service technician to determine if and when a fasting program is recommended.

Keeping birds calm and still during hot weather is important because the muscle contraction required for movement generates heat, which adds to the heat load.

Keeping birds calm and still during hot weather is important because the muscle contraction required for movement generates heat, which adds to the heat load. Many growers walk their birds during hot weather to release trapped heat between birds. However, be aware that bird movement generates heat.

Panting allows the broiler to dissipate body heat, but panting requires approximately 540 calories per gram of water lost by the lungs. The energy used for panting can not be used for growth. Thus, decreased energy efficiency accompanies hot weather (Butcher and Miles, 1990). Panting itself also generates body heat, which must be eliminated (Anderson and Carter, 1993). In addition, panting increases the relative humidity of the air surrounding the bird. As the relative humidity rises, birds work harder to lose body heat (Teeter et al., 1996). In addition, litter can become wet, raising the humidity at bird level and making the situation even worse. Broilers simply cannot tolerate high temperature coupled with high relative humidity. Death due to heat exhaustion will occur quickly, especially in birds near harvest weight, if both temperature and humidity are high (Butcher and Miles, 1990). In hot/humid environments, ventilation should be maximized to facilitate removal of heat and moisture.

Tunnel Ventilation and Evaporative Cooling

Most new houses now being constructed are tunnel ventilated and an increasing number of older houses are being retrofitted to tunnel. Most of these houses also have some form of evaporative cooling. This trend is occurring because today's fast growing bird can not withstand the stresses that it's predecessors could. This lack of ability to withstand stress is placing more and more demands on housing and equipment systems. Evaporative cooling technology has become a refined tool for managing the environment in hot weather. However, one must understand that evaporative cooling systems work only as an add-on to tunnel ventilation. Proper airflow is the most important item within the poultry house during hot weather. If you don't have enough fans, or fans aren't operating properly, the evaporative cooling system will not be able to overcome the lack of air velocity.

All evaporative cooling systems work by forcing warm incoming air through a thin film of water. The heat energy in the air powers the change water from liquid to water vapor. About 8,700 BTU's of heat are removed from the air for every gallon of water evaporated (Donald, 2000). Evaporative cooling cannot bring 95° or 100℉ air down to 70℉, but if the evaporative cooling system is working in conjunction with tunnel ventilation, it only needs to bring the air temperature down to the range where the tunnel wind-chill effect can help the birds feel as though it was near 70℉. For example, if the air temperature is 95℉ and the evaporative cooling system can bring the temperature down by 12 degrees, and we get another 10℉ "effective temperature" reduction from wind-chill, the birds will feel like they are in 73-degree air. This is what we should expect from properly designed evaporative cooling systems on most hot summer days. However, the actual performance of the cooling system will depend on two factors.

1. The moisture is present in the air (or relative humidity) determines the theoretical maximum cooling potential. The lower the relative humidity (RH) and the higher the temperature, the greater the theoretical cooling potential. When air temperatures are in the 90°-100℉

HEAT STRESS - continued on page 16

HEAT STRESS - continued from page 15

range the maximum theoretical cooling potential typically is around 15 to 17 degrees under Southeast U. S. conditions (Donald, 2000). This corresponds to a relative humidity of about 50%.

As mentioned earlier, relative humidity is critical because the less moisture or relative humidity in the air, the more cooling will occur. For example, early in the morning on a typical summer day, relative humidity may be close to 100%, but the temperature will be in the low 70s. As the day goes on, the temperature rises and the relative humidity drops. This is because hot air is capable of holding more moisture than cold air can. This means that when the temperature rises 20°F, the moisture in the air (relative humidity) is cut in half. By the time air temperature reaches 95°F, the relative humidity will have dropped to around 50%. This allows the evaporative cooling system to be effective, evaporating water into warm air, raising its RH but lowering its temperature.

2. The efficiency of the evaporative cooling system is an estimate of how much of the theoretical cooling potential we will actually achieve (Donald, 2000). Efficiencies of current systems range from around 50% to 76%. A 50%-efficient system, for example, will give half (50%) of the maximum potential cooling. This means that because of inefficiencies in the system we may actually drop the temperature 7 to 13°F when the air temperature is in the 90°-100°F range, with 50% RH (76% of 17 = 13; 50% of 15 = 7.5).

Evaporative cooling systems should be turned on when the house temperature reaches 80°-84°F, before signs of heat stress, with fully feathered birds. It is easier for the system to deal with heat as it comes into the house than to cope with a large heat build-up already in place when it is turned on. Care must be taken, however, not to chill younger birds by running tunnel ventilation or evaporative cooling when temperature reduction is not a necessity. Tunnel ventilation has proven to be very effective in keeping birds cool during hot weather but will only do so if maintained and operated properly. Czarick and Lacy (2000) recommend the following tips to help maximize cooling in tunnel-ventilated houses:

tips for cooling tunnel ventilated houses

1) Install migration fences by 3 weeks of age. When birds pack in at the pad end of the house, bird performance will be harmed due to insufficient feeder space and increased heat stress. Cool air coming in through the evaporative pads cannot move between crowded birds.

2) Starting the fifth week, clean shutters weekly. Dirty shutters can reduce the air moving capacity of a fan by 30%. A 30% reduction in wind speed can result in a 50% decrease in wind-chill effect.

3) Check fan belts. Are they riding high in the motor pulley. If the belt is riding below the top of the motor pulley, the air moving capacity of the fan can be reduced by 20%.

4) If birds have been heat stressed during the day, make sure you run all your fans all night long. Studies have shown that cooling birds off at night can increase weights by 20 points or more.

5) Make sure side wall curtains are held tight against the side wall. Air leaking around the side wall curtains will dilute the cold air entering through the evaporative cooling pads resulting in large temperature differences between the pad and fan ends of a house. Air leakage can increase house temperature 3 degrees or more.

6) Do not use all your tunnel fans on small birds. It will not improve performance and wastes electricity. Use fogging pads on young birds to temper the air, if temperatures rise significantly above your desired set points. However, bear in mind that young birds exposed to some heat can become acclimated so that they suffer less from its effects.

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7) If you use fogging pads, make sure the nozzles are wetting the entire pad. Many pads are dry along the top because the top line of fogging nozzles are placed too low. To maximize pad wetting, and therefore cooling, the top line of nozzles should be placed within one foot of the top of the fogging pad.

8) Make sure that the tunnel curtain when open does not restrict air flow through evaporative cooling pads. When the tunnel curtain hangs down in front of evaporative cooling pads the cooling produced by the pads is reduced and static pressure is increased. This situation reduces the air moving capacity of the fans.

9) If you have a controller, do not operate the tunnel fans off the average of all temperature sensors in the house. At night as temperatures decrease, the temperature at the inlet end of the house decreases while the temperature of the air at the fan end of the house increases. The average remains the same. By operating the tunnel fans off the temperature sensor nearest the tunnel fans, more fans will run at night and bird cooling will be maximized.

10) If you have a tunnel ventilated house with fogging pads, make sure that your water pressure is at least 180 psi, but a pressure of 220 psi is preferable. The higher water pressure will result in smaller water droplet size which will maximize air temperature reduction while at the same time keeping house wetting to a minimum.

11) If you have fogging pads, make sure you have between 40 and 60 one gallon per hour nozzles inside the house to increase cooling on extremely hot days. The nozzles should be installed in four to six lines running across the house. Two lines should be placed in the brooding end of the house while the other two to four should be placed in the nonbrooding (tunnel fan end of the house). Do not place fogging nozzles within 125' of the tunnel fans. Do not turn on interior nozzles until air temperature within the house exceeds 87°F. Turning on the nozzles before this point may lead to house and equipment wetting which may increase heat stress related problems.

12) Do not turn on evaporative cooling pads until house temperature has reached at least 80°F. During warm weather when outside air temperature is below 80°F the relative humidity of the air is above 80%, and therefore very little evaporative cooling can take place. Running an evaporative cooling system before the air temperature has reached 80°F will increase house moisture and encourage algae growth on pads which in turn will reduce the flow of air through the pads as well as decrease pad life.

13) Make sure you flush evaporative cooling pads with plenty of fresh water at the beginning of each growout to remove any trapped dust from the flutes. If allowed to accumulate, over time this dust will restrict air flow through the pads which leads to reduced bird cooling.

14) If you have fogging nozzles in your houses, make sure the temperature sensors and/or thermostats are protected from the fog. If the sensors/thermostats get wet, they will indicate that the air temperature is lower than it actually is which can cause exhaust fans to turn off prematurely.

Summary

Broilers under heat stress have to make critical life sustaining physiological adjustments. Feed intake decreases while water intake increases. Dietary adjustments can help reduce metabolic heat production and maintain nutrient intake. Minimizing bird activity during the

HEAT STRESS - continued on page 18

HEAT STRESS - continued from page 17

hottest parts of the day lessens the heat burden. Fasting can be beneficial and may increase survival rate of broilers during heat stress, but it must be closely controlled to be successful. Check with your service technician before implementing such an fasting program. Ventilation and cooling are a must for birds to survive high summertime temperatures. Adequate air flow is more important than any other factor in a hot weather house. Tunnel ventilation coupled with some form of evaporative cooling has proven to be very effective in keeping birds cool during hot weather. But tunnel ventilation and evaporative cooling are only effective if you maintain and operate the systems properly. ■

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Coming Events:

Date: June 28, 2001 **Location:** Conway
Event: Farm Bureau Policy Development Meeting
Arkansas Farm Bureau
(501) 228-1856

Date: July 10-13, 2001 **Location:** Fayetteville
Event: Poultry Science Youth Conference
Dr. Jason Emmert,
UAF, (501) 575-3595

Date: July 24-28, 2001 **Location:** Indianapolis, IN
Event: Poultry Science Association Annual Meeting
Poultry Science Association
(217) 356-3182

Frank T. Jones, Extension Section Leader
Center of Excellence for Poultry Science • University of Arkansas

Fun with Incubation - A New Booklet to Share With School-aged Children

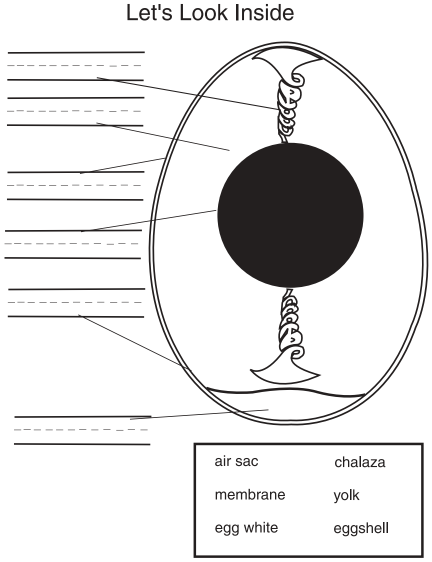
What is it?

Cooperative Extension agents and specialists often visit local schools and organizations to present information about poultry production in the state. Often these visits involve hatching chicks within the classroom. Yet often these experiences could be enhanced by a deeper understanding of the process involved.

To meet this need for understanding, extension poultry specialist Susan Watkins and one of her students, Cheryl Esters, have put together a 20-page booklet, highlighting the incubation process. The booklet includes instructions on the temperatures needed for successful incubation in various incubator types as well as step-by-step instructions on how to hatch healthy chicks from fertile eggs.

What ages are appropriate?

The booklet is aimed primarily at elementary school students. However, with some adaptation, the materials might be used with middle school or junior high students.



Added benefits

The booklet includes photos, which show the development of chicks from a tiny spot on an egg yolk to a healthy, fluffy chick. In addition, the booklet describes how chicks emerge from eggs and how to care for newly hatched chicks. The booklet also contains a worksheet to assist students in learning the parts of the egg and projects for younger students to cut out and color.

Getting more information

If you would like to have Dr. Watkins or an extension agent to present a program or demonstration to your school or organization, you may call the Poultry Center for more information at (501) 575-4952. A copy of the booklet can also be made available to assist you with your own presentation or "workshop." The booklet is on 8.5" x 11" paper and is designed to be reproduced on a standard copy machine. For further information, please contact Dr. Watkins at:

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Mr. Jerry Wooley, Extension Poultry Specialist, served as a county 4-H agent for Conway County and County Extension Agent Agriculture Community Development Leader in Crawford County before assuming his present position. He has major responsibility in the Arkansas Youth Poultry Program and helps young people, parents, 4-H leaders and teachers to become aware of the opportunities in poultry science at the U of A and the integrated poultry industry. He helps compile annual figures of the state's poultry production by counties and serves as the superintendent of poultry at the Arkansas State Fair. Mr. Wooley is chairman of the 4-H Broiler show and the BBQ activity at the annual Arkansas Poultry Festival.
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