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Critical Information for Improved Bird Performance Through Better House and Ventilation System Design, Operation and Management

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Ten Steps to Drier Houses and Good Paw Quality

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Cold weather has arrived. Managing broiler houses in cold weather shifts us into a much lower ventilation rate than in warmer weather. Our goal in cooler weather is to ventilate for moisture control and air quality. Done right, this will improve many other aspects of the bird environment, such as ammonia exposure and litter quality. However, if we get behind on ventilation, houses and litter can get wet very quickly. The key to good litter moisture management is to start the flock off with good litter moisture levels and run increasing ventilation as the flock progresses to keep up with the moisture that is being deposited daily by the birds. It is that simple.

If we don't keep up with a proper ventilation schedule, things can seem to get out of control very quickly. The house may seem dry enough today, but almost overnight turns slick and wet. When this happens the underlying reason is not that we weren't adequately ventilating for the past 24 hours, it is because we have not been ventilating properly for some time, perhaps five days to a week. During this time moisture has been gradually building up in the litter pack. We don't see it until the litter pack reaches capacity and can't hold any more moisture, so it slicks over.

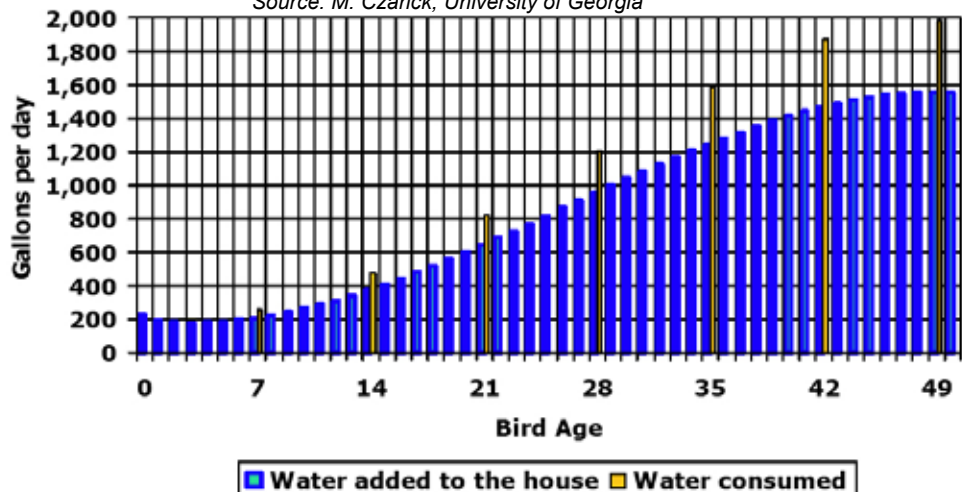
Many growers now rely on humidity meters to help in monitoring litter moisture. Keeping house relative humidity between 50% and 70% by ventilation for moisture removal, in most cases will move enough moisture out of the house to keep the litter from getting too wet. Managing litter moisture during the flock with good ventilation rates reduces wetness, ammonia, slicking, and foot pad problems. Since the US industry has found a profitable market for quality paws, keeping these paws in good condition is another reason to manage ventilation and litter quality.

Every grower and flock supervisor knows that when ventilation fans are run in cold weather it causes brooders and heaters to run, which increases fuel costs. It is somewhat less immediately obvious that failing to provide enough ventilation can also be very costly in terms of lowered flock health and performance brought on by problems caused by excessive wetness of the house.

For every pound of feed a bird eats, it will drink about a quart of water. Only about 20% of that water is retained and goes into bird growth. The rest of the water goes through the bird, most of it into the litter in the form of manure, but a part enters the air through respiration. This means a large amount of moisture is being added to the house, mainly in the litter, and this amount increases every day as the birds grow.

**Figure 1. Approximate Water Added to a House
During a Growout by 24,000 Birds**

Source: M. Czarick, University of Georgia



Essential Facts Managers Should Understand About Moisture Management

1. For every pound of feed a bird eats, it will drink about two pounds (about a quart) of water. Only about 20% of that water is retained and goes into bird growth. The rest of the water goes through the bird, most of it into the litter in the form of manure, but a part enters the air through respiration. This means a large amount of moisture is being added to the house, mainly in the litter, and the amount added each day increases throughout the grow-out. During week one, a thousand birds may add around 1.5 quarts per hour; during the 7th week, they may add around 11 quarts per hour. Figure 1 shows typical amounts of water added to a house by 24,000 birds during a 7-week growout. Note that in this example, the estimated amounts of water added to the house daily follows the bird growth curve, ranging from about 200 gallons/day in week 1 to almost 1,600 gallons per day during week 7.

2. The only practical way to remove excess moisture from the house is through ventilation. To understand how ventilation air can carry water out of the house even in cold, rainy, or snowy weather requires understanding of relative humidity (RH). The amount of moisture a given volume of air can hold varies considerably according to the temperature of the air. Warmer air can hold much more water than cold air. That is, the moisture-holding capacity of air is relative to its temperature. For example, at 40°F, 1,000 cubic feet of saturated air (100% RH) will hold about 6.3 ounces of water. If we warm that air to 60°F it now is capable of holding almost 12.8 ounces. Since it still contains that 6.3 ounces, it is now holding only half of its total capacity. This means its relative humidity has been reduced from 100% at 40°F to 50% at 60°F. As a rule of thumb, every 20-degree Fahrenheit (11-degree Celsius) increase in air temperature doubles its moisture-holding capacity.

This characteristic explains why warming up cold and wet outside air enables it to absorb moisture from the inside air and the litter. It's the same principle that makes an ordinary clothes dryer work. Figure 2 shows how cold outside air at 30°F and 100% RH will contain 4.3 ounces per 1,000 cu ft, but will have its moisture-holding capacity increased to 24.3 ounces per 1,000 cu ft when it is warmed to 80°F. Its RH would then drop to under 20%, but what happens is that it absorbs another 12.7 ounces of water from the air and litter on its way to being exhausted out of the house at 70% RH (12.7 oz. + the original 4.3 oz = 17 oz, which is 70% of capacity at 80°F).

Figure 2. Ounces of Water in 1,000 Cubic Feet of Air at Different Temperatures and Relative Humidities

AIR TEMPERATURE							
RH	30°F	40°F	50°F	60°F	70°F	80°F	90°F
10%	0.4	0.6	0.9	1.3	1.8	2.4	3.3
20%	0.9	1.3	1.8	2.6	3.5	4.9	6.6
30%	1.3	1.9	2.7	3.8	5.3	7.3	9.9
40%	1.7	2.5	3.6	5.1	7.1	9.7	13.2
50%	2.1	3.2	4.5	6.4	8.9	12.2	16.5
60%	2.6	3.8	5.4	7.7	10.7	14.6	19.8
70%	3.0	4.4	6.3	8.9	12.4	17.0	23.0
80%	3.4	5.0	7.2	10.2	14.2	19.5	26.3
90%	3.8	5.7	8.1	11.5	16.0	21.9	29.6
100%	4.3	6.3	9.0	12.8	17.8	24.3	32.9

Ventilation Management to Control Moisture

From a ventilation management standpoint, there are two basic steps essential for keeping relative humidity levels in the 50-70% range and keeping litter moisture at acceptable levels.

1. Provide at least enough air volume flowing through the house so that when the air is exhausted it will have picked up sufficient moisture to maintain the house moisture balance at a desirable level. In other words, each day as birds grow and more moisture is deposited into the bedding and exhaled into the air, the ventilation rate must be adjusted to provide the additional ventilation volume needed to remove that moisture. Minimum ventilation rates are based on the amount of moisture added to the house by birds at different ages, as explained above (see Figure 1), and the amount of moisture that a given volume of air can absorb, given its initial temperature and moisture content (outside air conditions) and its moisture-holding capacity (RH) at the temperature it will be warmed to as it is brought into the house (see Figure 2). In practice, instead of continually doing the arithmetic to make such calculations, growers typically rely on tables giving per-bird ventilation rates (cubic feet per minute) needed for moisture removal during each week of a growout, as shown in Figure 3.

Ventilation rates shown in Figure 3 would be considered more than adequate in the Southeast U.S. for outside temperatures ranging from 30°F to 60°F, and could be adjusted 10-20% lower for lower outside temperatures, and 10-20% higher for higher outside temperatures. Good litter conditions would also allow ventilation rates to be slightly lowered. The total ventilation rate needed is given by simply multiplying the per-bird rate times the number of birds in the flock. Since during minimum ventilation, a small number of fans are nor-

Figure 3. Example Per-Bird Ventilation Rates for Moisture Removal

Week 1 – 0.10 cfm	Week 5 – 0.65 cfm
Week 2 – 0.25 cfm	Week 6 – 0.70 cfm
Week 3 – 0.35 cfm	Week 7 – 0.80 cfm
Week 4 – 0.50 cfm	Week 8 – 0.90 cfm

TEN STEPS TO DRIER HOUSES AND GOOD PAW QUALITY

1. Run heating and ventilation to keep house air relative humidity at 70% or lower in cold weather. Get a relative humidity (RH) meter and use it. Humans cannot judge relative humidity very well. Start your flock with sufficient litter that has been conditioned and is not wet.
2. Check your air inlet openings and static pressure. A modern house relies on the proper inlet opening and the proper static pressure to throw air to the center of the house. In winter, a static pressure of about 0.10 with inlets opened to about 1 to 1-1/2 inches are what is needed. Failure to do this results in poor air mixing.
3. Check your house for cracks and air leaks. Since cold air falls and warm air rises, cold air coming in through a crack or around a curtain will drop straight to the floor. Stop up all cracks. This reduces sweating and litter caking, and improves the bird environment.
4. Consider using stir fans. The more we can stir the air without causing drafts on the birds the better the air is to pick up litter moisture. Stir fans also lower heating costs.
5. Take a hard look at your tunnel inlet and end doors. Most tunnel inlets are not sealed well enough. Consider a flap, an interior curtain, or other cold air barrier. Cold air leaking in at the tunnel inlet end causes sweating, condensation, and cake. Sealing this up is the solution to this problem.
6. Take a hard look at tunnel fans. Even the best shutters don't seal perfectly. In very cold weather installing bonnets or plastic over shutters that are not in use is a must, otherwise cold air hits the warm floors and causes condensation and caking.
7. Take a hard look at your fan run times. Too many folks cheat on fan run times. Insufficient run times lead to higher humidities, sweating, and higher litter moisture.
8. Look your ceiling over. If you have wet and dripping spots here and there on your ceiling, most likely you will find places with little or no insulation in the attic. Get into the attic and be sure your insulation has not shifted.
9. To stop sweating and fog in the back half of a tunnel house during brooding, quit pulling all the air to the back and exhaust some air from a side wall or front wall fan in the brood chamber. This reduces the amount of moist air going through the back of the house. Also turn on heat in the back of the house to 55-60°F.
10. Don't turn your heat off, even if you have big birds. In a cold winter, especially if your house is not very well insulated, you might well need some heat all the way to the end of the growout. Turning the heat off places too much demand on bird heat and causes us to load the house with moisture, resulting in heavy sweating and caked litter. Turning heat off also increases feed consumption.

mally cycled on and off, the percentage of time they would need to run to provide the total ventilation rate needed is given by dividing the total cfm's needed by the cfm capacity of the fans being used.

For example, in a house with 20,000 birds during week 2, the ventilation rate needed is $0.25 \text{ cfm} \times 20,000 = 5,000 \text{ cfm}$. If the fans to be used have a combined capacity of 30,000 cfm, then the fans need to be run one-sixth of the time or $5,000 \text{ cfm} \div 30,000 = 0.167$. Using a five-minute timer, this would mean fans would be on for 50 seconds ($0.167 \times 300 \text{ seconds} = 50 \text{ seconds}$).

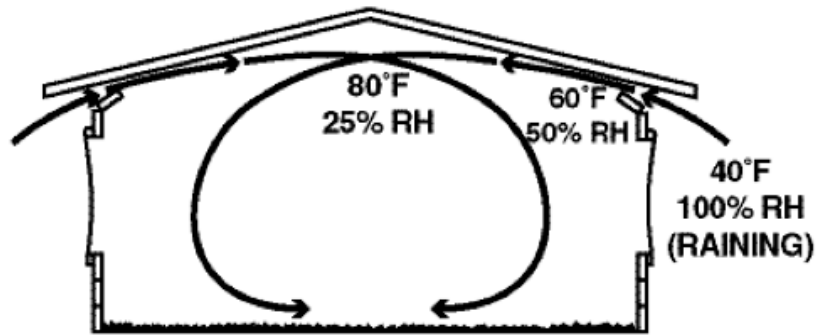
Although ventilation rates determined as explained above are extremely helpful, managers must realize that they provide only a starting point for effective ventilation management for moisture removal. Monitoring the house to keep track of actual conditions and modifying the ventilation rates to suit those conditions are essential to achieving top flock performance and reducing the incidence of Food Pad Dermatitis. Managers are well advised to have and use a high-quality hand-held humidity meter (humidistat or hygrometer), as well as visually and physically inspecting the barn and litter for signs of increasing wetness. It is paramount to remember that by the time wet litter is observed, conditions favoring Food Pad Dermatitis have been developing for several days.

2. Manage ventilation airflow so incoming air is conditioned before making contact with birds or litter. Cold air in contact with warm litter does a very poor job of removing moisture from the litter. Incoming minimum ventilation air must be brought into the house high, through either ceiling/attic inlets, ridge inlets, or perimeter inlets at the top of the wall. Air also must be directed across the top of the house at sufficient velocity so that it will mix with warm

house air before making contact with birds or litter.

Figure 4 shows an adequate minimum airflow pattern, with cold outside air coming in through perimeter inlets warming and drying as it travels across the top area of the house, then picking up moisture from the lower part of the house. Note that air movements and mixing in the house will be more complex than can be shown in this simplified graphic, and that in the US and in Europe there are several variations of minimum ventilation inlet arrangements (some fan-assisted) in use. What they all have in common is keeping incoming air high in the house and drying it out as it is warmed by thorough mixing with the inside air.

Figure 4. Minimum Ventilation Airflow to Achieve Adequate Conditioning of Air



Achieving good minimum ventilation airflow requires proper adjustment of air inlets and maintaining adequate static pressure, typically around 0.10 to 0.12 inches WC. It is the pressure difference between inside and outside that generates enough incoming air velocity (or "throw") to get good mixing high in the house. For this reason, the house must be "tight," with no unplanned openings that will allow cold outside air to leak into the house. Such air leaks will result in lowered air velocity through the air inlets and are likely to cause condensation on litter and sidewalls. Common sources of leaks are poorly closing fan shutters, unsealed wall plates, and unsealed tunnel or sidewall curtains.

Additional Considerations

In many locations litter moisture can be lowered and humidity reduced through the use of simple stirring or air recirculation fans installed in the top of the poultry barn. Unlike minimum ventilation fans, stirring fans are usually on all the time instead of being cycled on and off, so that they can considerably reduce temperature stratification by keeping in-house air constantly moving. Many variations of stirring fans, which stir approximately 10 to 15% of the building volume and are located in such a manner not to put cold drafts on the birds, have been proven immensely valuable in many areas of the U.S. for reducing foot pad problems.

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