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Summertime Cooling of Commercial Broiler Chickens

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The commercial poultry industry in the U.S. holds a significant position in global agriculture and is key to meeting critical protein demands for meat and eggs. In addition, poultry farming throughout the world plays a pivotal role in advancing rural development, enhancing nutritional standards, and bolstering food security, especially in developing countries. However, challenges persist in poultry farming despite ongoing advances in technology and management practices, particularly concerning birds' thermal comfort, productive performance, energy utilization and air quality. Due to consumer preference for quick and easy meal preparation, demand for deboned poultry meat has increased compared to requests for a whole bird. To meet this demand, broiler chickens today reach market weights of about 2.3 to 4.5 kg (5.1 to 9.9 lbs) at 42 to 63 days of age (Akter et al., 2022). The larger body weights and extended time on the farm increase the risk of thermal stress before the birds go to market.

Thermal stress is **one of the primary challenges faced by poultry growers** and represents a key environmental factor in poultry health and production performance (Su et al., 2026). Global warming and climate change cause more heat waves in the summer and, consequently, birds are experiencing greater heat stress in summer due to increased temperature for longer periods of time. Heat stress increases mortality rate (Warriss et al., 2005) and feed conversion ratio (Awad et al., 2016) and decreases feed intake (Sohail et al., 2012) and body weight (Quinteiro-Filho et al., 2012), leading to economic loss and compromising animal welfare.

The mechanical ventilation system is a critical fundamental part of the infrastructure of the modern poultry house that ensures the stable operation of poultry houses and plays a pivotal role in maintaining a healthy environment by regulating temperature, humidity and air quality (Wang et al., 2019; Guo et al., 2022). The mechanical ventilation system in a poultry house serves two primary needs: 1) thermal comfort and 2) litter drying.

Thermal Comfort

Poultry are warm-blooded animals (homeotherms). In addition, birds, as endotherms, can regulate body temperature using heat generated in their bodies. The thermoneutral zone of homeothermic animals is defined by a range of ambient temperatures within which the energy expenditure required to maintain body temperature is minimal and remains almost constant (Mount, 1974). The **body temperature of poultry typically ranges between 41 C and 42 C** (106 F and 108 F) (Wasti et al., 2020). For maximum production performance in poultry, the bird body temperature must remain at approximately 41 C (106 F) (Scanes, 2015).

To maintain core body temperature within this range, the thermoregulatory system adjusts physiological responses to either enhance or diminish heat loss (Su et al., 2026), depending on environmental conditions. As birds lack sweat glands and therefore cannot perspire, heat removal becomes challenging, and they predominately dissipate excess heat from exposed integumentary surfaces such as the comb, wattles, shanks and the un-feathered regions beneath the wings (Krishnan et al., 2023). Environmental thermal perception constitutes a critical determinant for the initiation of thermoregulatory responses in poultry, and this perception is predominantly governed by the combined effects of ambient temperature, relative humidity and airflow velocity over the body surface (Miragliotta et al., 2006).

The ability of poultry to dissipate heat decreases as ambient temperature and relative humidity rise above the thermoneutral zone. As a result, the bird's body temperature rises, resulting in heat stress (Curto et al., 2007). When thermal perception deviates from the thermoneutral zone, poultry actively regulate body temperature via behavioral and physiological adaptation. Under conditions of elevated ambient temperature and high relative humidity, birds predominantly augment heat loss by increasing respiratory rate; however, prolonged hyperventilation can lead to respiratory alkalosis (Ribeiro et al., 2020). By regulating air temperature, relative humidity and airflow velocity around the birds, **mechanical ventilation directly influences heat exchange efficiency and thermal perception**, better enabling poultry house environments to be maintained within the thermoneutral zone and preventing excess energy expenditure and physiological stress caused by environmental variations.

Litter Drying

Litter is another challenging aspect for the poultry industry, specifically, wet litter. Poultry litter, a byproduct of production facilities, is generally considered a waste product and consists of a composite of wasted feed, excreta, bedding material and feathers (Khodadadi and Masoumi, 2025). Bacterial and pathogen proliferation accelerates when litter moisture content exceeds 35 percent to 40 percent (Avidov et al., 2021), thereby increasing the risk of health problems like footpad dermatitis (FPD) (Durmus et al., 2023) and suboptimal welfare conditions (Tulsi et al., 2025). Litter moisture content correlates with the emission of ammonia (Oliveira et al., 2021), dust (Pal et al., 2021) and odor (Zhang et al., 2024). Dunlop et al. (2016) reviewed numerous factors contributing to wet litter conditions in poultry houses and indicated that inadequate ventilation is one of the primary causes. Ventilation enhances the evaporation rate of moisture from litter (Mou et al., 2025).

In addition, de Holanda Pasolini et al (2024) investigated the effects of air velocity and air temperature on litter drying and indicated that temperature has a more pronounced influence than airflow speed, as it plays a critical role in enhancing mass transfer and thereby accelerating moisture evaporation. However, constant uniform air speed throughout the house is important for heat and moisture removal, especially for today's larger birds that remain on the farm for extended periods. Air speed, cool cells, static pressure, sprinkler systems, nighttime cooling and precision livestock farming (PLF) technologies must all work together to ensure that chickens avoid heat stress conditions and stay safe during periods of high summer temperatures.

Air Speed Is Critical

There are various classifications of ventilation strategies used in poultry houses. The three main strategies, based on outdoor climate conditions, include minimum power ventilation (winter), transitional ventilation (spring and fall) and tunnel ventilation (summer). There are several steps growers must take to prepare tunnel ventilation equipment for the hot weather that every summer brings. Most of these steps should be accomplished long before July or August get here. Some may require a small expense (such as new fan belts), but most require only an investment in time. Certain steps are time consuming and/or require the fans to not be running to complete (cleaning the blades and shutters, greasing bearings, checking belt and pulley wear, adjusting the belt tensioner, etc.). Therefore, they must be accomplished in advance of hot weather while birds are still small and the fans are not yet needed or the grower is in between flocks. **Plan ahead and do preventive maintenance-type projects early.** There will be plenty of other chores that require your attention once hot weather arrives.

The growing U.S. demand for large broilers (8.25 lbs, and up) often makes minimizing heat stress on these larger birds the top priority for broiler growers throughout the summer period. Broiler chickens today with their rapid growth, high metabolic rate and susceptibility to high temperatures, **do not perform well under heat-stress situations.** Modern, tunnel-ventilated broiler houses can provide adequate house conditions if they are well maintained and properly managed. However, the 400 ft/min air speed down the house that was adequate a few years ago with smaller birds is no longer sufficient today. Many modern tunnel houses are now capable of a minimum of 600-700 ft/min (while some may manage 800-1,000 ft/min), all of it needed with today's larger broilers and changing climate.

Adequate fan capacity (Fig. 1) is what allows 600-700 ft/min (or greater) air speed. Fans and uniform air movement are the first line of defense against high summer temperatures. However, to generate an air velocity of 600 ft/min or more, the number of tunnel fans required must be based on their air moving capacity at a **static pressure of 0.10"** (Czarick, 2007a). Determining the number of fans based on a lower static pressure will reduce the available air speed. In addition, any belt-driven fan is only as good as its belt. Loose belts cannot spin the fan blades at the maximum rpm and add wear to the pulley. In most situations, **fan belts should be replaced** once a year; more often if a belt is riding low in the pulley (Fig. 2). Fan blades and shutters must also be kept clean. Numerous field studies indicate that **dirty shutters can reduce air flow by as much as 30 percent** (Donald, 1996; Simmons and Lott, 1997; Casey et al., 2008; Tabler and Wells, 2019).

Also, don't forget the bearings. A dry bearing requires more power to turn. This results in a loss of fan efficiency and shortens the life of the bearing. Lubricate bearings twice per year (spring and fall) if they have a grease fitting and are not sealed. Some bearings are sealed and do not require lubrication. However, you should remove the protective guard or shutter and take a grease gun and **manually grease any bearing with a grease fitting** (Fig. 3) twice a year.

Figure 1. (Top left) *Adequate fans are the first line of defense against high summertime temperatures. Source: Tom Tabler*

Figure 2. (Top right) *Fan belts should ride flush with or slightly above the top of the pulley. Source: Tom Tabler*

Figure 3. (Bottom left) *Belt-drive fans often have bearings and grease fittings that require grease twice a year. Source: Tom Tabler*

Having **enough air speed** is critical, especially when growing larger birds. But just as important is having **uniform air speed** from side-to-side and end-to-end of the house. You will have only about a third of your birds receiving adequate cooling if you have 700 ft/min air speed down the center of the house but only 300-400 ft/min near the sidewalls. It is better to have 600 ft/min throughout the house than to have 750 ft/min in the center and 350 ft/min near the sidewalls. Smooth solid sidewalls work better than curtain-sided houses or solid wall houses with exposed posts. Smooth solid sidewall houses usually have less than 20 percent variation in air velocity between the sidewalls and the center of the house whereas most curtain-sided houses have variations in air velocities ranging from 30 to 50 percent (Czarick, 2007a). The reason for this is that exposed posts create an uneven surface that tends to force air off the sidewalls and greatly reduces air velocity along the walls. Wall-mounted space furnaces will have the same effect. Anything other than a smooth wall surface will significantly reduce air speed over birds near the sidewalls.

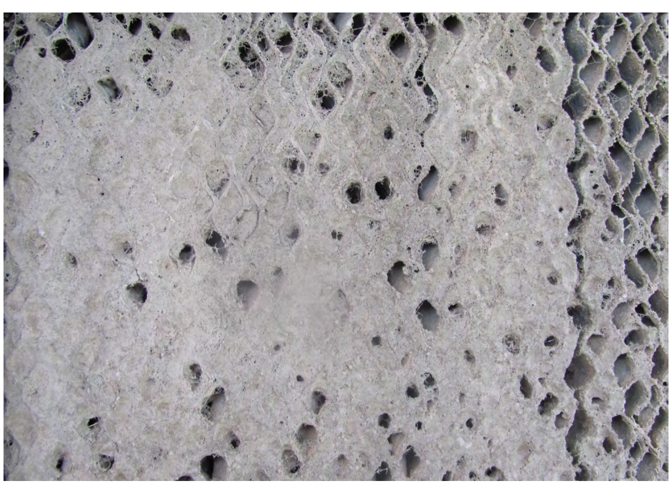

Figure 4. *Mineral buildup has clogged much of this cool cell pad. Source: Tom Tabler*

Cool Cell System

Uniform air speed is critical to summertime ventilation but will likely not be enough during extremely hot weather. This is where the cool cell system enters the picture. However, to be most efficient, we must maximize the amount of wetted pad surface that air passes through. Dry pad area allows hot air to pass directly into the house and reduces the cooling effect of the wetted pad area (Donald et al., 2002). **Preventive maintenance on the pad system is just as important as preventive fan maintenance.** Clogged pads force the fans to work harder, slow the air speed, reduce the wind-chill effect and lessen the cooling capability. The flutes should be free of dust, cobwebs and mineral deposits. It is important to know the mineral content of your water source.

This can be determined by sending a water sample to a laboratory capable of doing a water quality analysis (such as the University of Arkansas Central Analytical Laboratory in Fayetteville, AR). Mineral buildup over time can eventually ruin a set of pads and the only solution will be to replace them (Fig. 4).

Make sure the holes in the distribution header pipe along the top of the pads remain free of debris. Regularly check them to make sure that they remain clean and open. Flush the distribution line before charging the system in the spring to remove any dirt or debris that may have accumulated in the sump over the winter. **The entire pad should get wet when the distribution header pipe is operated.** Dry streaks on the pad indicate clogged holes in the header pipe. Dry streaks also mean that hot air is entering the house without being cooled, decreasing the effectiveness of the cool cell system. Often, direct sunlight shining on the pads and distribution pipe may result in excess algae growth that can plug the distribution holes or the pads. New houses are often built with roof overhangs that shade the pads and distribution system to help reduce algae growth. Use filters on the pad system to help minimize problems with debris clogging the holes in the header pipe and regularly perform preventative maintenance on these filters to prevent a water restriction.

In addition, the flutes or holes in the pads must also be kept open. Flutes in the pads are notorious for collecting dust, cobwebs and mineral buildup. Don't make matters worse by blowing grass clippings from the discharge on your mower or **brush hog** toward the pads. Always aim the discharge away from the pads to prevent clippings from being sucked into the flutes and restricting air flow. Keeping the flutes open is sometimes just a matter of spraying water on them with a garden hose. Do not use bleach or any product containing chlorine to clean the pads. Strong chlorine solutions destroy the cellulose material that most pads are made from. Furthermore, do not use high pressure for cleaning, as it will likely damage the pads. For extremely dirty pads, commercial products that can be applied with a 3-gal pump-up garden sprayer are available to help cut and loosen dirt. However, always check the label to make sure the product is approved for use on the pads.

Static Pressure

Birds must be able to dissipate about 12 **Btu of heat per hour per pound** of body weight if they are to maintain their comfort level (Donald et al., 2012). As the air temperature near the bird increases above what is comfortable, its ability to dissipate heat from the body surface decreases, forcing the bird to rely more on panting to cool itself. Typically, at a comfortable temperature, **birds will lose about 5 Btu of heat per pound per hour from their body surface and about 7 Btu through breathing.** Birds will increase their breathing rate and start panting as the air temperature rises above what is comfortable. If the air temperature reaches such a high level that panting can no longer maintain a normal body temperature, the bird's internal body temperature will rise. This rising internal body temperature results in severe heat stress and will lead to mortality if the situation cannot be corrected by supplemental cooling (Donald et al., 2012).

It is important to know what the static pressure is in the house with all the tunnel fans running. This is especially true in steel truss or high ceiling houses that have had baffle curtains installed to improve the air velocity. The **static pressure should never be more than 0.12"** (Czarick, 2007b). If it is, the fans must work too hard. Many controllers today have the capability to monitor static pressure at least in one location. However, you may not know what the pressure is at various locations down the house. It's important to know the pressure just past the pads (20-30 ft.) and just past the last baffle curtain (20-30 ft.) at the fan end of the house. The reading near the last baffle curtain will likely be higher but it shouldn't be too much higher. If you have a reading of 0.04" near the pads and 0.10" to 0.12" near the last baffle curtain, it is possible the baffle curtains may be too low and may need to be raised a foot or so. This should increase air velocity down the house and reduce the static pressure, relieving some of the workload on the fans and improving house conditions. If the pressure is high at or near the pads, you have other serious problems. The pads may be dirty or clogged with mineral deposits. You will need a magnehelic pressure gauge (Fig. 5) and some plastic tubing to measure static pressure at various locations throughout the house. These can usually be purchased for around $100 or your service technician may carry such items.

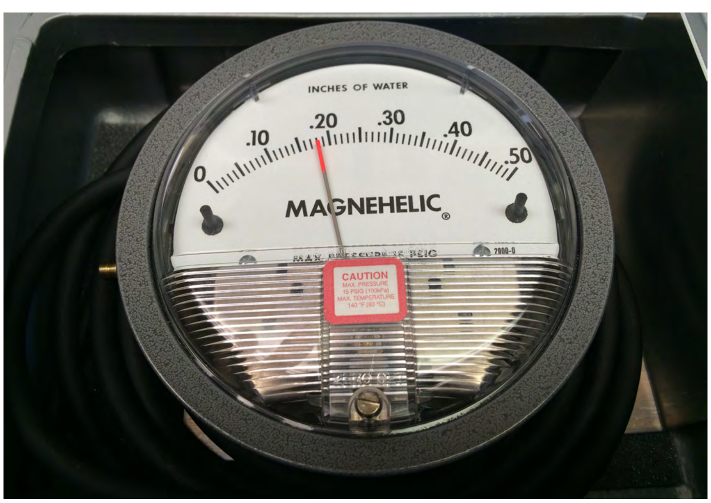

Figure 5. *A magnehelic gauge can measure static pressure inside poultry houses. Source: Tom Tabler*

Sprinkler Cooling

Another option that is perhaps more environmentally friendly is to use sprinklers in combination with cool cells pads to cool broilers while reducing cooling water use. Cool cell systems provide a valuable need, but they use tremendous amounts of water, which is raising concerns across the poultry industry from a sustainability and environmental footprint standpoint. In addition, cool cell systems create high humidity levels in the house that often leads to wet litter and FPD issues. Sprinklers have proven their worth in the beef cattle, dairy cattle and swine industries for many years. However, the poultry industry has been a bit slow to take advantage where sprinklers are concerned. These other livestock sectors recognized years ago the benefits of sprinkling livestock during periods of heat stress and the importance of maintaining a low humidity while doing so.

The poultry industry has been somewhat reluctant to accept sprinkling broilers for fear it would result in wet litter, leading to animal welfare issues and increased cases of FPD. However, an increasing body of **research related to sprinkling broiler chickens from multiple researchers has proven these fears unfounded** when sprinkling is managed correctly (Berry et al., 1990; Tabler et al., 2008; Liang et al., 2010; Liang et al., 2012; Liang et al., 2014; Dunlop, 2018; Liang and Tabler, 2018; Liang et al., 2020; Dunlop and McAuley, 2021; Moon et al., 2023; Tabler et al., 2025a, b). As our colleagues in the cattle business learned long ago, the key is to correctly manage the sprinkler on/off interval and control the humidity. When managed correctly, poultry producers can maintain an in-house humidity level that is at least 20 percent less than what is common in a conventional cool cell house (less than 70 percent humidity instead of the 90 percent or higher humidity common in a cool cell situation). This lower humidity plays a huge role in maintaining dry litter and keeping our chickens alive during periods of heat stress.

It is not high temperature alone that kills big chickens in hot weather. It is the combination of high temperature and high humidity that kills chickens. If we can maintain the relative humidity at or below 70 percent in the broiler house, the chickens can tolerate some fairly high in-house temperatures, allowing them to use their own evaporative respiration and the evaporation of sprinkler water off their body surface to remove body heat and cool themselves. Humid air can evaporate very little water; it takes dry air to evaporate water. However, dry air is often hotter air, and hot air in a house full of big chickens scares most growers. But there is no need to be concerned if you see the temperature approach 88 F or 90 F in a sprinkler-cooled house. What this tells you is if the temperature is that high, the humidity is going to be reasonably low. Cool air is moist, humid air. Hot air is dry air, and **dry air is beneficial** from the standpoint of lower in-house humidity, drier litter conditions, improved welfare and footpad scores, greater evaporative respiration potential from the birds and a more comfortable in-house environment.

As a grower, you do not want to operate a sprinkler-cooled broiler house at 82 F to 84 F like you would a cool cell house. A sprinkler-cooled house needs to operate at 88 F to 90 F to be effective. Raise the cool cell set point temperature to operate at 88 or 90 F to prevent the house from becoming too warm; and operate the cool cells (if necessary) only on temperature (not on timer) for short time intervals (10 to 15 seconds) to prevent house temperatures greater than 90 F, you don't want to raise the humidity level in the house, but you also don't want the house temperature to increase to more than 90 F. Short 10- or 15-second cool cell runs only when the house temperature reaches 90 F will prevent the pads from becoming saturated with water and increasing the house humidity but will also prevent the temperature from exceeding 90 F. **Warmer house temperatures do take some getting used to** but, anything less than 88 F and the sprinkler house will be too cool and too humid for the sprinkler water to evaporate, and you will have issues. Don't worry about the higher house temperature. It's at this higher temperature and lower humidity when the sprinkler system is most efficient, and bird performance will not suffer. With the tunnel fans providing adequate air flow down the house (wind chill), the birds may actually be more comfortable at 90 F and 70 percent humidity in a sprinkler-cooled house than at 82 F and 90 percent humidity in a cool cell house, resulting in improved performance.

Nighttime Cooling

Don't miss the opportunity to take advantage of nighttime cooling. Running fewer fans at night may save a small amount of electricity but it could cost you significant performance losses. One reason for this is relative humidity. Humidity is much higher at night (usually between 80 and 95 percent). However, even at night, regardless of air temperature, birds rely on evaporation of water off their respiratory system to cool themselves. High humidity makes it much more difficult for the bird to accomplish significant evaporative heat-loss off the respiratory system because the air it breathes in is almost as saturated as the air it is breathing out. If we maintain high air movement at night by running additional fans, we can increase the amount of heat loss due to air movement and use wind chill to help reduce the bird's need to cool itself through evaporation off the respiratory system (Fairchild and Czarick, 2005).

In addition, at night as the temperature drops, there is a larger difference between air temperature and bird's body temperature. This makes it easier for air movement to pull heat away from the bird and lower its body temperature. As its body temperature drops at night, the bird will regain the appetite that it lost during the hot part of the day. However, increased feed intake will lead to increased heat production and the need to maintain increased air movement late into the night to provide optimum cooling (Fairchild and Czarick, 2005). Running additional fans later into the night will use slightly more electricity but the increased bird performance resulting from additional cooling should more than offset the additional power costs.

PLF Possibilities

Precision livestock farming systems use sensors and imaging to track core body temperature, respiration rates, heat-load indices and behavioral changes such as panting and feather spread (Idowu and Idowu, 2026). For example, thermal imaging cameras can detect surface body temperature variations, enabling immediate detection of heat stress before it becomes severe (Chai, 2022). By matching sensor data with multi-omics biomarkers (genomics, transcriptomics, metabolomics), **PLF can predict individual bird susceptibility to heat stress** and identify early signs of thermal distress, allowing for proactive management rather than reactive cooling (Idowu and Idowu, 2026).

Cooling strategies benefit from PLF systems that allow automated, condition-based cooling. For example, sprinkler systems can activate when air temperature exceeds a certain threshold, and thermal cameras can document cooling effectiveness (Chai, 2022). This can be valuable in humid conditions when evaporative cooling systems are less efficient. Precision livestock farming systems also have the potential to integrate environmental and management controls, optimizing ventilation, lighting, and housing density in real time, ensuring that birds remain within their thermoneutral zone.

While offering much potential, large-scale PLF adoption faces several challenges such as standardizing biomarkers, collecting longitudinal field data, and understanding epigenetic/transgenerational effects (Idowu and Idowu, 2026). Overcoming these challenges will be key to making heat stress management on a large commercial scale more achievable and cost-effective. However, **PLF technology can address heat stress in broiler production** by monitoring, predicting and adapting to thermal challenges in real time, using both environmental controls and enhanced management practices to improve welfare, productivity and sustainability.

Summary

Thermal stress is one of the primary challenges faced by poultry growers each summer and represents a key environmental factor in poultry health and production performance. Producers should plan ahead and make sure equipment is ready to go before the first hot day of summer arrives. Thermal comfort and dry litter are key to keeping flocks alive and healthy throughout summer months and into fall, until the weather cools down. Uniform air flow down the house is critical to keep flocks safe. Preventive maintenance on tunnel fans and cool cell systems must be done before hot weather arrives to ensure best response to heat-related challenges. Cool cell systems also require that sumps, pumps, and header pipes be working properly. Pads should be free of debris and mineral deposits. Sprinkler systems used in combination with cool cells can reduce cooling water use by over 50 percent without sacrificing performance, thus improving poultry industry sustainability and lessening its environmental footprint.

Cooling broiler chickens in times of heat stress requires implementation of inventive approaches guided by comprehensive research and technical advances. By taking advantage of PLF technologies and utilizing intelligent sensors and real-time analytics, precision agriculture **optimizes environmental conditions for improved comfort and performance** of broiler chickens. Work on development of genetically resilient broiler strains that can endure various climate-related challenges and maintain productivity is dependent on genomic selection for multi-trait resilience, which extends beyond just heat tolerance. Climate-adaptive housing designs, which incorporate innovative ventilation and cooling systems, play a critical role in mitigating the adverse effects of extreme temperatures on broiler welfare and providing a favorable living environment. Modern broiler production is rapidly becoming **a journey built on precision agriculture, genetic selection and sustainable production practices.** With technologically advanced sensors and real-time data analytics, PLF can optimize climate management for improved broiler production and well-being throughout the long, hot summer.

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