

Ventilation and Lighting for Gamebirds

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VENTILATION

The function of a ventilation system is to remove heat and moisture from a building, and maintain fresh air by supplying an adequate level of oxygen and removing moisture, carbon dioxide, ammonia, dust, and odors.

Natural ventilation

Natural ventilation utilizes the natural movement of air through open sided buildings or windows. This allows for convection currents to move air, much as a chimney moves warm air up and out. The use of ridge and eave openings on a closed-sided building will result in a constant flow of air being produced if the outside temperature is cooler than the temperature at floor level inside a building. This effect is most useful in cold weather under still conditions.

Mechanical ventilation

Mechanical ventilation may be used in all sizes of buildings or facilities. Fans can be used to create either positive or negative pressure within the building. The proper use of fans and air inlets can result in a good mix of air in the building and produce a cooling effect during hot weather. Parts of a mechanical system include fans, inlets, thermostats and timers.

With properly designed and spaced inlets, air enters across the ceiling mixing with the warmer air at the top of the room and moving down across the floor to the exhaust fans. In this type of system the location of fans is not critical. Many broiler houses use tunnel ventilation where the fans are placed at one end of the house and all of the inlets are at the opposite end. Air is drawn through these large inlets and moves down the house in a wall-like fashion. The air entering the house can be cooled by drawing it through evaporative cooling pads or by using fogging nozzles spaced throughout the house.

With tunnel ventilation, air moves down the house with a velocity in the range of 350 to 400 feet per minute (fpm) (4 to 5 mph). Velocities in the range of 350 to 400 fpm produce a wind chill effect that can produce a cooling effect equivalent up to a 10°F temperature drop. This effect drops as air temperature increases, but still produces cooling even when temperatures reach the mid to high 90s°F.

Positive pressure ventilation is accomplished by placing fans in the sidewalls or ends of the building and forcing air into the building. This is not used much for poultry or gamebird facilities, except during extremely hot weather in open sided buildings or pens when extra cooling is necessary.

Fan Sizing

Some key points in ventilation of poultry and gamebirds are to prevent drafts on the birds and remove excess moisture and gasses. This can be accomplished by designing a system that will provide between 5 and 50 air changes per hour, depending on the outside temperature.

Example: You have a 10'x10'x8' pen, so that is a total of 800 cubic feet. To provide for just 5 air changes per hr that is the same as removing 4000 cu feet of air in 60 min or about 67 cfm. . To provide 50 air changes per hr is the equivalent of 667 cfm. So a variable speed fan rated at about 1000 cfm would suffice for this room. A 10" or 12" fan can be found with that rating. Attached to a timer, a 1000 cfm fan running for about 4 minutes per hours would do the 5 air changes and running constantly would provide the 50 plus changes.

Most fans are rated at different static pressure ratings, and we generally look to see the rating at 0.05" static pressure.

What about Insulation?

Insulation is any material that reduces heat transfer from one area to another. It is used to keep buildings warm or cool. Insulation can be used in the ceiling or under the roof, in walls and in curtains. Insulation in either the ceiling or under the roof will reduce radiant heat load on the birds, but insulation under the roof provides fewer nesting places for potential pests (e.g., rodents, birds).

Insulation plus a vapor barrier

Moisture condenses on the inside surfaces of buildings when the temperature of the building material falls below the dew point of the inside air. Insulation along with a vapor barrier helps keep moisture from reaching the cold interior surface of an exterior wall or roofing member while the insulation helps maintain a more comfortable environmental temperature.

Remember that the vapor barrier is to be placed on the inside surface of the insulation, the side facing the room.

Preventing condensation

For summer, a ventilation system's main purpose is to remove excess heat from inside of houses. For winter, however, it is just the opposite; we want to keep heat inside houses. So the ventilation system must still be operated during cold weather for moisture control. The moisture generated by the birds must be removed from the house to prevent damp conditions which can lead to condensation on walls and ceilings. Using a vapor barrier with insulation, as discussed above, is one way to reduce condensation.

To ventilate for winter conditions in most buildings, running fans periodically throughout the day with a time clock will control condensation. The ventilation rate will range from ¼ to 2 cfm per bird depending on the bird size. The fans should operate on a 5- or a 10- minute

timer, although using a 5 minute timer will provide more uniform conditions in the house. Running time should be adjusted to maintain a relative humidity of between 50 and 70 percent. For young chicks, the humidity should be on the high end of this range. If the humidity drops below 50 percent, airborne dust can become a problem. If the humidity rises above 70 percent, the chance of condensation increases.

Determining size and number of air inlets

For buildings less than 150 ft long, use equally spaced inlets as follows: Determine total inlet opening area (A) by providing 1.66 sq ft of opening for each 1000 cfm fan capacity. The number of openings (N) is determined by multiplying the length (L) of the house by 5 and divide by the width. (W) ($N = 5 \times L / W$).

The size of each opening is found by dividing the total inlet area by the number of openings. Each Opening Size = A/N

EXAMPLE : Summer ventilation for a house 150' x 34' requiring 19,600 cfm

$$A = 1.666 \text{ sq ft} \times 19,600 \text{ cfm} / 1000 \text{ cfm} = 32.6$$

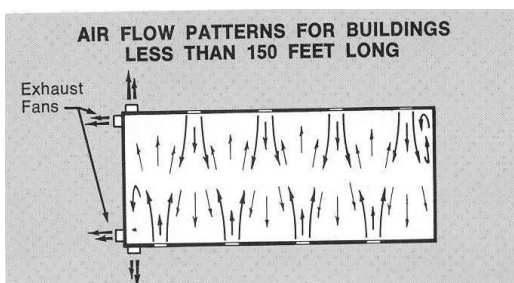
So round up to 33 sq ft of opening.

$$N = 5 \times L / W = 5 \times 150' / 34' = 22 \text{ openings}$$

$$\text{Size of each opening} = A/N = 33/22 = 1.5 \text{ sq ft.}$$

SO make 11 openings on each sidewall spaced from 12 to 14 ft apart. Each opening provides 1.5 total sq ft. Make sliding openings for the slots and you can decrease the ventilation for winter.

Or purchase commercial adjustable vents of the size needed.



From Environmental Control Handbook for Poultry and Livestock. ACME Engineering

Lighting for Gamebirds

Light is an important aspect of an animal's environment. Avian species as well as mammalian species respond to light energy in a variety of ways, including growth and reproductive performance. The value of regulating the photoperiod of poultry and livestock to stimulate reproduction has been recognized for many years and is used regularly by commercial poultry and livestock farmers. For chickens there are three major functions of light: 1. to facilitate sight, 2. to stimulate internal cycles due to day-length changes, and 3. to initiate hormone release. Providing light for chickens has become a little more complex during the last 15 years than just screwing in a bulb and flicking on a switch. Now there are a wide variety of lighting programs and devices available to poultry producers, each with its own characteristics and applicability to rearing chickens. However, before we get to the details, I have found that most people are slightly confused about what light is and what

aspects of it are important to rearing poultry. I would therefore like to elaborate on this just a little.

WHAT IS LIGHT?

Visible light is just a tiny portion of the total electromagnetic spectrum, which includes radio waves, microwaves, x-rays and gamma rays. The light environment can be classified in three ways, *wavelength, intensity and duration*. Each of these aspects will be discussed relative to rearing poultry.

WAVELENGTH OR COLOR OF LIGHT

Research has shown that the color of light can have many different effects on behavior, growth and reproduction in poultry. Birds sense light through their eyes (retinal photoreceptors) and through photosensitive cells in the brain (extra-retinal photoreceptors). Since long wavelengths of light (towards red end of the spectrum) penetrate the skin and skull more efficiently than short wavelengths, it has been observed that growth and behavior are linked to retinal photoreception (and shorter wavelengths) whereas the reproduction has been linked to extra-retinal photoreceptors. From these observations it has been reported that **blue** light has a calming effect on birds, however, **red** has been used to reduce cannibalism and feather picking. It has also been shown that **blue-green light stimulates growth** in chickens while **orange-red stimulates reproduction**. Birds have pigmented oil droplets on their cone cells that correspond to peak sensitivities of 415 nm, violet; 460 nm, blue; 510 nm, green; and 560 nm, yellow for young birds with a peak at 580 nm, orange for adults. Recently, it has been shown that the lens of birds is transparent to light in the UVA range (320-400 nm).

However, they probably see brightness of color different than humans. These facts are important to remember when selecting a light source for illuminating poultry.

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The lighting industry uses four methods to describe light color but only one really applies to selecting lighting for poultry, *chromaticity*. Chromaticity is the measure of a light source's warmth (warm light) or coolness (cool light) expressed in degrees Kelvin. The scale runs from 2000 to 7000K. Chromaticity values of 4000K and higher are considered cool (mostly blue light), those around 3500K or 3600K are called "balanced" or "neutral" and those of about 3000K or lower are considered warm (more red light). A color temperature designation is truly accurate only for an incandescent lamp because it produces a continuous spectrum. Fluorescent and HID (high-intensity discharge; HP Sodium and Metal Halide lamps) lamps are said to have a "correlated" (apparent) color temperature and are thus always described using the term *correlated color temperature* (CCT) (Knisley, 1990).

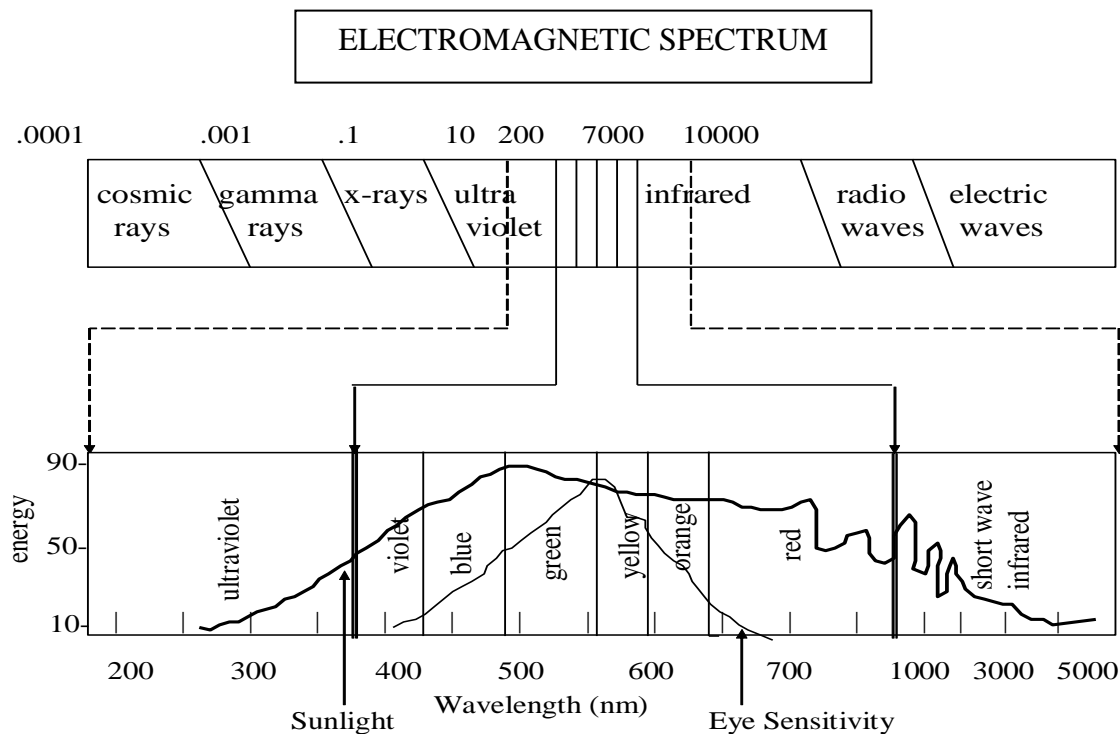
Chromaticity is the measure of a light sources' warmth (warm light) or coolness (cool light) expressed in degrees Kelvin. The scale runs from 2000 to 7000K. Chromaticity values of 4000K and higher are considered cool (a lot of blue light), those around 3500K or 3600K are called "balanced" or "neutral" and those of about 3000K or lower are considered warm (more red light). A color temperature designation is truly accurate only for an incandescent lamp because it produces a continuous spectrum. Fluorescent and HID (high-intensity discharge; high pressure (HP) Sodium, Low pressure sodium and Metal Halide lamps) lamps are said to have a "correlated" (apparent) color temperature and are thus always described using the term *correlated color temperature* (CCT).

WHAT KIND OF LAMPS IS AVAILABLE TO POULTRY PRODUCERS?

Incandescent, Fluorescent, Metal Halide and High-Pressure Sodium lamps are currently being used in poultry production facilities for laying hens, breeder flocks and growing meat birds. The *incandescent* bulb is the current standard by which others are compared, relative to poultry production.

Incandescent bulbs produce light by passing an electric current through a tungsten filament, heating it to incandescence. These lamps provide light energy over the entire visible spectrum, however much of the electrical energy is converted to heat energy as infrared. They have a light efficiency of about 8 - 24 lumens per watt and a rated life of about 750-2000 hours. A tungsten-halogen incandescent lamp will last about 3000 hours with an efficiency of about 20 lumens per watt.

Fluorescent lamps produce light by the passage of an electric current through a low-pressure vapor or gas contained within a glass tube. The ultraviolet radiation given off by the mercury-vapor arc stream produced along the length of the tube is absorbed by the phosphor material coating the inside of the glass tube, causing it to fluoresce at wavelengths that are seen as visible light. The wavelengths emitted depend upon the phosphors used in coating the tube.



The new CF lamps all use a special triphosphor coating, resulting in light emitted in discrete wavelengths from each of the primary colors, red-orange, green and blue, giving an appearance of balanced white light. There are several styles of the CF lamps, including twin, quad and spiral tubes. They come in 5, 7, 9, 13, 16, 22, and 28 watt sizes with efficiencies of 50 to 69 lumens per watt and rated lifetimes of greater than 10,000 hours. Recent research has demonstrated that some may last more than 20,000 hours under poultry house conditions. However, these lamps will decrease their light output by about 20 - 30% over their lifetime,

(Darre and Rock, 1995) and this must be considered upon initial installation. All fluorescent lamps require a ballast. The CF lamps have been used successfully in all types of poultry operations, including caged layers, (Darre, 1986) breeder flocks, growing broilers (Andrews and Zimmerman, 1990; Scheideler, 1990), growing pullets and turkeys. Research by Widowski, et al., (1992) indicated a preference for CF lamps over incandescent lamps by Leghorn layers.

High Pressure Sodium (HPS) lamps discharge an electric arc through a concentrated sodium vapor producing energy across the entire visible spectrum, but with the highest intensity in the yellow, orange and red regions. These are considered warm lights at about 2100K color temperature. They run at about 51-132 lumens per watt and come in wattages ranging from 35 to 1000. They have the longest rated life of all the lamps discussed, at about 24,000 hours. All HPS lamps require a ballast. These lamps require a warm up time to full illumination of between 5 and 15 minutes, which means that after a power outage, backup lighting may be necessary until full illumination has been achieved again. These lamps have been used successfully in poultry facilities, mostly in breeder houses and turkey facilities, with peaked roofs so that light distribution is more easily controlled (Andrews and Zimmerman, 1990).

Metal Halide (MH) lamps have ratings from 32 to 1500 watts and come in three different outer bulb finishes, clear, phosphor coated and diffuse. The MH lamps emit light across the entire visible spectrum, but are considered a cool light, having a lot of blue. They have efficiencies of about 80 to 100 lumens per watt and are rated at about 10,000 to 20,000 hours of life. MH lamps require a ballast also. Because these lamps must be mounted in a specific orientation (vertical or horizontal) they are not used much in the chicken house, but have been used in warehouse areas and egg handling rooms, where ceilings are high and efficient, bright lighting is required. These lamps also have a warm up period of between 5 and 15 minutes to achieve full illumination.

Cold Cathode Fluorescent Light (CCFL) is a tubular light that works by passing an electrical current through a gas or vapor, much like neon lighting. Cold cathode lights can come in many sizes and colors, and there are many advantages over neon and fluorescent lighting.

The first advantage is that cold cathode lights do not get hot. Another is that a cold cathode light is up to five times brighter than neon lighting, and it has one of the longest lives of any lighting fixture at about 50,000 hours. Unlike incandescent bulbs, the longevity of one of these lights is not shortened by the repeated action of turning it off and on. Cathode Lighting Systems offers several different systems for varying applications, with light outputs up to 709 lumens per linear foot (2340 lumens per meter). Dozens of pastel and neon colors are available, as well as a wide array of high-color-rendering white hues. Lastly, they are dimmable using current incandescent lamp dimmers. The disadvantage is their initial expense. There are also CCFL designed to replace long life incandescent lamps and lamps that are used in dimming applications. These CCFL lamps are virtually the same size and shape as the incandescent lamps they were designed to replace. They include an integrated miniature electronic ballast, fully dimmable to less than 5%.

Light Emitting Diodes (LED) have been used for many applications where long life and reliability are required. Most run on low voltage (3.6 – 12 volts) and when put into an array, they can produce high light output in either a focused or wide angle beam. The LED arrays

are relatively expensive, but are getting less expensive all the time. They are illuminated solely by the movement of electrons in a [semiconductor](#) material, and they last just as long as a standard transistor.

Table 1. **Lighting Source Comparison**

	Inc.	CF	MH	HPS	CCFL	LED
Initial Cost	Low	Moderate	High	High	High	High
Operating Cost	High	Moderate	Low	Low	Very low	Very low
Efficiency*	8-24	50-69	80-100	51-132	150 +	150+
Rated Life (hrs)	500+	10,000+	15,000+	24,000+	25,000+	100,000+
Color Temp (K)	2500K	2700K	700- 4000K	2100K	?	?

* Efficiency is measured as the rated lumens per watt.

HOW BRIGHT AND HOW LONG?

Now that the physical aspects of the lamps have been discussed, it is time to turn our attention to *intensity* and *duration*.

LIGHTING BREEDERS

Intensity: In natural light (window) housing the natural light is supplemented with 1.5 - 5.0 fc for the period when supplemental lighting is used. It has been found that birds exposed to very dim lights, say 3 hrs at .02 - .03 fc) prior to exposure to bright lights, say 8 hrs at .5 fc or more, might perceive this as sunrise and daylight and shift their biological clock as if exposed to 11 hours of normal light. However, the reverse, dim following bright, does not shift their perception. It appears that the threshold intensity for photostimulation is about .15 fc. However, maximal egg production has been achieved at intensities between .5 and 10 fc. for most gamebirds.

The next important aspect is **duration** of light stimulation. Two rules exist for this.

1. **Never Increase** the duration or intensity of light during the **growing period**.
2. **Never Decrease** the duration or intensity of light during the **production period**.

WHEN TO STIMULATE WITH LIGHT

Pheasants, Chukars and Bobwhites respond best when they are at least 30 weeks of age when exposed to stimulatory lighting programs, provided they have been preconditioned under short daily photoperiods of 8 hours per day for a period of 6 to 8 weeks.

Males respond more slowly than females and must be given stimulatory light two weeks in advance of the hens in order that both reach sexual maturity at the same time.

For coturnix it has been found that the females will start laying at about 35 days of age, thus the whole program must be started much earlier to photostimulate them.

It has been found that a continuous lighting of about 13 to 16 hours is all that is needed, with the intent to keep the hours of light a bit longer than natural daylength to prevent the birds from being exposed to decreasing hours of light during lay. Use of any of the lamps that provide full spectrum or with a good amount in the orange-red portion will suffice.

At this point, the optimum light intensity for game bird breeders in lay has not been determined. However, good egg production has been reported for pheasants and partridges given 10 foot candle, at bird level. Some believe that game birds require a higher light intensity (at least 5 to 10 fc) to induce lay for the first cycle of egg production but will do well on a lower light intensity (2 or 3 fc) after they have experienced at least one cycle of lay.

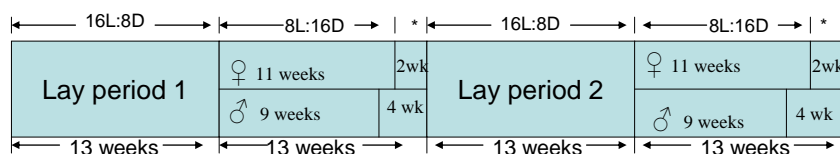
To “rest” the birds between laying cycles, the building must be reasonable light tight, i.e. no light seepage around the doors, windows or ventilation system. The dark period must never be disrupted by light for any reason. Studies have shown that refractoriness in partridges can be terminated on a light intensity of less than .1 fc (1 lux) irrespective of the day length. The usual practice is to reduce the amount of light to 8 hours per day, preferably given during the natural daylight hours, for a period of eight and ten weeks for Chukars and Pheasants, respectively.

For chukars and pheasants, onset of lay begins somewhere between 18-21 days after the birds are given stimulatory light. About ten days later the flock will attain 50% rate of lay. Duration of the production depends on the species and management.

LIGHTING PROGRAMS FOR RECYCLING AND FORCE MOLTING GAME BIRDS

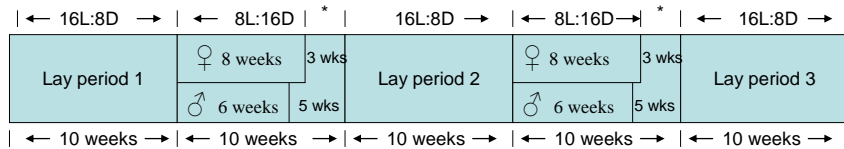
A program for cycling Pheasants and Chukars for year-round production is shown below. Basically, pheasants are given stimulatory light for 13 weeks followed by a rest period of 13 weeks and partridges are given stimulatory light for 10 weeks of production followed by 10 weeks of rest.

Suggested lighting schedule for Recycling pheasants.



* Start light stimulation for next period. Light males 2 weeks prior to lighting females.

Suggested lighting schedule for Recycling partridge.



* Start light stimulation for next period. Light males 2 weeks prior to lighting females.

(From Raising Gamebirds, Earnst, Woodward and Vohra, ANR publicaicon 8155)

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