ROSS

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THE INSIDE CHIRP

POULTRY NEWS VOL 39

LIGHTING FOR BROILERS

AVIAGEN MANAGEMENT ESSENTIALS

Aviagen®

LIGHTING

Objective

To achieve optimal broiler productivity and welfare through appropriate lighting and its management (hours of light and dark, light intensity, and distribution).

Principles

Broilers benefit from having a defined pattern of light and dark (day and night), creating distinct routine periods for rest and activity. Many important physiological and behavioural processes follow normal diurnal (daily) rhythms. Therefore, defined cycles of light and dark allow broilers to experience natural growth patterns, development and behaviour.

VISION DIFFERENCE IN POULTRY

Light Penetration

In poultry, light can reach the photo-receptors in two ways: through the retina and via direct penetration of the skull to the photo-receptors located in the brain's hypothalamus.

Wavelengths vary in their ability to penetrate the brain; for example, long wavelengths (e.g., red light, >620 nm) appear to penetrate cranial tissue more than short wavelengths (e.g., blue light, <495 nm). These differences may result in changes to the physiological or behavioural responses of the bird.

Color Vision

Color vision is defined by the number of different types of cone cells in the retina. The more types of cone cells, the more colors can be perceived. Humans have 3 types of cone cells and can distinguish between 3 colors: red, green, and blue. The retina of poultry contains 4 types of cones, an additional type of cone cell for the perception of ultraviolet (UV, <400 nm) light, which is invisible to the human eye **(Figure 1)**.

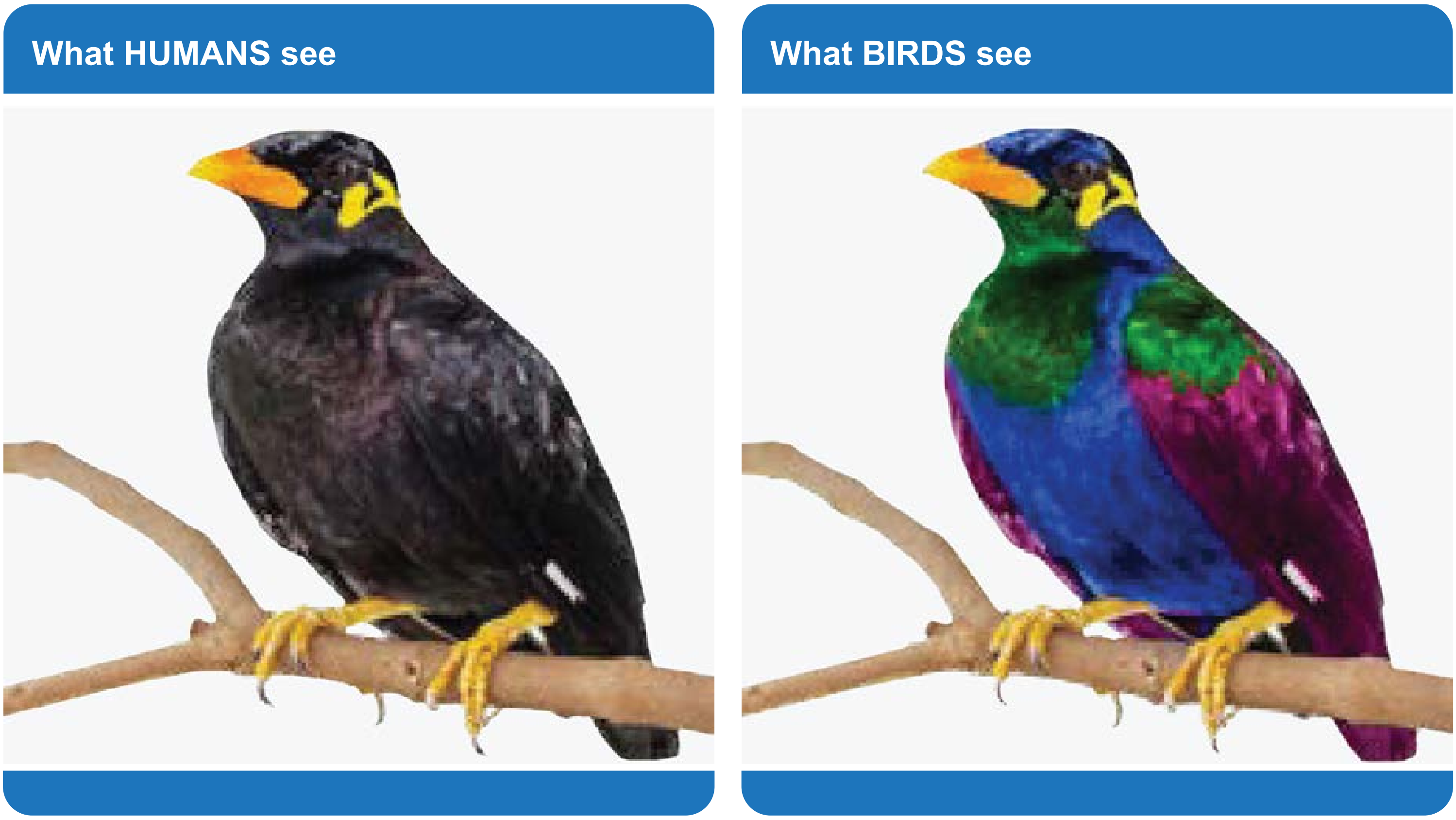
To account for this, gallilux/ clux (what poultry see) should be measured instead of, or in addition to, lux (what humans see). The effects of light color (wavelength combination) and intensity on broilers are mainly behavioural, which can improve productivity indirectly.

Flicker

Compared to humans, birds have a high flicker fusion rate (the frequency at which flicker can no longer be perceived), creating the ability to see fast-moving objects. This aspect of a bird's vision is important when considering lighting because birds can detect flicker (a visible change in brightness) when humans do not.

Flicker leads to stress, which will eventually lead to decreasing animal welfare and performance. Flicker has been found to reduce essential behaviours such as eating, drinking, preening and bill wiping in starlings.

Figure 1: UV Vision in Birds



CONSIDERATIONS FOR LIGHTING MANAGEMENT

Lighting Components

The four essential components of a lighting program are:	
1. Photoperiod Length	The number of hours of light and dark given in a 24-hour period.
2. Photoperiod Distribution	How the hours of light and dark are distributed throughout a 24-hour period.
3. Colour Temperature	The warmth or coolness of a light source depending on the composition of wavelengths.
4. Light Intensity	How bright the light provided is.

The interactive effects of these factors need to be taken into account when lighting broilers. For example, some production and/or welfare parameters (growth, FCR, and livability) may change as the photoperiod distribution changes during a 24-hour period. Also, as light intensity changes, so does the wavelength composition.

Light Duration and Pattern

Aviagen does not recommend continuous or nearcontinuous lighting (the provision of a short dark period of up to one hour) for the entire life of the broiler flock. The assumption that the provision of continuous lighting results in higher feed consumption and faster growth is incorrect. Not only does the provision of such a lighting program for the life of the flock result in depressed market weights, but it also has negative impacts on broiler health and welfare.

A number of factors influence the degree to which a lighting program will affect broiler production:

Factors affecting broiler production:	
The broiler flock age at program implementation	Early implementation is the most effective in benefiting bird health.
Age at rocessing	Older birds are likely to benefit more from darkness exposure.
Feeder and drinker management	Dawn-to-dusk settings will mean the flock will slowly wake up and access the feeders and drinkers. When dark periods are prolonged, birds will be more eager to access both feeders and drinkers when lights are turned on, which can result in increased levels of scratches and, therefore, bird rejections at processing.
Broiler growth rate	The impact of lighting will be greater in rapidly growing birds.

Considering a lighting program for broilers? the following points are important:

Day 0–7:
23 hours light and 1 hour dark for the first days after placement, gradually reaching 4–6 hours of darkness by 7 days. This will ensure chicks have a good early feed intake and drinking activity, optimizing early growth, health, and welfare.

After 7 days:
Around 5 hours may be optimum (4–6 hours). It is recommended that a minimum of 4 hours of darkness should be provided from 7 days of age (this should be introduced gradually).

Establish a consistent lighting schedule for each flock, ensuring the lights are turned on at the same time each day.

Consider the seasonal effects on the light schedule for different flocks. Failure to do this will result in:

- Abnormal feeding and drinking behaviors due to sleep deprivation.
- Suboptimal biological performance.
- Reduced bird welfare.

Lighting programs for broilers are subject to local laws and regulations, and the actual duration of dark periods given must comply.

Just before processing, giving an increased amount of light hours (e.g., increasing to 23 hours of light 3 days before depletion) can help with feed withdrawal (by stabilizing feed intake patterns) and catching (by helping keep birds calm), but can negatively impact FCR and may not be in line with laws and regulations in some areas.

Gradual vs. Abrupt Changes in Light

Abrupt changes (reductions in hours of light) create immediate drops in feed intake, body-weight gains, and feed efficiency. Although over time broilers will adapt their behavior (change their pattern of feed intake) in response to such a change, gradually changing the lighting program (both day length and light intensity) is preferable. This is particularly important if birds are to be processed at younger ages. Under these circumstances, birds will have less time to adapt to their feeding and drinking behavior, so the effects on live performance will be more pronounced.

In addition to making gradual changes to the lighting program itself, making a gradual change (over 2–3 days) to the introduction of dark or light periods may also be beneficial. Feeding activity in broilers is greatest immediately after the lights go on and for a period (of approximately 1 hour) before the lights go off. Using dawn-to-dusk programs (initiating dark or light periods over a period of 15–45 minutes) will result in birds gradually moving toward the feeder and can help alleviate crowding of all birds at once.

Intermittent Lighting Programs

Intermittent lighting programs consist of blocks of time containing both light and dark periods, which are repeated throughout the day. Splitting the dark period into two or more sections may have impacts on some productivity parameters in broilers:

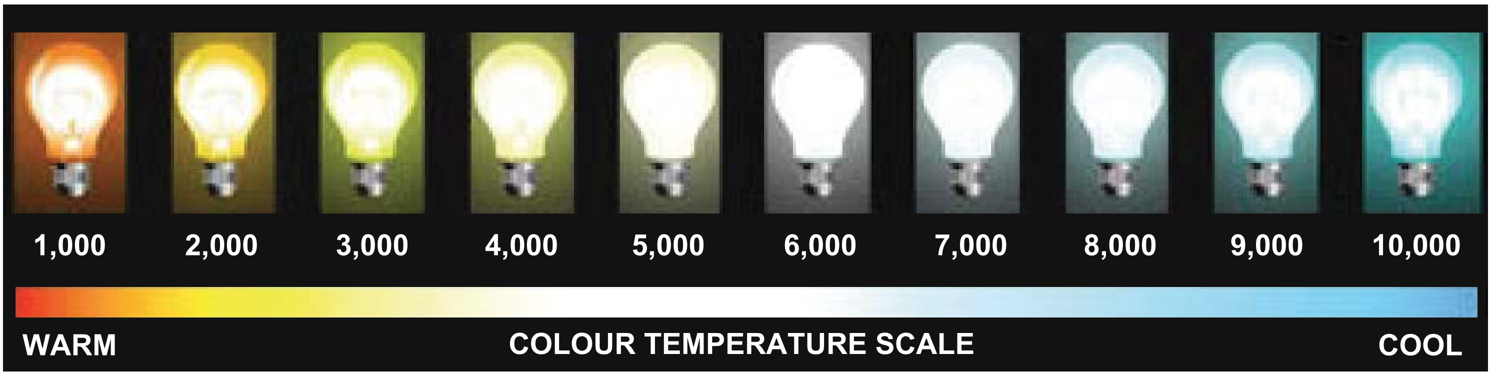
- Body weight at market age and breast meat percentage may be higher.
- The extra activity caused by a regular light and dark pattern may benefit leg health and carcass quality.

If intermittent lighting programs are used, they should be designed as simply as possible to allow for practical implementation. At least one of the dark periods should contain a continuous block of at least 4 hours of darkness. Any intermittent lighting program must adhere to local laws and regulations. If an intermittent lighting program is used, adequate feeding and drinking space must be provided. It may also be necessary to stagger the light (awake) periods from house to house across the farm to ensure that the water supply is not pushed beyond its maximal limits.

Color Temperature

Color temperature is the temperature required to heat a blackbody (something black) to get a specific color. The color temperature of visible light is measured in degrees Kelvin (K) on a scale from 1,000–10,000 **(Figure 2)**.

Figure 2: The Kelvin scale for measuring color temperature



At the lower end of the scale, <3,000 K, the light produced is considered "warm white," where red is the dominant wavelength. Above 4,000 K, the light produced is considered cool, and the dominant wavelength is blue.

Knowing the K value of the lights will provide information about the dominant wavelength within that light. This allows the right temperature of the light bulb to be chosen for the specific circumstances of the flock (e.g., market weight). For broiler flocks targeting <2 kg, the color temperature should be 5,000–6,000 K, whereas broilers >2 kg should target a color temperature of 3,500–4,500 K.

Wavelength (Light Colour)

There is no strong scientific evidence to show that one particular light bulb color performs better in broilers when comparing white light, which contains all colors of the human visible light spectrum (380–700 nm) **(Figure 3)**. Birds have a much wider spectral range from 330–740 nm.

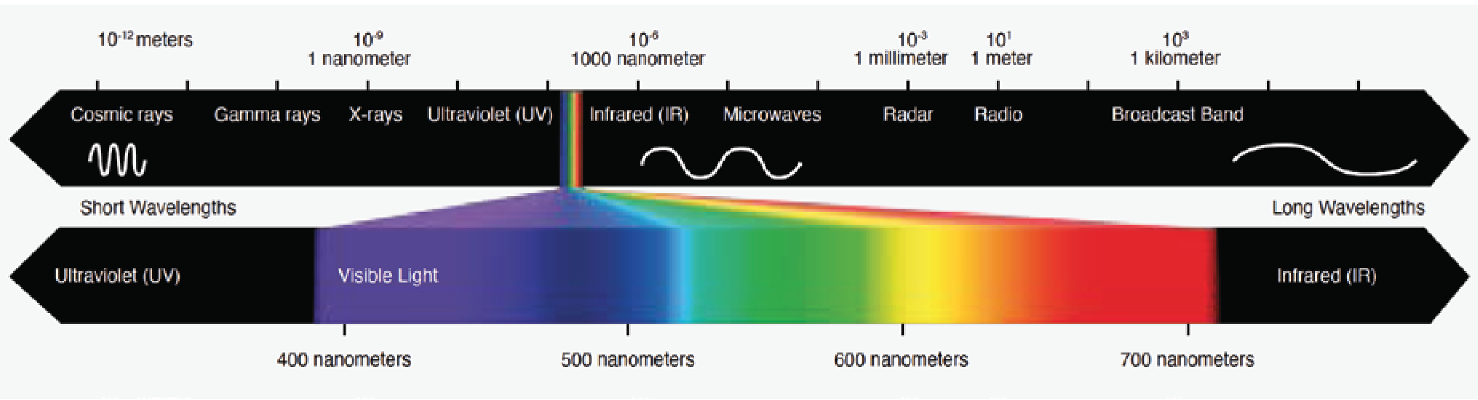
With the increased uptake of LED lights in the field and, therefore, the ability to alter the light color, there has been increased research into the exact requirements of light color for broiler flocks. Light color is dictated by the composition of wavelengths, which can impact broiler behavior and the resulting productivity and welfare outcomes.

The requirements and effects of different wavelengths on broiler behavior differ from breeding stock flocks. Red wavelengths have been found to increase aggression through increased testosterone production. In contrast, the provision of light with a higher proportion of blue/green wavelengths (450–560 nm) has been shown to promote calmness, which can improve FCR, livability, and leg health and reduce processing rejects.

At the hatchery and during catching, the provision of these blue/green wavelengths has been generally accepted to calm birds and complete these processes in a calm, efficient, and welfare-friendly manner.

When comparing various wavelengths of monochromatic light at the same light intensity, broiler growth rate appears to be better in broilers exposed to wavelengths of 415–560 nm (violet to green) than in those exposed to >620 nm (red) or broad spectrum (white) light.

Figure 3: The light spectrum



PROVISION OF LIGHT — LAMP TYPES

There is no consistent data to show that one type of lamp induces better performance than any other, so lamp choice will depend on availability, capital outlay, running costs, and the ability to dim using conventional voltage-reduction equipment. The advantages and disadvantages of various lamp types are given in **Table 1** below.

Table 1: Advantages and disadvantages of different lamp types.

Lamp Type	Advantages	Disadvantages	Wavelength Spectrum
Incandescent	Good spectral range. Can be used with dimmer. Inexpensive.	Inefficient. Lasts 700–1,000 hr and need to replaced frequently. ≈15 lumen/watt (tungsten). ≈25 lumen/watt (halogen). High energy cost.	Warm light. Mixture of wavelengths.
Fluorescent/ Compact Fluorescent	More efficient than incandescent. Uses less power. Lasts longer. Reduces electricity cost compared to incandescent. Relatively inexpensive but more expensive than incandescent.	Difficult to dispose of (contain mercury). Cannot be used with dimmer. Loses intensity over time. Issues with flicker. Does not reach maximum intensity immediately when turned on.	White light. 400–700 nm — similar color spectrum to incandescent lights. Available in both cool and warm spectra (K). Emits very specific wavelengths and these are combined to provide the color needed, but intermediate wavelengths are missing.
LED	Energy efficient. 200 lumens/watt. Lasts up to 50,000 hr. Specific lighting colors can be chosen. Some can be used with a dimmer.	High initial cost. Cheaper lights will not have suitable light spectrum or be suitable for the environment in the poultry house. Flicker can be a problem if not installed correctly.	Provides a full spectrum of light. The actual light color spectrum can be changed depending on the chemicals used in the light.
Halogen	Luminous efficiency. Stable color temperature. Almost no light decay. More efficient than incandescent.	Not ideally suited to dusty environments. Less efficient than LED and fluorescent lamps. More expensive than incandescent lamps. Emits a lot of heat.	Produces continuous spectrum of light (like incandescent lamps) but the spectrum is shifted toward blue.
Sodium Vapour	Energy efficient. Long life span. Consistent color temperature (warm).	Sodium is hazardous. Warm up time is required (5–15 mins). Requires a ballast.	Warm light with highest intensity in yellow, red, & orange. Color temperature is ≈2,100 K.

Currently, there is little evidence that light source affects the biological performance of broilers. However, there are several points that should be considered:

- **Flicker:** Broilers detect light bulb flicker at frequencies below ≈180 hertz (Hz). High-frequency (>200 Hz) light bulbs should be used where available and should be replaced as required. This will, among other things, reduce/avoid flickering of light, which is negative for bird welfare and can affect bird behavior.

- **Compatibility**: It should also be noted that the lighting system should be fully compatible, and therefore, the dimmer, bulb, and control panel work seamlessly together.

- **Poultry-specific light**: Do not purchase and use domestic LED bulbs in poultry houses; they are of lower quality and are not designed to cope with the conditions within a poultry house. In addition, the spectrum of light they emit may not be broad enough for broilers

Measuring Light

Because chickens perceive light differently, it is reasonable to measure light intensity differently. Depending on the light source and color spectrum, birds may perceive light intensity as up to 50% or higher than that measured by a light meter (using lux). Therefore, it is valid to use an approach that corrects this. Specific gallilux (the spectrum and intensity of light the bird actually sees, also known as clux) meters are available, but light meters sold for agricultural purposes will have conversion tables for converting lux to gallilux in the instruction booklets. Determining what light intensity is actually perceived by the birds will allow a more accurate selection of suitable light and more precise management of light intensity. The light meter needs to be appropriate for the light type. For example, not all agricultural light meters are necessarily accurate for LED lights.

Measure light intensity at the bird level across a number of points within the bird area.

Figure 4: Example of 10 lux/1 fc (top) and 30 lux/3 fc (bottom) light intensity.

Light Intensity

Local laws and regulations for light intensity must be followed*, but a minimum light intensity of 30–40 lux (2.8–3.7 fc) in whole house brooding or 80–100 lux for spot brooding from 0–7 days of age and 5–10 lux (0.5–0.9 fc) thereafter will improve feeding activity and growth. **Figure 4** illustrates two examples of light intensity. Chick activity should be monitored to determine if the light intensity is appropriate for their age.

**For example, European law requires a minimum of 20 lux on at least 80% of the house surface and at least a total of 6 hours of darkness starting from 8 days of age (Directive 2007/43/EC).*

A low daytime light intensity (<5 lux/0.5 fc) may negatively impact mortality, FCR, and growth. Low light intensities may also:

- Affect eye growth.
- Lead to increased footpad lesions.
- Reduce activity and comfort behaviors (dust bathing, scratching, etc.).
- Impact on physiological rhythms as birds may not be able to detect the difference between day and night.

The light intensity should be less than 0.4 lux (0.04 fc) to attain a state of darkness. During the dark periods, care should be taken to avoid light leakage through air inlets, fan housings, and door frames. Regular tests should be conducted to check the effectiveness of light-proofing. One way to do this is to stand in the center of the house and turn the lights off. Any light leakage into the house will be observed.

Uniformity of Light Intensity

Light must be uniformly distributed throughout the house where the difference between the lightest and darkest areas of the bird area is minimized, and variation is <30%. Differences in light intensity in the brood area can lead to localized high stocking density and, therefore, increased pressure in feeder and water lines, leading to compromised productivity and reduced welfare outcomes. Lights should be evenly distributed throughout the house and be equidistant from the house floor. Lighting manufacturers can provide recommendations on the number and position of the bulbs to minimize light uniformity issues. Lights must be kept in good working order, and when replacing singular bulbs, they are replaced with similar replacements.

Hot Weather Management

In hot weather conditions and where environmental control capability is limited (such as in open-sided housing), the period without artificial light should be timed to maximize bird comfort. For example, feed can be removed for a time during the heat of the day, and a light period provided during cooler external conditions to allow birds to feed during this cooler period.

A continuous dark period of at least 4 hours must be provided during the night.

T: +27 (0) 16 366 0249
www.rosspoultrybreeders.co.za

ROSS
An Aviagen Brand

Block D, Techno Link Office Park,
63 Regency Drive, Route 21 Business Park, Irene.
Republic of South Africa

P.O.Box 297
Meyerton 1960
Republic of South Africa