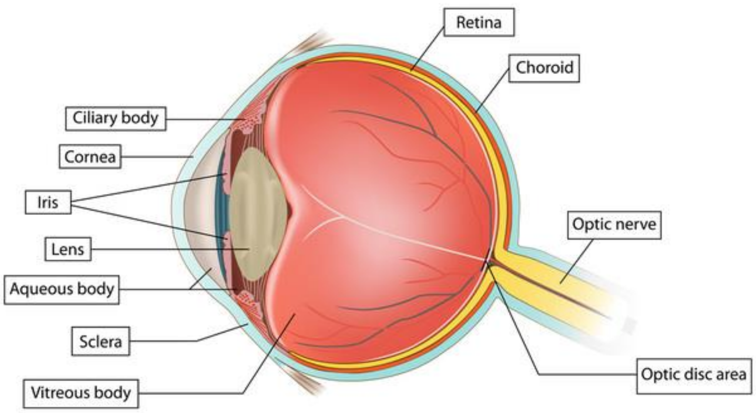
Lighting Practices for Successful Laying Hens

By Ericka Mongeau

Bird Biology – Poultry Eyesight

Sight is the most important sense for birds, as good eyesight is essential for safe flight, and birds have several adaptations that provide superior visual acuity relative to other vertebrate groups[1].

Eyes share a basic common structure across species with some adaptations befitting evolution. In chickens, the eye functions as it does in humans: light enters the cornea and iris to stimulate the retina at the back of the eye. The retina translates the light pattern to the optic nerve, which transmits the image to the brain.



There are, however, some differences. Chickens are tetrachromatic[2], meaning they can see red, green, and blue light (the visible spectrum seen by humans[3]) as well as violet light, including some of the ultraviolet spectrum[4]. In addition to the common rods and cones seen in most structures[5], chickens have a double-cone structure that aids in tracking movement[6].

Lastly, because their skulls are so thin, chickens can also "see" light directly in their brain. Chickens have extra retinal photoreceptors in the pineal gland and the hypothalamus allowing them to perceive light through the dorsal surface of the brain. Photoreceptors transform the light energy into a biological signal[7] that controls the circadian rhythm – a 24-hour hormonal and behavioral cycle – which regulates sleep patterns, feeding times, and egg production.

The perception of light depends mainly on hypothalamic photoreceptors. They are biological transformers that convert the energy of light into neural impulses. The hypothalamus is the main hormone control center. It receives the neural and environmental

Lighting Vocab

Photoperiod: Duration of light within a 24-hour period.

Visible light spectrum: Portion of the electromagnetic spectrum that is visible to the human or animal eye

Illuminance: Total luminous flux on a surface. Measured in lux or foot candles.

Luminous Flux: Total perceived power of light produced by the light source. Measured in Lumens.

Luminous Intensity: Power emitted by a light source in a particular direction per unit solid angle. Measure in Candelas.

Clux or galliux: Unit for measuring light intensity based on the spectral sensitivity of poultry.

Ultraviolet (UV): Electromagnetic radiation from 10-400nm.

Infrared light: Electromagnetic radiation from 700-1,000,000nm.

Photopic spectral sensitivity: Color sensitivity or sensitivity to light under bright conditions.

Chromaticity: The objective measurement of the color of a light source independent of the illuminance.

---

[1] Diyan Li, et al. The Effect of Monochromatic Light-emitting Diode Light on Reproductive Traits of Laying Hens. *Poultry Science Association, Inc.* 2014.
[2] Ibid.
[3] Ibid.
[4] Hy-Line Understanding Poultry Lighting: A Guide to LED Bulbs and Other Sources of Light for Egg Producers
[5] Samara Paula Verza, Erika Codensey Toledo Mello Peixoto, Petronio Penheiro Porto, Marcos Augusto Alves da Silva. LED in production system of Laying Hens: An alternative to increase sustainability. *African Journal of Research.* 20 April 2017.
[6] Hy-Line: Guide to LEDs
[7] Verza, et al., 2017.

signals, and instructs the release of reproductive hormones like progesterone and estrogen. Progesterone acts on the secretion of albumen. Estrogen acts on the egg yolk synthesis by the liver[8].

Because of the chickens' sensitivity to light and its importance in regulating behaviors, it's used as a management tool to optimize productivity. Light, as an environmental factor, consists of three aspects that can affect the physical activity of chickens: photoperiodic regimen or light duration, light intensity, and color spectrum[9]. Building an effective lighting program first requires an understanding of how light duration, intensity, and spectrum affect the birds at each stage of production.

Duration

The length of time that pullets and hens are exposed to light affects growth in pullets and egg production in layers. In general, pullets require less daylight, and so can be raised on a shorter photoperiod. Longer daylight periods are used to stimulate the on-set of lay in fresh layer hens. The photoperiod manipulation can anticipate or delay the start of egg production, improve the quality of the shell and the size of the eggs, and maximize feed efficiency[10]. Ideally, light duration should reach 16 hours by 30-35 weeks of age[11].

Intensity

Light intensity can vary significantly throughout a house depending on the light source and its location. Often measured in lux, clux, or foot candles, this can more easily be described as brightness. If the house is too dark, it may stunt pullet growth, yet conversely, a house that is too bright may cause nervousness and aggressive behaviors. Light intensity influences bird activity, immune response and growth rate and has been used to alleviate mortality issues related to metabolic diseases[12].

Spectrum

The spectrum of light refers to the expressed bulb color. Usually measured in degrees Kelvin (K), different perceived colors can affect hens differently. It is thought that pullets raised with greater portions of blue and green light show enhanced growth. Laying hens should have sufficient red spectrum as red light is vital for stimulating sexual maturity and egg production. Red light can penetrate the skull to stimulate extra retinal photoreceptors and it does this up to 50 times more efficiently than blue, green, and yellow-orange light[13].

Lighting Options

Growers must understand the spectral composition of different light sources to select the best lighting option for their operation. Sunlight, incandescent lights, compact fluorescent lights, linear fluorescent lights, or LEDs are all viable options depending on location and farm design, though recently there has been an increased interest in LEDs, as they prove to be safer and more energy efficient[14].

Light sources have similar impact on various species of poultry in terms of egg production. Age and body weight of hens have also been shown to affect feed consumption and egg production[15]. The luminous

[8] Ibid.
[9] Li, 2014.
[10] Verza, et al., 2017.
[11] Hy-Line: Guide to LEDs
[12] Fawwad Ahmad, Ahsun-ul-Haq, M. Ashraf, Jibran Hussain, and M. Zubair Siddiqui. Production Performance of White Leghorn Hens Under Different Lighting Regimes. *Pakistan Veterinary Journal.* Department of Poultry Science, University of Agriculture, Faisalabad, Pakistan
[13] Hy-Line: Guide to LEDs
[14] Ibid.
[15] Ibid.

intensity provided to the birds can affect the productive performance, so it is necessary to adapt the type of the lamp, taking into account the chromatic intensity oscillation, the temperature, the illuminance distribution, and the quantity of lux[16].

Sunlight[17]

Pros	**Cons**
Consistent from season to season in equatorial regions	Spectral composition changes throughout the day, per season, and with cloud coverage
Full spectrum light ranging from UV to IR	Intensity changes throughout the day as it comes from different areas of the house
Requires little to no artificial supplemental lighting for lower energy costs	Intensity is much higher, overcoming seasonal changes in day length can present challenge
	High intensity may cause aberrant behavior like pecking or feather pulling

Incandescent[18]

Pros	**Cons**
Inexpensive	Short lifespan, require frequent replacement
Good red spectrum output	Metal or glass construction prone to breakage
Quick turn-on	90% of energy goes to heat rather than light
No performance change in cold weather	Most types don't comply with new energy efficiency standards

Compact Fluorescent[19]

Pros	**Cons**
Energy efficient	Uncovered spiral tubes may be difficult to clean
Relatively inexpensive	Metal and glass construction prone to breakage
Similar color spectra as incandescent	Do not dim well and are more prone to burning out when dim – prone to flickering
Available in warm and cool spectra	Looks like white light but has color spectra peaks depending on phosphors
	Require several minutes to reach max intensity when turned on
	Poor performance in cold weather
	Require ballast to regulate current and voltage supplied to the lamp

---

[16] Verza, et al., 2017.
[17] Hy-Line: Guide to LEDs
[18] Ibid.
[19] Ibid.

Linear Fluorescent Light[20] – traits similar to above with addition of following:

Pros	**Cons**
More uniform light distribution at all vertical levels	More expensive than compact fluorescents
Casts broad, even light in floor houses with fewer fixtures	More glass and hazardous debris if broken
	More difficult to store and transport safely

LEDs[21]

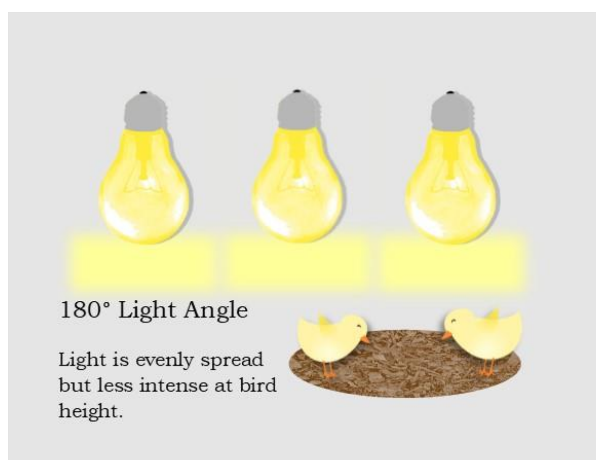
Pros	**Cons**
Provide full spectrum light	Expensive
Most energy efficient	Is directional and requires proper lens/diffuser to focus or distribute light
Can focus light onto specific areas	Efficiency of heat fins are reduced if not given enough space or covered in dust
Color spectrum can be adjusted depending on phosphors	May not burn out after expected lifespan but could be up to 70% dimmer
Easy to dim – dimming can extend bulbs lifespan	Cheaper LEDs may not have appropriate heat sink, spectrum, hardware, or warranty for poultry environment
Long lifespan – up to 10 years when used for 16 hours per day	
Rapidly reach peak intensity when turned on	
Efficient in cold weather with no performance change	

Dimmers

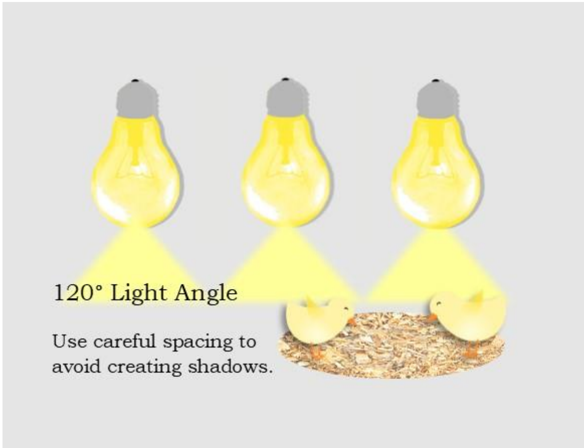
Dimmers are used in the poultry house to easily simulate night and day lighting. The dimmer must be compatible with the specific light used and with a bulb rated for dimming. A quality dimmer will have resistance built into it[22].

Light spacing

Achieving light angle output of less than 180 degrees is beneficial to direct light towards birds, but careful spacing must be done to avoid shadows. Birds tend to gather in dark spots and are more



[20] Ibid.
[21] Ibid.
[22] Ibid.



likely to lay floor eggs in dark corners. Low hung lights and less than 120 degree angles create spotlighting effect, creating dramatic light and dark areas[23]. Further prevent dark areas by replacing burned out bulbs and keep light bulbs clean to maintain consistent light intensity[24].

Uneven lighting in cage or tier systems can lead to both under and over stimulation in the same house, a problem when consistency is key. Laying hens should have 30 lux near the feed trough[25]. Measure at feed trough every 25cm or 1 foot between lights at every level of the system in houses with tiers and manure belts[26]. Measure at the wall, feeder, drinker lines, and two to three times between lights in floor systems[27].

Pullets

Young birds require more light to jump start their sight development and help them adjust to their surroundings. Birds need downtime to rest and grow, so it's advised to use an intermittent lighting program for the first week. Using bright light (30-50 lux) will help young birds find food and water and navigate their new environment[28].

Light is a management tool to optimize pullet growth, age of sexual maturity, egg weight, and egg production. Egg production is directly related to changes in day length to which the pullets are exposed so the egg number, livability, and profitability can be favorably influenced by a proper lighting program[29].

Both light rhythm and the quality of the light source are important to early development[30]. Pullets grown under white light had significantly higher body weight at six weeks of age than those raised under green light[31]. Chicks reared under 16 hours of light showed lower indication of stress than birds raised with only eight hours of daylight[32].

When introducing new chicks to a system, it's considered best practice to follow an intermittent lighting program. This will help to train birds – they will learn to eat when lights come on, then rest when lights are

[23] Ibid.
[24] Hy-Line W-36 Commercial Layer Guide
[25] Ibid.
[26] Ibid.
[27] Ibid.
[28] Hy-Line W-36 Commercial Layer Guide
[29] Ahmed, et al.
[30] Stefan Gunnarsson et al. Effect of Day Length and Natural versus incandescent light on perching and the diurnal rhythm of feeding behavior in layer chicks. *Acta Agriculturae Scandinavica.* June 2008.
[31] Ahmed, et al.
[32] Gunnarsson, et al., 2008.

off. This frequent rest time can help to improve both seven-day livability and pullet weight, as well as antibody response from vaccinations, making the birds healthier.

An intermittent lighting program alternates light and dark periods to synchronize feeding and other activities. For example, two hours of dark is followed by two hours of light and so on throughout the day. This program is generally used for the first seven days, though can be used longer based on grower preference. After week one, reduce light intensity and begin a slow step-down lighting program. Pullets can brood two to three weeks at 30-50 lux, then dim gradually to 10-15 lux until 14 weeks.

Layers

Layer hens require a minimum amount of light intensity for optimal egg production, usually between five and 10 lux[33]. They also require a full day length period. Both estrogen and progesterone are required to form eggs, and a short daylength will not stimulate the secretion of these hormones.

The color of light has been shown to affect the size and weight of the eggs. Eggs laid under red light were the heaviest, but had the smallest egg weight percentage. Birds reared under green light laid the fewest eggs, but those eggs had the best quality.

Artificial light is routinely used in lighting systems for commercial laying hens to delay or accelerate sexual maturity, stimulate egg laying, and improve weight gain. Delaying the beginning of the egg production through light control determines a better quality of shell, fewer eggs with two yolks or deformed eggs, and lower mortality due to prolapse[34].

For the best lighting control, producers must limit how much natural birds are exposed to. Light traps and shutters block natural light from coming into the barn[35]. Window shades and curtains prevent direct light coming in through open sided houses[36]. To make management easier, try staggering “lights on” time between houses in laying flocks to facilitate egg collection on multiple flock complexes[37].

Light presence during the night improves the growth and adaptation to the environment[38]. It can help to increase food consumption in under-weight birds and aid in calcium absorption in laying hens.

Lighting Programs

Continuous Lighting Program

Supplies 15 to 16 hours of uninterrupted light followed by eight to nine hours of darkness[39]. Mimics natural daylight.

---

[33] Ahmed, et al.
[34] Verza, et al., 2017.
[35] Hy-Line W-36 Commercial Layer Guide
[36] Hy-Line: Guide to LEDs
[37] Hy-Line W-36 Commercial Layer Guide
[38] Verza, et al., 2017.
[39] Flavio Manabu Yuri, et al. Intermittent lighting programs for layers with different photophases in the beginning of the laying phase. *Ciencia Rural.* Nov 2016.

Intermittent Lighting Program

A few hours of light followed by a few hours of darkness. For example, four hours of light, two hours of dark, repeated throughout a 24-hour period. Intermittent lighting programs do not affect the eggs quality[40]. May result in increased feed intake.

Step-down Lighting Program[41]

Start pullets at 20-22 hours of light at 20 lux during the first week. Decrease to 18 hours of light in the second week. Decrease further to 10-12 hours of light by seven to nine weeks. Maintain this lighting schedule until approximately 17 weeks, when light stimulation begins. Light programs of rearing and production houses should be matched at transfer[42].

Light Stimulation Program[43]

Only provide stimulation when birds have reached recommended 17-week weights and 80% uniformity. Delay stimulation until these requirements are met. If laying flock has large spread in hatch ages or poor uniformity, light stimulate the flock based on the youngest hatch date or lightest birds[44].

The initial daylight increase should be no more than one hour. Increase by 15-30 minutes per week until 16 hours of light is reached. Stimulation should last until 28-32 weeks of age. Light intensity should also gradually increase to 10-20 lux.

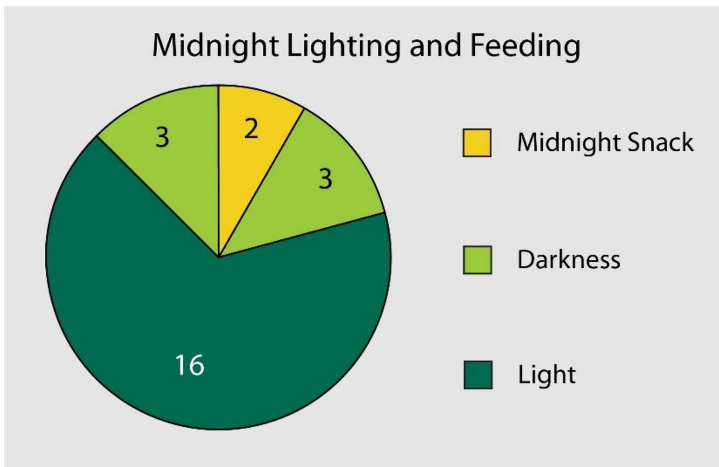
Midnight Feeding/Lighting Program[45]

A midnight feeding and lighting program can be used in laying flocks to increase feed intake during peak production and increase calcium absorption during the night when most egg shell is formed[46]. Follow these guidelines to execute a successful midnight feeding and lighting program:

1. There must be at least three hours of dark before and after the midnight feed.

2. Fill feeders before lights are turned on.

3. Initiate program by turning lights on for 1-2 hours during the dark period.



The light provided during midnight feeding is in addition to regular day length, meaning there is less dark time, or down time, for the flock. When the midnight feeding program is removed, reduce light time

[40] Ibid.
[41] Hy-Line Brown Commercial Management Guide
[42] Hy-Line W-36 Commercial Layer Guide
[43] Hy-Line Brown Commercial Management Guide
[44] Hy-Line W-36 Commercial Layer Guide
[45] Ibid.
[46] Hy-Line Brown Commercial Management Guide

gradually at rate of 15 min per week. The midnight technique is also applicable in heat stress conditions, or any time more feed intake is desired in either growing or laying flocks[47].

Effects of Light Color

There are substantial benefits to using the proper color of light in a poultry barn. The effects can be long-term, by impacting the onset of first lay, or short-term, by influencing the level of aggressiveness within the flock[48].

Extensive research has been done to determine which color is best for raising and rearing laying hens. It was found that blue-green light stimulates growth in chickens, whereas orange-red light stimulates reproduction[49]. Red light, in the 630nm wavelength range, was found to be superior to any other wavelength in increasing egg production[50]. Birds reared under red light produced more eggs from age at first egg to 42 weeks of age and birds reared under blue light produced fewer[51]. However, blue light has a calming effect on birds whereas red may enhance feather pecking and cannibalism[52].

Conclusion

Chickens are incredibly sensitive to the presence of light. The length of the photoperiod and the intensity or brightness of the light will affect the birds' laying cycles, as well as their eating and sleeping patterns. The light color often dictates their behavior towards each other.

Knowing how light affects the physiology of the chickens can help producers create a lighting plan that optimizes layer performance. It's important that growers spend time with their flocks, monitoring egg production, behavior, and growth.

There are some key points to keep in mind. First, clean, well-spaced lights will reduce shadows, and therefore reduce floor eggs. Second, young birds require brighter light to help their eyes adjust and to easily find feed and water. When it comes time to transfer pullets into the hen house, the lighting conditions and patterns should match between houses to limit stress on the birds. And lastly, lighting practices are not a "set it and forget it" management tool. The only way to find what is best for your individual operation is to observe and adjust accordingly. Consult the breed guidelines as necessary. They're often a great starting point, but do not make up for good husbandry.

---

[47] Ibid.
[48] Delabbio, Juliette. The Science of Poultry Lighting. Once Innovations.
[49] Li, 2014.
[50] Delabbio, Once Innovations.
[51] Li, 2014.
[52] Ibid.

Want to learn more about our
Laying Hen solutions?

Contact Us!

1-800-99VALCO in the USA

1-419-678-8761 for International

info@val-co.com

www.val-co.com