POULTRY LED LIGHTING TECHNOLOGY

By Monaghan Electrical Wholesale Ltd.

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Content

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1 Chicken Consumption Trends in the World

1.1 Chicken Meat and Chicken industry

Chicken meat touches the lives of most human on an almost daily basis, with 90 per cent of the population eating chicken meat at least once a week, and a third of the population eating it three or more times a week.

Chicken has grown to become an important staple of the people diet, and is now human' most significant source of meat protein. Chicken meat is widely recognized to be a low fat protein source and also provides essential vitamins and minerals, notably niacin, vitamin A, vitamin E and magnesium.

Its versatility and ease of handling and cooking has made it a popular menu item, whether cooked fresh at home or in a restaurant, eaten as takeaway from a quick service restaurant, or purchased as a partially prepared meal or snack to be cooked and served at home or in a wide variety of food service situations.

The chicken meat industry is substantial and growing, with a strong presence in many rural and regional communities, where it employs people in both agricultural and food processing environments.

Forecasts uniformly predict continued steady growth in both production and domestic consumption of chicken meat.

The industry's growth over the last fifty years has been supported by a strong commitment to research and a dynamic approach towards embracing the best new technology from all over the world and adapting it for the local circumstances. This has resulted in the adoption of superior genetics, improved bird nutrition and more effective management practices. Together, these have contributed to improved growth and bird performance and better feed conversion, boosting overall industry efficiency and productivity.

Participants in the chicken meat industry remain mindful of their responsibilities to the birds in their care, the environment in which they operate, and the consumers who place their trust in the food the industry provides. This is reflected in the industry's involvement in a range of programs focusing on food safety, environmental sustainability, animal welfare and disease risk management.

Here are a few Poultry fun facts

- Poultry is the second most widely eaten meat in the world, accounting for about 30% of meat production worldwide, after pork at 38%.
- Chickens have panoramic vision of about 300°
- Chickens and other birds are thought to have descended from dinosaurs.
- The first Poultry Exhibition in the US took place Nov. 14, 1849

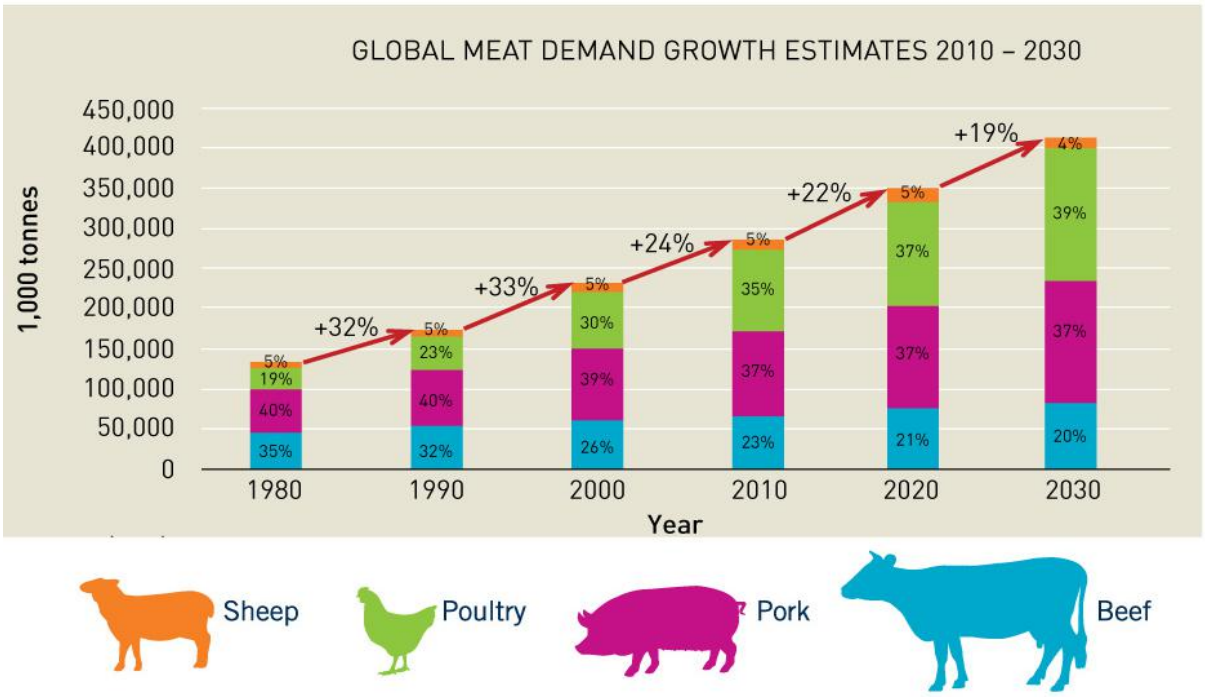
1.2 Global context

"According to recent FAO work using longer term population and income projections, global food production needs to increase more than 40% by 2030 and 70% by 2050, compared to average 2005-07 levels."

OECD-FAO Agricultural Outlook 2009 – 2018

Meat forms an important part of the diet for most people around the world.

Source: Rabobank (2011)



Twenty years ago the global demand for meat was 173 million tonnes, of which poultry made up 23 per cent. In 2010, the annual global demand for meat sits at 285 million tonnes, with poultry now comprising 35 per cent or 100 million tonnes of this.

This growth has in part been driven by productivity gains that have allowed chicken meat to become the best value meat option. Chicken sales have also benefited from favorable consumer attitudes towards the product, in particular its versatility, consistency, popularity across the family and increasingly recognized contribution to a healthy diet.

Looking to the future, global food production needs to increase by more than 40 per cent by 2030 and 70 per cent by 2050 to meet the needs of an ever increasing global population.

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The global demand for meat is estimated to increase by 40per cent to over 400 million tonnes by 2030 to support the world's growing population and its increased appetite for meat. Poultry's growth rate is expected to be the highest at 60 per cent, with poultry forecast to make up 39 per cent of worldwide meat demand by 2030 and become the most consumed meat globally.

Whilst there are several reasons for this strong growth forecast, possibly the most significant is poultry's efficient use of inputs including feed.

Globally, the world's largest chicken meat producing countries are the USA, China and Brazil, with world production growing steadily.These three countries also consume the most chicken meat.

SELECTED CHICKEN MEAT PRODUCING NATIONS (2010)

Country	Production (kt)	Total domestic consumption (kt)
United States	16,563	13,463
China	12,550	12,457
Brazil	12,312	9,132
European Union	9,095	8,779
Mexico	2,809	3,344
India	2,650	2,923
Russia	2,310	2,649
Iran	1,600	1,660
Argentina	1,600	2,063
South Africa	1,290	1,395
Thailand	1,280	1,514
Australia	934*	910**

Sources: USDA (2011); *ABS (2011); **ACMF estimate, see table at 4.1

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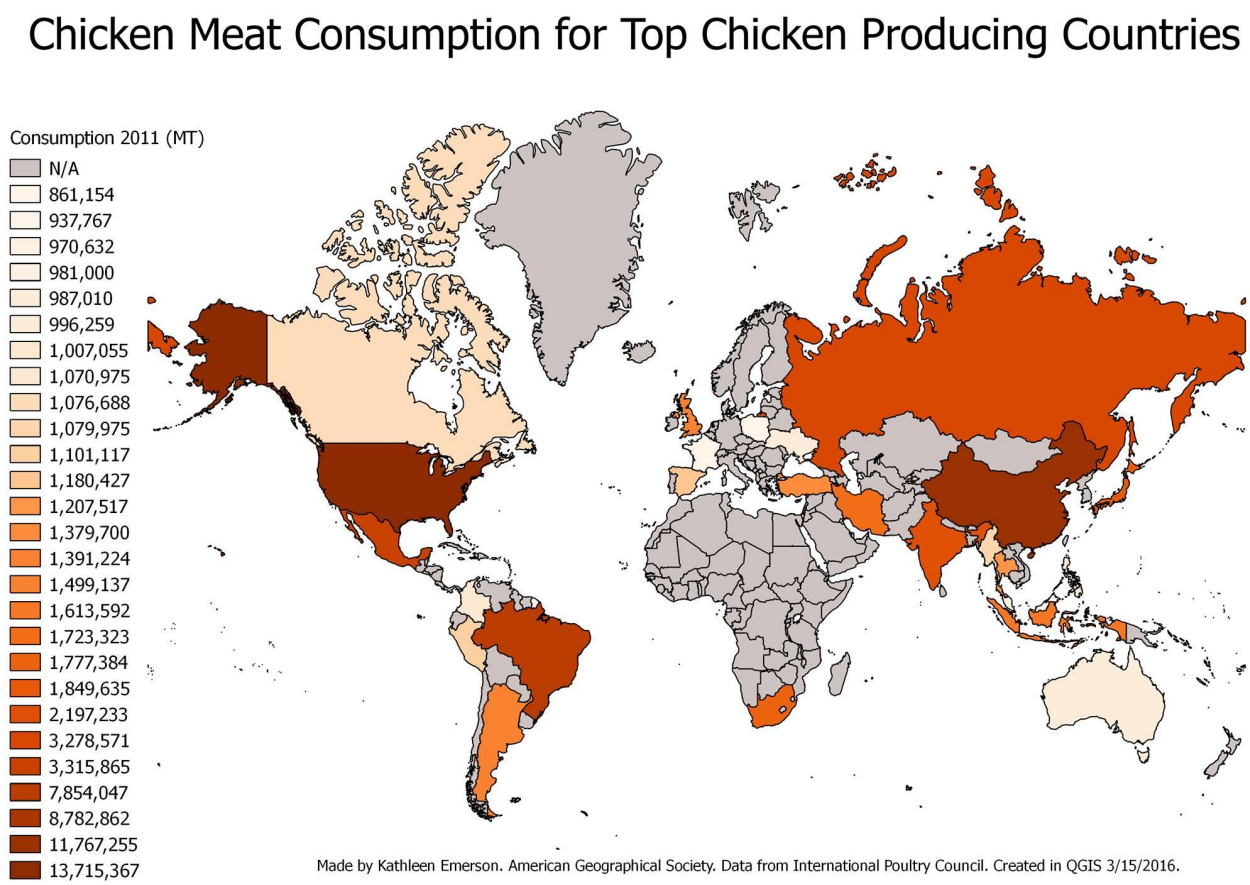
1.3 Chicken Meat Consumption for Top Chicken Producing Countries



The demand for food worldwide is expected to double by 2030. To meet that demand, producers are adopting new technologies that will enable them to increase production at a reduced cost with less stress on the environment. Most of these production technologies focus on enhancing traditional inputs such as water, air, nutrients, and housing. One largely unexplored production input is light.

By utilizing LED lighting and taking advantage of the unique spectral requirements of poultry, swine, dairy cattle, fish, or crustaceans, farmers can reduce stress and mortality, regulate circadian rhythm, and substantially increase the production of eggs, meat, and other protein sources, while dramatically reducing energy use and other input costs.

For most of Europe, increases in the consumption of chicken/person will depend on:

- Further improvements in the real incomes of the population
- Whether the chicken industries can maintain or improve on their level of competitiveness against other meats
- How chicken companies innovate to meet changes in consumer demand as additional factors other than the value of the product, such as animal welfare, become more important in influencing consumers' buying behaviour – an aspects of particular importance in developed economies.

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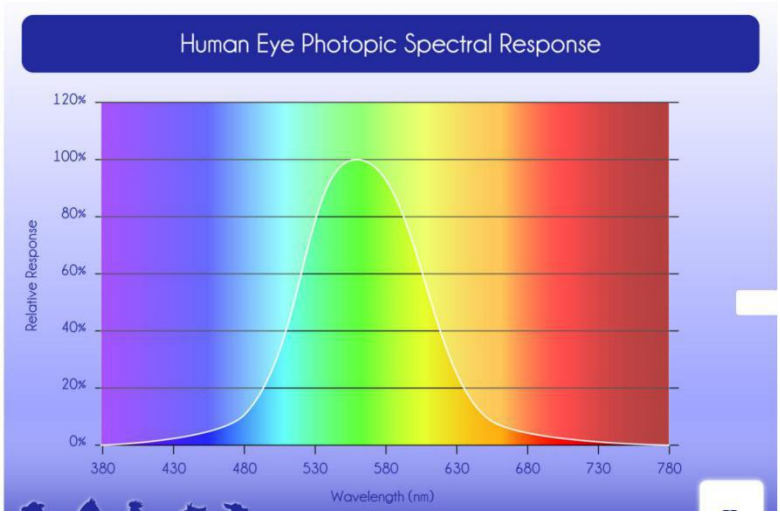
2 Chicken see more of the visible light spectrum than human

2.1 Visible Light Spectrum of Human and Chicken

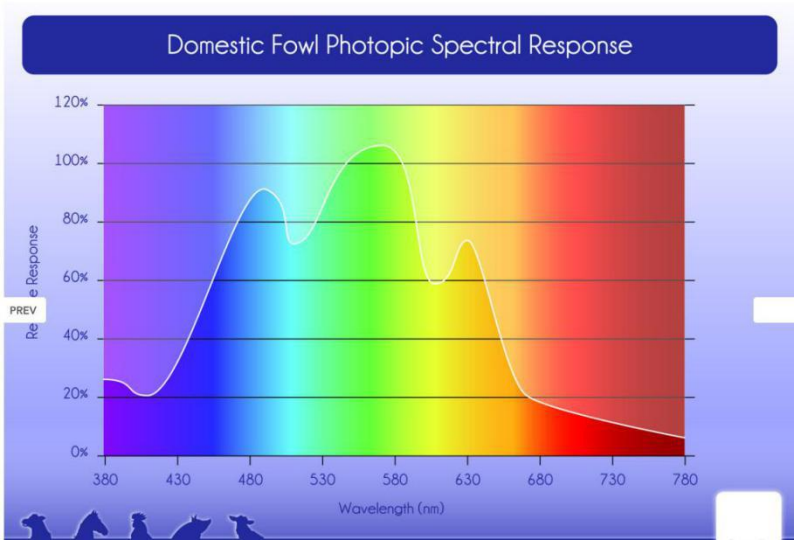
Chickens' eyes are different from human's, the light we perceive is the part of the electromagnetic spectrum our eyes can detect, known as the visible spectrum.

The same is true in animals, including poultry, but with one significant difference. The spectral sensitivity and visible spectrum of poultry, or what they actually see, is not the same as humans. It is why chickens may behave differently under the same intensity light from two different sources that look identical to us.

The following chart shows the color distribution of the Human (Top)and the Chickens(Bottom)



Human Eye Photopic Spectral Response



Domestic Fowl Photopic Spectral Response

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3 Why is Poultry LED Lighting Superior to Traditional Poultry Lighting?

3.1 Incandescent and CFL lamp

Incandescent, the most common form of poultry barn lighting, are missing many critical **portions of the full spectrum found** in sunlight. For instance, an incandescent bulb produces a highly diminished amount of both greens and blues.

CFL (fluorescent lamp) : produce only narrow bands of color in the red, green and blue spectrums. These narrow bands mean that a large amount of the rich color wavelengths found in sunlight are lost.

Compare these charts to the following chart that shows the color spectrum of sunlight. Notice how weak the color distribution is in these traditional sources as compared to sunlight.

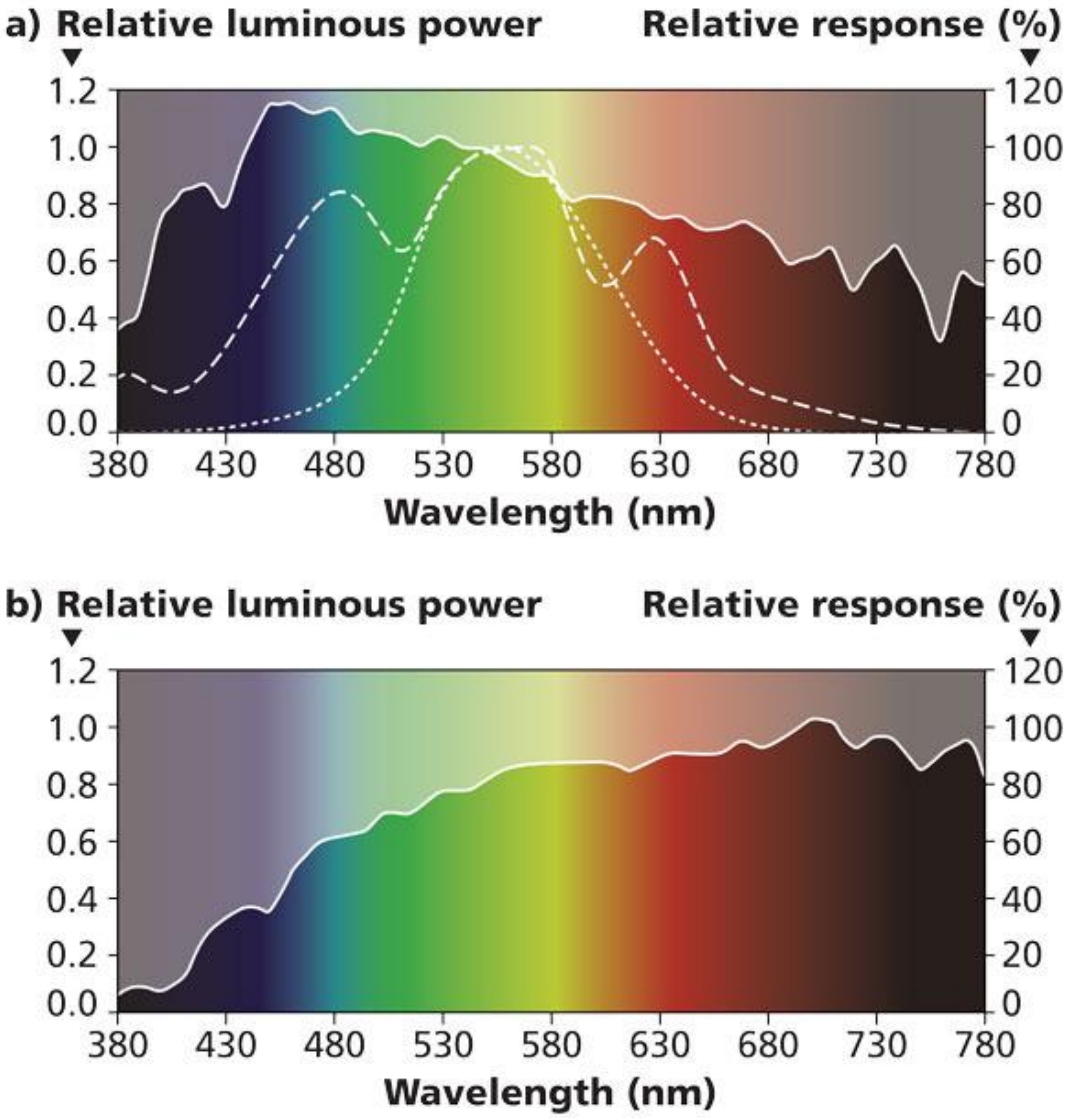

FIG. 1. Daylight spectrum (a) versus sunset spectrum (b).

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Modern barn lighting systems attempt to mimic the sun's spectrum, which provides a continuous spectrum containing all colors with no gaps in between. Incandescent light (Fig. 2a) effectively simulates sunlight at sunset, producing a continuous spectrum rich in reds with diminished greens and very little blue. However, this spectrum does not simulate midday sunlight, which is rich in blues and greens with diminished red. Some manufacturers try to put coatings on the bulbs to alter the spectrum, but this approach does not produce a continuous spectrum. Incandescent bulbs are also highly inefficient (producing more heat than light), burn out often, and require a fixture that is wet-location rated. All that will soon be moot, of course, as new production of incandescent lights is banned.

3.2 LED Light

The following chart shows the color distribution of incandescent (top) and CFL (bottom)

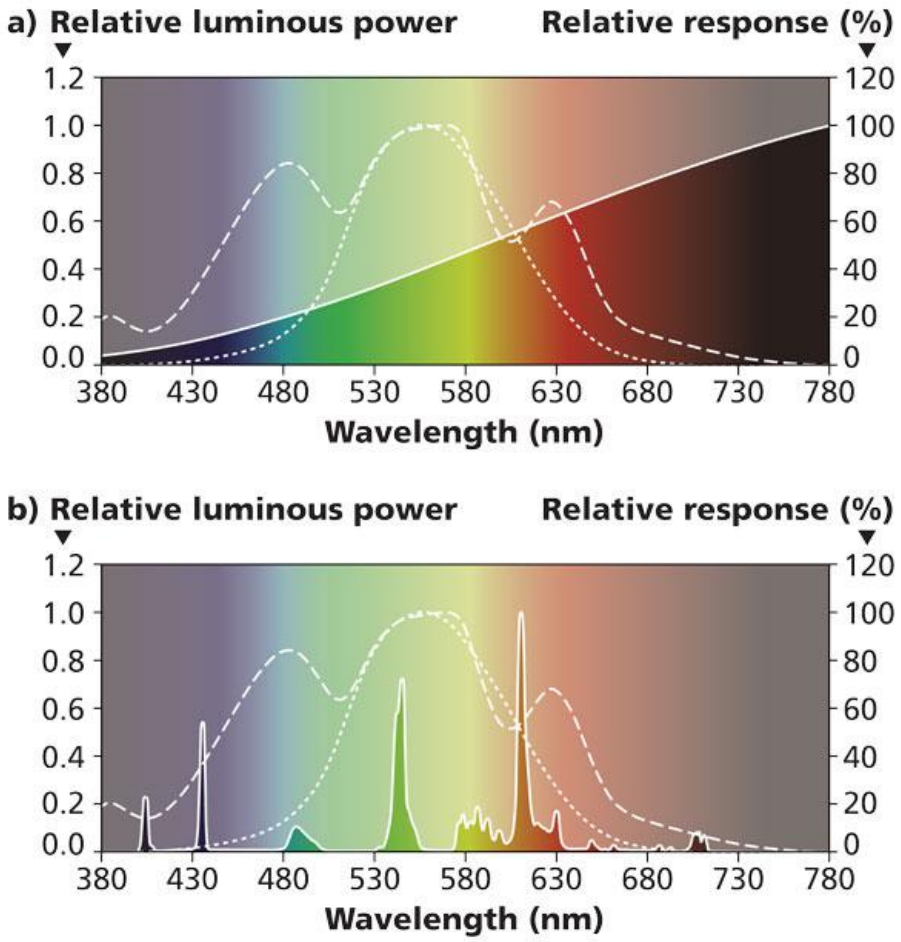

FIG. 2. Incandescent spectrum (a) versus CFL spectrum (b).

Compact fluorescent lamps (CFLs) have good efficiency and produce white light, but again, CFL light output is tailored to human vision. The white light is achieved by producing and combining narrow bands of red, green, and blue. As a result, there are large gaps in the spectrum between the red, blue, and green spikes,

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and many of the red, blue, and green wavelengths present in sunlight are lost (Fig. 2b). Blue light is exceptionally weak, and most of the deeper reds are lost. Overall, CFLs do a terrible job of mimicking natural sunlight. They are also hard to clean (because of their curly shape), contain small amounts of toxic mercury, require an enclosure to be wet rated, and do not dim well — plus their lifetime is shortened significantly when dimmed.

Now compare these charts to the chart below that shows the spectrum of colors found in LED lights. While not as rich in color as natural sunlight, LED lights clearly do a far better job of replicating an even distribution of colors than incandescents or CFLs.

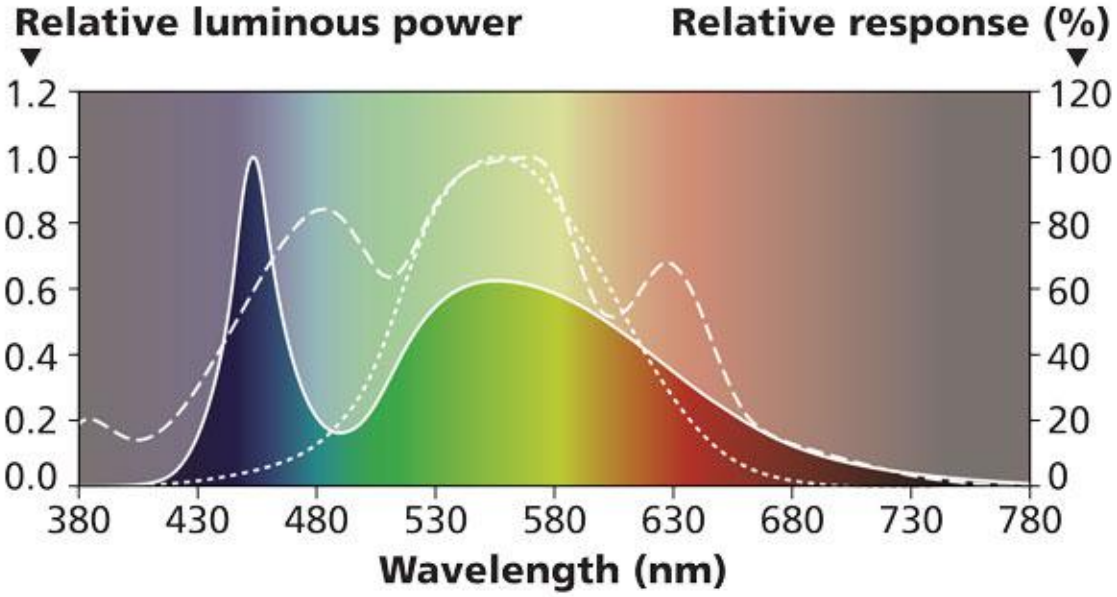

FIG. 3. Standard white LED spectrum.

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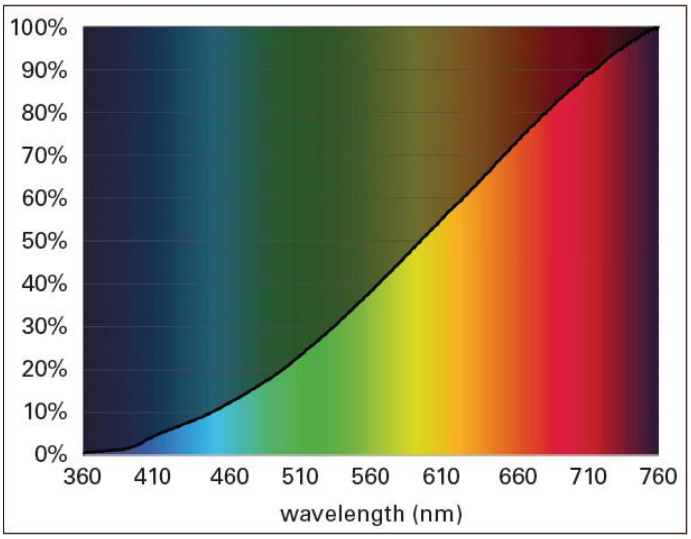
4 Benefits and Shortcoming of Poultry Lights

Incandescent Lights (INC)



Benefits

- Inexpensive
- Good red spectrum output
- Excellent light distribution
- Quick to turn on
- No difference in performance when used in cold weather

Shortcomings

- Short lifespan and must be frequently replaced
- Usually constructed of metal and glass and are prone to breakage
- More than 90% of the energy used by the bulb goes to heat rather than light.
- Many types of incandescent bulbs do not comply with new energy efficiency standards.

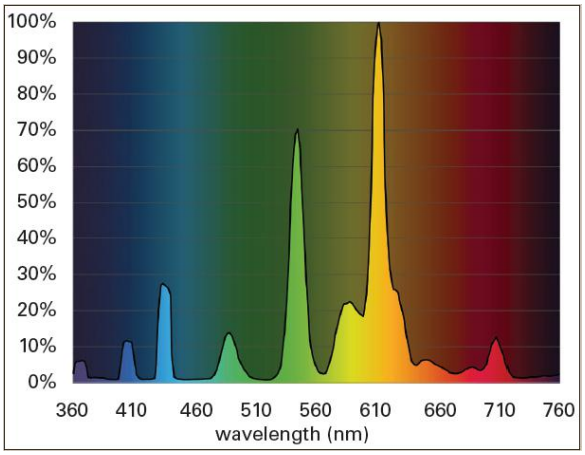
Compact Fluorescent Light (CFL)

Benefits

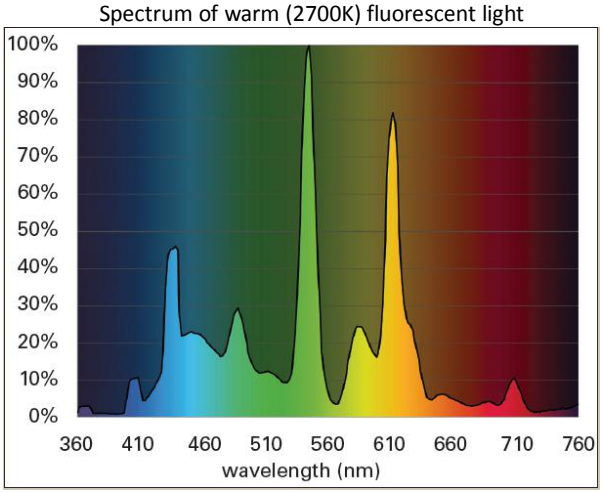
- Energy efficient
- Relatively inexpensive
- Similar color spectra as incandescent bulbs
- Available in both warm and cool spectra (K)
- Proven success in layer and breeder industries

Shortcomings

- Contain mercury
- Uncovered spiral tubes may be difficult to clean.
- Made out of metal and glass and are prone to breakage
- Bulbs do not dim well, with the potential to burn out more quickly when dimmed
- While appearing to be white light, CFLs are composed of light spectrum peaks depending on the color spectra phosphors utilized in the bulb.
- Bulbs require several minutes to reach maximum light intensity when turned on.
- Poor performance in cold weather
- Not ideal in situations where light must be turned on and off multiple times per day.
- Requires an electronic ballast to regulate current and voltage supplied to the lamp.



Spectrum of warm (2700K) fluorescent light



Spectrum of cool (5000K) fluorescent light

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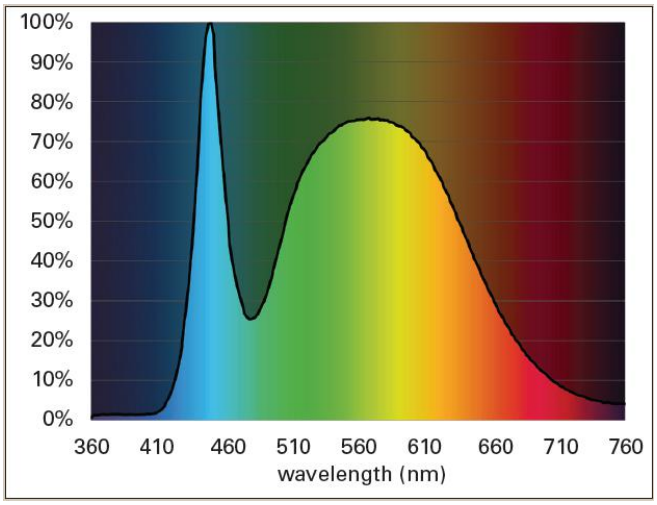
Light Emitting Diode (LED)

Benefits

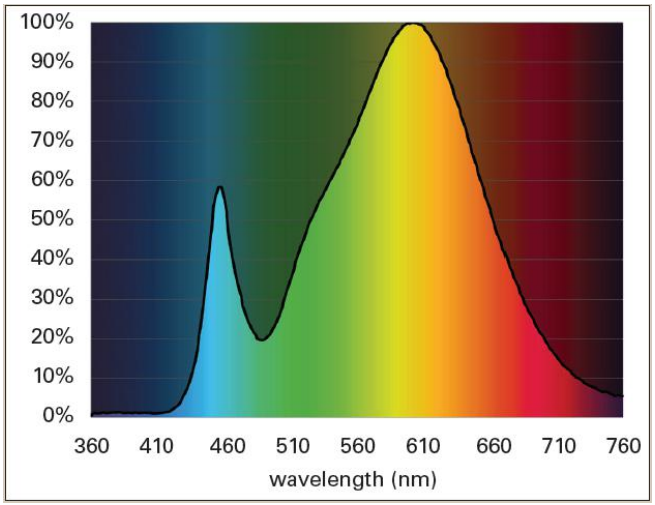
- Provides a full spectrum of light
- Typically the most efficient light bulb measured in lumens per watt
- Because LED do not emit infrared radiation (heat), they can be constructed out of non-glass materials that are waterproof and shatterproof.
- Typically manufactured from non-toxic materials
- Can be designed to focus the light onto desired areas
- Color spectrum of the light can be adjusted depending on phosphors used.
- Easier to dim than CFL bulbs
- Dimming can extend the lifespan of the bulb
- Very long lifespan – up to 10 years at 16 hours per day (50,000 – 60,000 hours)
- Rapidly reaches peak light intensity after being turned on
- Ideal for areas where lights are frequently turned on and off
- Efficient in cold weather with no change in performance

Shortcomings

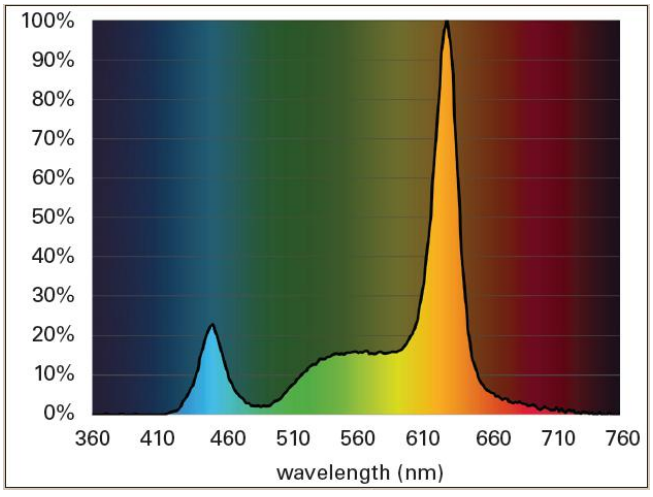
- Expensive
- Must use the proper dimmer, otherwise the light may flicker and burn out more quickly.
- LED light is directional and requires an appropriate lens to focus light, or appropriate diffusers to cover a broader area.
- May need to change wiring in a house to fit the ideal LED electrical specific cations.
- Lights may not burn out after expected lifespan but will be dimmed greater than 70% of original lumen output. As a result, baseline lux testing in the house may be required to determine when bulbs should be changed.



Spectrum of cool (5000K) LED light



Spectrum of warm (2700K) LED light



Full spectrum LED with emphasis on red spectrum

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5 Understanding cost and efficiency

	Incandescent Light Bulbs	CFL (Compact Fluorescent Light Bulbs)	**LED (Light-Emitting Diode Light Bulbs)**
Life Span (in hours)	1,500	10,000	50,000
Watts	100	42	18
Cost	$1.50	$6.28	$17.00
KWh of electricty used over 50k hours	3,000	1,250	400
Electricity Cost (@ $0.3 per KWh)	$690.00	$287.50	$92.00
Bulbs needed for 50k hours of usage	33	5	1
Equivalent 50k hour bulb expense	$49.50	$31.40	$17.00
Total 50,000 Hour Lighting Spend	**$739.50**	**$318.90**	**$109.00**
Calculate Your Energy Savings			
# of household light bulbs	30	30	30
Your estimated daily usage (hours)	5	5	5
Days in month	30	30	30
Household savings over 50,000 hours (energy + replacement)			
Household cost	$22,185.00	$9,567.00	$3,270.00
Savings by switching from Incandescent - LED	$0.00	$12,618.00	$18,915.00
Monthly household energy savings			
KWh used per month	270	113	36
Electricity Cost (@ $0.23 per KWh)	$61.63	$25.68	$8.22
Savings by switching from Incandescent - CFL - LED	$0.00	$35.95	$53.41
Yearly household energy savings			
KWh used per year	3,285	1,369	438
Electricity Cost (@ $0.23 per KWh)	$749.82	$312.42	$99.98
Savings by switching from Incandescent - CFL - LED	$0.00	$437.39	$649.84

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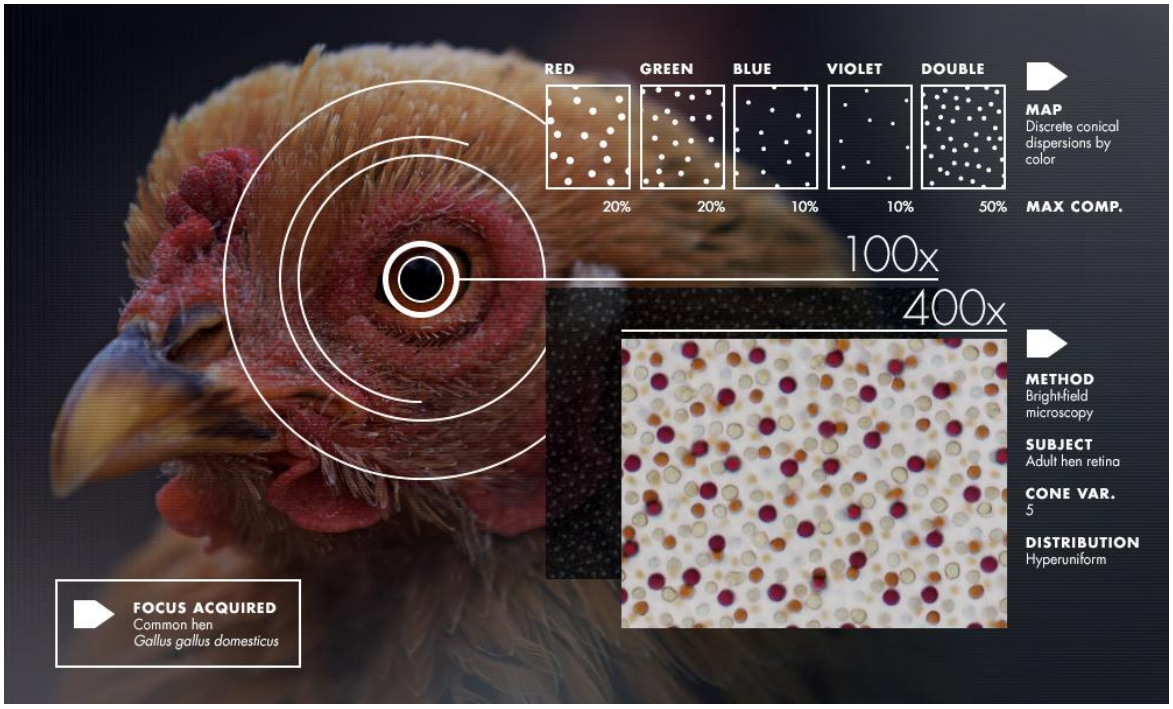
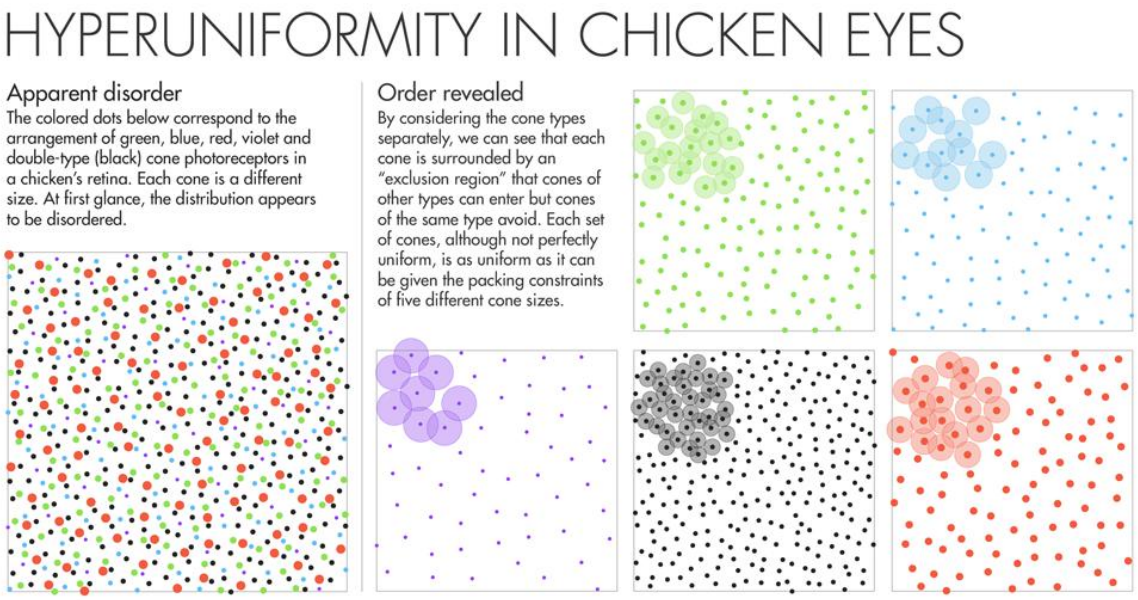
6 Chicken's Eyes





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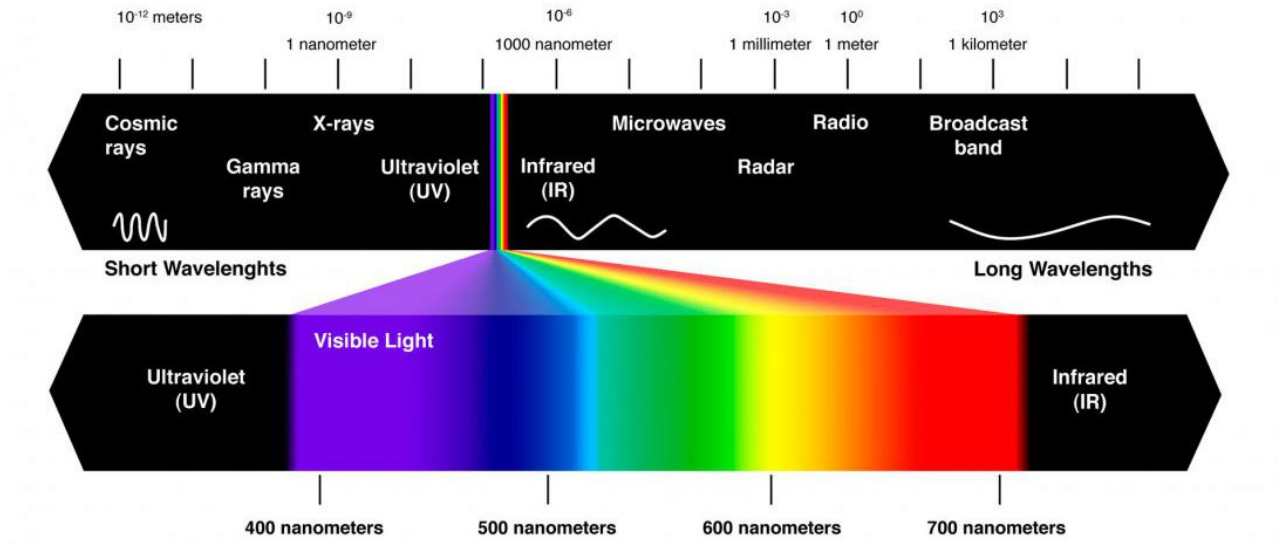
7 What kind of color is good for chickens?

Understanding the color spectrum given off by a light source will assist producers in selecting a light bulb which can deliver the proper amounts of red, green and blue light. Light bulb color can be expressed in degrees Kelvin (K) and color rendering index(CRI).

However, neither of these measurements expresses the spectral peak intensity in the red, green, and blue spectra that are important for poultry growth and production.



Chickens have four cone cells typical of birds: the UV-cone (ultraviolet, peak sensitivity = 420 nm), S-cone (small wavelength, peak sensitivity = 470 nm), M-cone (medium wavelength, peak sensitivity = 540 nm), and the L-cone (large wavelength, peak sensitivity = 600 nm) .

White Color:

The “white” visible light launched naturally by both sun and artificial light sources are actually comprised of numerous colors, actually composed of a range of colors, red, green and blue color. It is available from 2700K to 6500K. According to the research , pullets may be reared with warm or cool lights, but laying hens should have lights with a sufficient red spectrum (2700K – 3000K)

Red Color:

In poultry, red light is vital for stimulating sexual maturity and egg production. Birds exposed to red light versus blue, green or white light consistently have higher egg production than the other color groups. Red light is able to

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penetrate the skull to stimulate the extra retinal photoreceptors. Red light (around 650 nm) penetrates the skull and brain (hypothalamus) four to 50 times more efficiently than blue, green light. The hypothalmus is important in regulating the production of hormones important for egg production. Red light also reduces the amount of feed consumption per egg laid with no differences in egg size, shell weight, shell thickness, or yolk and albumin weights. Overall, red light has been shown to lengthen the peak production period and increase egg production by up to 38 eggs per hen, while potentially decreasing food consumption by up to 20%.

Green Light:

Green light, significantly increases growth rate at an early age by enhancing proliferation of skeletal muscle satellite cells.

Blue Light:

Blue light increases growth at a later age by elevating plasma androgens and keeps birds calmer which improves feed conversion.

Blue and Green light:

Together, green and blue light promote myofiber growth due to more effective stimulation of testosterone secretion and improved feed conversion.

8 Animal welfare - RSPCA

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8.1 Introduction

Principles underpinning the RSPCA Approved Farming Scheme Standards

The Standards are underpinned by the ‘Five Freedoms’:

- freedom from hunger and thirst: by ready access to fresh water and a diet to maintain full health and vigour
- freedom from discomfort: by providing an appropriate environment including shelter and a comfortable resting area
- freedom from pain, injury or disease: by prevention, rapid diagnosis and treatment
- freedom to express normal behaviour: by providing sufficient space, proper facilities and company of the animal’s own kind
- freedom from fear and distress: by ensuring conditions and treatment which avoid mental suffering.

These ‘freedoms’ provide a comprehensive framework for the assessment of animal welfare on farm, during transport and at slaughter, which, for the Standards in this Scheme, is presented as follows:

- sourcing and management of chicks
- food and water
- environment and housing
- stocking density
- management
- health
- on-farm euthanasia
- catching
- transport
- slaughter

RSPCA Australia considers that these ‘freedoms’ will be better provided for if those responsible for the care of chickens provide:

- caring and responsible planning and management
- skilled, knowledgeable and conscientious husbandry staff
- appropriate environmental design
- considerate handling and transport
- humane slaughter.

Eligibility

These Standards apply to meat chickens kept in eligible systems in Australia. Definitions of eligible housing systems under the scheme include:

- indoor systems where chickens are housed within a shed which meets the specifications of these Standards
- outdoor systems where chickens are housed within a shed, but have, by choice, access to an outdoor area. Both the shed and outdoor area must meet the specifications of these Standards.

Products that are eligible for Approval under the RSPCA Approved Farming Scheme must be derived from meat chickens housed in systems which meet the provisions of these Standards.

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Licensees are responsible for ensuring that the housing system, in addition to meeting the Standards, meets the labelling (production descriptor) requirements of the industry and/or retailer (whichever is appropriate).

RSPCA Australia has discretion to determine the suitability or eligibility of the housing system as applicable within the context of the Scheme.

Application

The documentation that supports the RSPCA Approved Farming Scheme consists of:

- Operations Manual — details the operation of the Scheme for both Approved Producers and Licensees, including the application process and the Assessment procedure
- Standards (specific to each species) — provide the requirements for the rearing, handling, transport and/or slaughter of the species
- Templates — for assessment and reporting.

Additional information is provided in boxed sections at the start of each chapter within the Standards. These may include the reasoning behind a standard, the RSPCA's specific concern with an aspect of production and/or an area where a standard may be reviewed in the future.

Requirements of the RSPCA Approved Farming Scheme

It is a requirement of the Scheme that:

1. The RSPCA Approved Farming Scheme Standards — Meat chickens are complied with.
2. The requirements in the relevant state or territory legislation and Model Codes of Practice or standards for animal welfare are complied with, including:
   - Australian Model Code of Practice for the Welfare of Animals — Domestic Poultry (or equivalent Australian standard or state code where one exists)
   - Australian Standards and Guidelines for the Welfare of Animals — Land Transport of Livestock (or equivalent code of practice where one exists)
   - Australian Model Code of Practice for the Welfare of Animals — Livestock at Slaughtering Establishments (or equivalent Australian standard or state code where one exists)
   - all other requirements in the state or territory legislation relevant to the farming enterprise, including land use, transportation, processing, environmental sustainability, food safety and product labelling.

RSPCA Australia has discretion to request proof of compliance with legislative and regulatory requirements through the provision of documentation from the relevant local council, state/territory government, quality assurance program or other appropriate body.

3. The following are completed and subsequently updated on an annual basis:
   - Animal Care Statement — specifying management and standard operating procedures
   - Veterinary Health Plan — specifying health management protocols and procedures.

Existing QA manuals for other programs or accreditation schemes and/or existing standard operating procedures, HACCP tables or records to support production activities may be utilised to meet the requirements of these Standards, provided the specific provisions and targets in these Standards are demonstrated. Equivalence, on this basis, is determined by RSPCA Australia.

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4. Each enterprise nominate a dedicated person who has:
- responsibility and accountability for the operation of the farming enterprise
- responsibility for overseeing the management and application of the requirements of the scheme.

The owner of the birds raised under the RSPCA Approved Farming Scheme Standards has, at all times, the final responsibility for ensuring on-going compliance with these Standards and the welfare of the birds.

8.2 The Standards for Lighting in the barn

Lighting: Provision of daylight is strongly recommended as it prevents eye abnormalities and can reduce the incidence of injurious pecking by encouraging foraging, exploration, and a range of social behaviours. A gradual transition between light and dark periods will stimulate birds to feed and, particularly during a natural or simulated dusk period, allow them to find a suitable perch or resting place for the night.

3.23 After 7 days of age, the lighting system in the shed must provide a minimum period of 8 hours artificial lighting per day - unless birds have access to natural daylight which provides at least the minimum required intensity - and a minimum period of 4 hours continuous darkness (with all lights off) to be provided at night, in every 24-hour period.

3.24 From 1 January 2015, the light intensity between lighting periods must be adjusted in a gradual manner (using dimmers or switching individual lights on/off) over at least 15 minutes.

3.25 After 7 days of age, the light levels in the shed (at bird head height) must ensure that, during the light period:
No area of the shed floor is lit at less than 10 lux
The average light intensity across the entire shed floor is equal to or greater than 20 lux (except during catching).

9 The Intensity and Duration for Chicken Growth

Intensity - Light intensity, measured in lux, clux or foot candles, is also important for poultry production. In general, light intensity below 5 lux is too dark to stimulate proper growth and production, while higher light intensity (above 50 lux) may cause nervousness and aberrant behavior. Reducing lighting intensity may be beneficial on farms using low – lighting environment to reduce hyperactivity, pecking damage and energy costs without physiological stress effects on broiler welfare, according to USDA researchers in Mississippi. There were some significant effects of light intensity on some carcass characteristics.

There were no differences in feed conversion ratio, but the birds subjected to dim lighting were around 70g heavier than those in bright light. The birds in bright light were more active and fed more during the day but less active and fed less at night than those reared with dim light. Birds on low light intensity had larger and heavier eyes than those receiving bright light. These results suggest that light intensity, rather than photoperiod, has more influence on broiler behaviour and eye health and that very low intensity appears to dampen behavioural rhythms.

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Duration - As a general rule, decreasing light duration is utilized for growing pullets and increasing light duration is used to stimulate layers. Light stimulation (usually an increase of as little as one hour) has an immediate effect on the production of reproductive hormones. The standard level of light for maximum production is 16 hours.

The following tables provide some of the most common lighting programs for different types of poultry operations.

Table 1 Lighting Programs for Commercial Layers

Lighting Options	Flock Age		Light Intensity lux (foot-candles)	Photo Period (hours of light per day)
Option 1	**Pullets**			
	Brooding	(1 - 3 days)	20 (2)	23
	Growing	(4 days - 19 weeks)	5 (0.5)	9 to 11
	Laying	(20 - 72 weeks)	10 - 30 (1 - 3)	Increase by ½ hour per week to maximum of 16 - 17 hours.
Option 2	**Pullets**			
	Brooding	(1 - 3 days)	20 (2)	23
	Growing:	(4 days - 2 weeks)	5 (0.5)	23
		(2 - 3 weeks)	5 (0.5)	21
		(3 - 4 weeks)	5 (0.5)	19
		(4 - 5 weeks)	5 (0.5)	17
		(5 - 6 weeks)	5 (0.5)	15
		(6 - 7 weeks)	5 (0.5)	13
		(8 - 9 weeks)	5 (0.5)	11
		(9 - 20 weeks)	5 (0.5)	11
	Laying	(20 - 72 weeks)	10 - 30 (1 - 3)	Increase by ½ hour per week to maximum of 16 - 17 hours.

Table 2 Lighting Programs for Breeders (broiler and commercial layers)

Lighting Options	Flock Age		Light Intensity lux (foot-candles)	Photo Period (hours of light per day)
Option 1	**Pullets**			
	Brooding	(1 - 4 days)	20 (2)	23
	Growing:	(4 days - 3 weeks)	5 (0.5)	15
		(3 -19 weeks)	5 (0.5)	11
	Laying	(20 - 60 weeks)	50 - 60 (5 - 6)	Increase by ½ hour per week to maximum of 17 hours.

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Table 3 Lighting Programs for Broilers/Roasters

Lighting Options	Flock Age		Light Intensity lux (foot-candles)	Photo Period (hours of light per day)
Option 1	Brooding	(1 - 2 days)	20 (2)	23
	Growing	(2 days - market)	5 (0.5)	23
Option 2	Brooding	(1 - 3 days)	20 (2)	23
	Growing:	(3 - 10 days)	5 (0.5)	8
		(10 - 15 days)	5 (0.5)	12
		(15 - 21 days)	5 (0.5)	16
		(21 - 35 days)	5 (0.5)	18
		(35 - 42 days)	5 (0.5)	23
Option 3	Brooding	(1 - 3 days)	20 (2)	23
	Growing	(3 days to market)	5 (0.5)	16
Option 4	Brooding	(1 - 3 days)	20 (2)	23
	Growing:	(3 - 10 days)	20 (2)	18
		(10 - 15 days)	5 (0.5)	8
		(15 - 21 days)	5 (0.5)	12
		(21 - 28 days)	5 (0.5)	16
		(28 - 42 days)	5 (0.5)	18

Table 4 Lighting Programs for Turkeys

Lighting Options	Flock Age		Light Intensity lux (foot-candles)	Photo Period (hours of light per day)
Option 1	Brooding	(1 - 3 days)	50 (5)	23
	Growing	(3 days - market)	5 - 10 (0.5 - 1)	23
Option 2	Brooding	(1 - 3 days)	50 (5)	23
	Growing:	(3 days - 8 weeks)	5 - 10 (0.5 - 1)	2.5 L : 3.5 D
		(8 - 12 weeks)	5 - 10 (0.5 - 1))	2.5 L : 2.5 D

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10 Why Farmers Prefer Beken Poultry Lighting?

Beken has been dedicated in Poultry Lighting filed for 4 years. In 2013, the first chicken farm dimming system came out and succeed in testing in Australia chicken farms. Now we have helped many customers increase their sales value and got good feedback from the poultry farmers. Experience and more requirements in Poultry farm project impels Beken to continuously to develop products which more suitable for chicken growth.

Using Beken Poultry Lighting chicken farmers can:

- Lower lighting costs, saving 95% compared with Incandescent
- Increase musculoskeletal development and weight gain by 5.06%
- Decrease feed consumption by 3.2%
- Increase feed conversion by 5%
- Decrease the Death rate of the chickens by 2.1%
- Induce earlier maturity for hens destined to lay eggs
- Increase egg output and quality
- Regulate reproduction cycles
- Increase length of reproductive life

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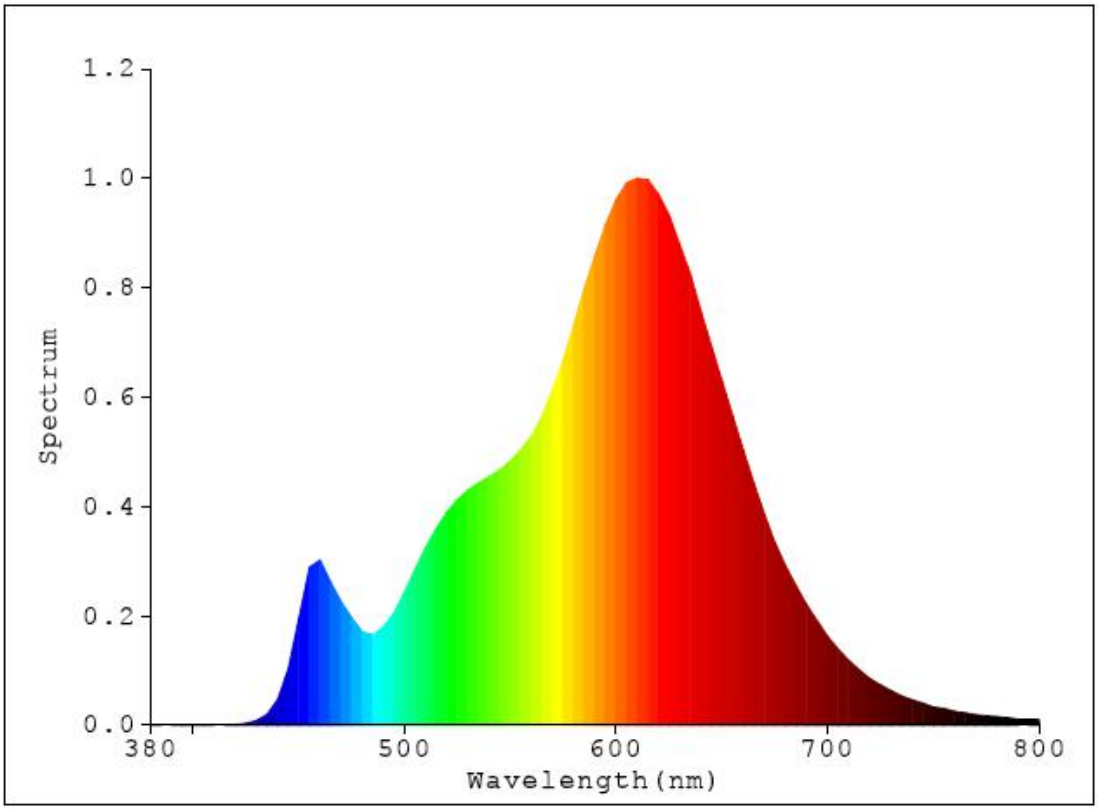
11 Beken Poultry Lighting

Research on layer pullets indicates that LED lights with a greater portion of blue and green spectra result in better body weights and uniformity compared to incandescent bulbs, although more data is needed (Settar, unpublished data). Overall, pullets may be reared grown with warm or cool lights, but laying hens should have lights with a sufficient red spectrum (2600K – 3000K).

11.1 2600K LED Poultry Lighting For Layer



2700K Color Spectrum

Color Parameters:

Chromaticity Coordinate: x=0.4723 y=0.4177
Chromaticity Coordinate: u'=0.2673 v'=0.5319(duv=1.64e-03)
Tc=2588K Dominant WL:Ld=584.3nm Purity=67.2% Centroid WL:600.0nm
Ratio: **R=28.8%** **G=69.2%** **B=2.0%** Peak WL:Lp=610.0nm HWL:106.2nm
Render Index: **Ra=86.1**
R1 =86 R2 =95 R3 =95 R4 =86 R5 =87 R6 =97 R7 =82
R8 =61 R9 =18 R10=89 R11=88 R12=79 R13=89 R14=98 R15=77

Photo Parameters:

Flux: 2249.7 lm Fe: 7.0311 W Efficacy:96.76 lm/W

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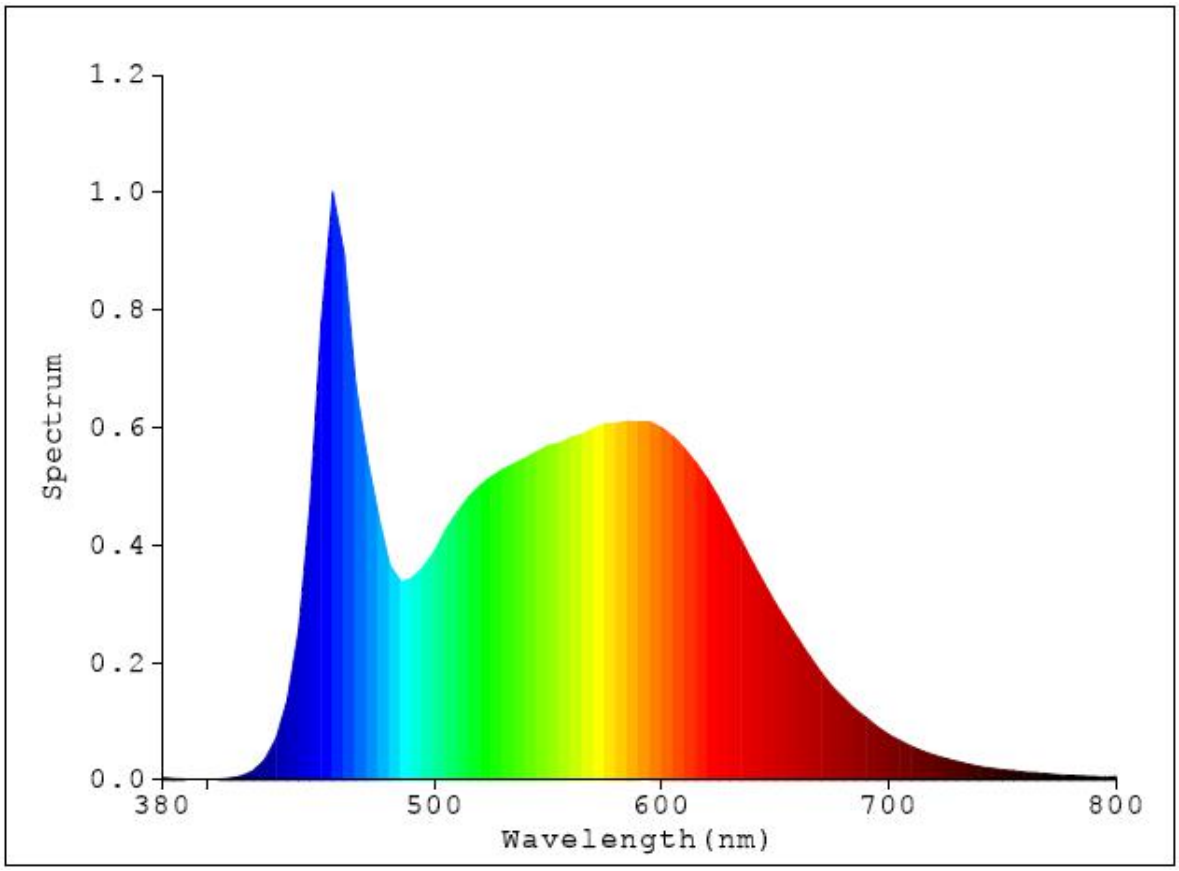
11.2 5000K LED Poultry Lighting For Broiler



5000K Color Spectrum

Color Parameters:

Chromaticity Coordinate: x=0.3431 y=0.3558

Chromaticity Coordinate: u'=0.2084 v'=0.4864 (duv=2.92e-03)

Tc=5089K Dominant WL:Ld=568.5nm Purity=9.7% Centroid WL:554.0nm

Ratio: **R=17.3%** **G=77.7%** **B=5.0%** Peak WL:Lp=455.0nm HWL:27.1nm

Render Index: Ra=85.8

R1 =85 R2 =94 R3 =95 R4 =82 R5 =85 R6 =90 R7 =86

R8 =69 R9 =19 R10=84 R11=82 R12=64 R13=88 R14=98 R15=80

Photo Parameters:

Flux: 2596.6 lm Fe: 8.2134 W Efficacy:110.4 lm/W

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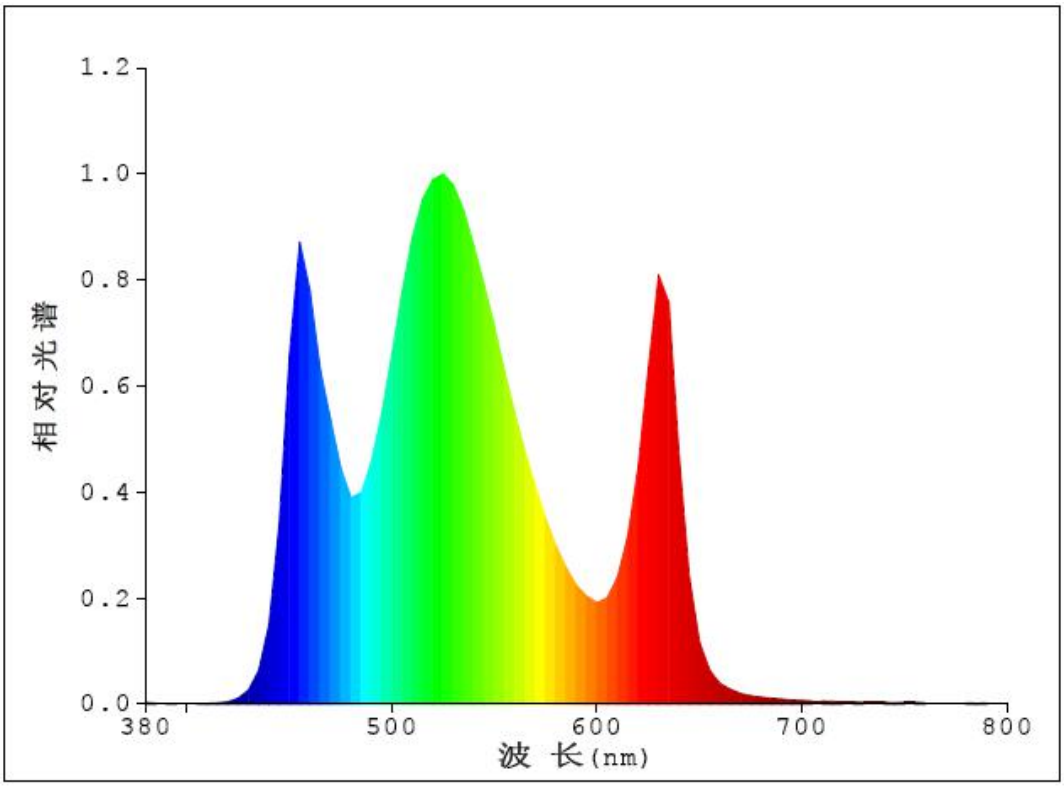
11.3 Full Spectrum LED Poultry light for Broiler and Layer



Color Full Spectrum

Color Parameters:

Chromaticity Coordinate: x=0.2847 y=0.4129

Chromaticity Coordinate: u'=0.1542 v'=0.5032(duv=5.23e-02)

Tc=7070K Dominant WL:Ld=515.2nm Purity=16.6% Centroid WL:530.0nm

Ratio: **R=11.4%** **G=83.5%** **B=5.2%** Peak WL:Lp=525.0nm HWL:70.9nm

Render Index: Ra=77.1

R1 =67 R2 =74 R3 =93 R4 =69 R5 =69 R6 =71 R7 =89

R8 =86 R9 =51 R10=53 R11=60 R12=40 R13=63 R14=97 R15=67

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NOVEMBER2013

RSPCA welfare standards for

CHICKENS

Introduction

The *RSPCA welfare standards for chickens* have been developed to provide the only RSPCA-approved scheme for the rearing, handling, transport and slaughter/killing of chickens. They take account of legislation, government welfare codes, scientific research, veterinary advice, recommendations of the Farm Animal Welfare Committee (FAWC) and the practical experience of the farming industry.

The standards are based upon the 'Five Freedoms' as defined by FAWC (hence the name 'Freedom Food' - see page iv). Although these 'freedoms' define ideal states, they provide a comprehensive framework for the assessment of animal welfare on farm, in transit and at the place of slaughter/killing, as well as representing an important element of farm assurance requirements.

- **Freedom from hunger and thirst**
  by ready access to fresh water and a diet to maintain full health and vigour.
- **Freedom from discomfort**
  by providing an appropriate environment including shelter and a comfortable resting area.
- **Freedom from pain, injury or disease**
  by prevention or rapid diagnosis and treatment.
- **Freedom to express normal behaviour**
  by providing sufficient space, proper facilities and company of the animal's own kind.
- **Freedom from fear and distress**
  by ensuring conditions and care which avoid mental suffering.

These freedoms will be better provided for if those who have care of livestock practise/provide:

- **caring and responsible planning and management**
- **skilled, knowledgeable and conscientious stockmanship**
- **appropriate environmental design**
- **considerate handling and transport**
- **humane slaughter.**

Guide to the use of the RSPCA welfare standards

(i) The numbered requirements are the standards, all of which must be complied with.

(ii) Boxed sections (indicated by ⓘ) give additional information, including: providing the reasoning behind a standard, expand on a standard, state how a standard can/will be assessed and/or highlight areas where the standards will be reviewed in the future.

* (iii) It is expected that all relevant UK legislation regarding farm animal husbandry and welfare on-farm, during transport, and at the abattoir, will be fully implemented in addition to the RSPCA welfare standards.

(iv) **Farmers are required by law to have a thorough knowledge of the *'Defra Code of Recommendations for the Welfare of Livestock: meat chickens and breeding chickens'*.**

Chicks

The following standards apply to the rearing and handling of chicks and are to be implemented in addition to all other relevant standards in the other sections of this document.

Chick sourcing

C 1.1 Chicks must:

a) be hatched according to the current version of the 'RSPCA welfare standards for hatcheries'

b) be sourced from a Freedom Food approved hatchery.

Specific provisions for chicks

C 2.1 Prior to the placement of chicks, all houses must be thoroughly cleansed, disinfected and tested free from infectious agents as specified in the Veterinary Health and Welfare Plan (VHWP) (see Health and welfare monitoring section and specifically H 1.12 d)).

C 2.2 Day old chicks must be:

a) handled carefully

b) placed in an appropriate environment.

C 2.3 Up to the first 7 days of age, the number of feeders and drinkers placed, air quality parameters and ventilation rates must be at least to the levels specified within the breeding company's published management guidelines.

> ⓘ **For clarity, after the first 7 days of life, the above parameters are to be implemented according to the levels specified within this document.**

> ⓘ **See standard E 5.1 for stocking rate requirements.**

C 2.4 Birds must be exposed to natural daylight as soon as possible, and certainly no later than 7 days of age.

> ⓘ **Prior to 7 days of age, artificial light may be used to achieve the minimum 20 lux light level requirement (see E 4.4).**
>
> **Some producers expose chicks to daylight from day old, whilst others have waited until the chicks are three days of age.**
>
> **Experience has shown that exposing birds to events occurring outside the house at an early age allows them time to develop recognition and familiarity and therefore reduce their fearfulness towards them. This may be of particular benefit to free-range birds and may help encourage ranging behaviour.**

C 2.5 Great care must be taken to avoid heat/cold stress.

C 2.6 Sufficient time must be allowed to ensure that the necessary target brooding temperature at bird level is achieved prior to the chicks being placed, allowing for differences in the time of year and external temperature.

C 2.7 Throughout the brooding period the behaviour of the chicks must be closely monitored and the brooding temperature adjusted accordingly.

C 2.8 Where spot brooding is used:

a) particular care must be taken in the placement and maintenance of brooder heaters to ensure against risk of fire and emission of carbon monoxide

b) the brooder must be suspended above the centre of the surround

c) the height of the brooder must be adjustable to ensure that the temperature at the level of the litter is maintained at the optimum level

d) brooder surrounds and feeding and watering equipment within the surround must be designed and constructed such that chicks can move freely towards or away from the brooder

e) supplementary lighting must be hung next to the brooder for the first few days after placement to attract chicks to the heat source and provide extra illumination of feeders and drinkers

f) care must be taken to ensure that feeders do not become hot, especially when metal feeders are used.

C 2.9 Supplementary feed trays and small water fonts must be provided in addition to any automatic feeders and drinkers at the start of brooding.

> ⓘ **For the first several hours after placement, cardboard egg trays can be used as additional water containers.**

C 2.10 Feeders and drinkers must be kept clean and free from litter.

C 2.11 With the exception of birds reared as free range, the moving of birds from one building to another during the rearing cycle, e.g. brood and move operations, is prohibited.

C 2.11.1 Where it is permitted to move birds from one building to another during the rearing cycle (see C 2.11), the following standards must be met:

a) birds must only be moved once

b) feeders and drinkers used on the finishing unit must be included within the initial rearing stages

c) changes to the diet must take place gradually over a period of at least 3 days

d) birds must be caught and transported in accordance with relevant standards within the transport section, with the exception that stocking density must be reduced by at least 30%

e) the rearing site and finishing site must each be managed as ‘all-in / all-out.’

Lighting

The introduction of natural light into chicken houses is likely to be beneficial to bird welfare by, for example, enriching the birds environment, as natural light can provide a range of illuminance levels in different areas within the house, which changes throughout the day, and is spectrally different to artificial sources. Also producers have reported that the birds display more natural behaviour and are more active compared to birds not exposed to natural light.

Research has shown that chickens prefer different light intensities for the performance of different activities. Dimly lit areas provide the opportunity to rest, whilst brighter lit areas provide the opportunity to perform more active behaviours. Perches should be positioned in the dimly lit areas.

E 4.0 Adequate lighting, whether fixed or portable, must be available to enable the chickens to be thoroughly inspected at any time.

E 4.1 In each 24 hour period, chickens must be provided with:

a) a minimum period of 8 hours continuous light

b) a minimum period of 6 hours and a maximum of 12 hours continuous darkness, except:

   i. for birds up to a maximum of 7 days of age and 3 days prior to slaughter, when the minimum period of continuous darkness must be at least 2 hours

   ii. where natural light is provided and the natural period of darkness is shorter than 6 hours.

E 4.2 Lighting patterns in all houses must be recorded.

Where possible, the lighting pattern should be recorded automatically.

E 4.3 Natural daylight must be provided:

a) at all times during the natural daylight period

b) through all the required openings (see E 4.5).

E 4.4 No area of the house must be lit at less than 20 lux.

E 4.4.1 E 4.4 must be achieved by natural daylight alone, except on dark days when artificial lighting can be used.

> **The minimum 20 lux light level is to be achieved on a day when the natural daylight level is neither excessively bright (i.e. through direct sunlight entering the shed) or dark (i.e. an overcast/stormy day).**

> **Chickens have well-developed colour vision. The report on '*The Welfare of Chickens Kept for Meat Production'* by the Scientific Committee for Animal Health and Animal Welfare's (2000, p. 62) concluded that brighter lighting is important to stimulate activity. Increased activity can help reduce the incidence of leg disorders and contact dermatitis, such as hock and foot pad burn.**

> **The installation of light sensors within the buildings to automatically turn artificial lights on/off and ensure the minimum light level of 20 lux is achieved at all times during the light period should be considered.**

E 4.4.2 Measures of illuminance must be taken at bird eye level.

E 4.5 The natural light openings in the house must correspond to at least 3.0% of the total floor area of the house.

> **The greater the proportion of window area to floor area achieved, the more natural daylight will enter the shed and consequently the less likely artificial lights will have to be turned on to achieve the minimum lighting level of 20 lux on darker days.**

> **It is important that a sufficient number and size of light inlets are provided to ensure the lighting requirements can be achieved at all times. Installing light openings down both sides of a house can allow greater control over the light entering the building. For example, if the shutters on one side of the house have to be closed to block out direct sunlight then daylight can still enter the building through the inlets on the opposite side. Similarly, more than the required amount of total window space for a building should be provided.**

E 4.6 At least 90% of all the light openings required to achieve E 4.5 must be no smaller than 0.56m^2 (e.g. 0.75 x 0.75m or 1.0 x 0.56m).

> **It is acknowledged that it may not be possible to install light openings of a minimum of 0.56m² in all areas of the house. Therefore, 10% of the light openings required to achieve Standard E 4.5 are permitted to be smaller than 0.56m².**

E 4.7 Where glass windows are used, these must be constructed of safety/toughened glass.

> **Windows constructed from two sheets of 2-ply polycarbonate (the same material and specification as that used for home conservatory construction) have been shown to work well in practice. Polycarbonate windows also appear to be better at diffusing direct sunlight within the house, helping to avoid patches/streams of sunlight.**

> **The use of transparent windows that allow birds to see out of the building may be beneficial by providing an additional level of enrichment to their environment. Transparent glass windows provide good light distribution, with minimal filtering and distortion, and do not discolour with time.**

> **The installation of toughened, double-glazed windows, are strongly encouraged.**

E 4.8 Birds must be exposed to dawn and dusk periods.

> **This can be achieved through natural or artificial means (see E 4.8.1).**

E 4.8.1 If used outside the natural daylight period, e.g. to extend the light period, artificial lights must be switched on and off:

a) in a stepped or gradual manner

b) over a period of at least 15 minutes.

> **Turning artificial lights on/off gradually allows time for the birds to prepare for daytime or darkness. Before the dark period, research has shown that it promotes natural settling behaviour and stimulates birds to have a last meal, which can help improve feed conversion efficiency.**
>
> **The Scientific Committee for Animal Health and Animal Welfare's report on The Welfare of Chickens Kept for Meat Production (2000, p. 61) recommends that changes in illuminance should take place over about 30 minutes, to allow chickens sufficient time to prepare for the light and dark period. The RSPCA intends to move towards the 30 minute recommendation in the near future.**

E 4.9 Where there are areas of different light intensity across the floor of the house there must be:

a) a gradual change in light intensity between each area

b) no patches of bright light.

> **Patches of bright light on the floor of the house, for example, when windows are not evenly distributed around the house or when windows are not of a similar size, can attract birds to these areas. An unequal distribution of birds around the house, with increased activity in localised areas, could adversely affect litter quality and bird welfare.**
>
> **To ensure compliance with standard E 4.9 b), observations should take place on bright and sunny days, at different times during the day, and with any artificial lights turned off.**

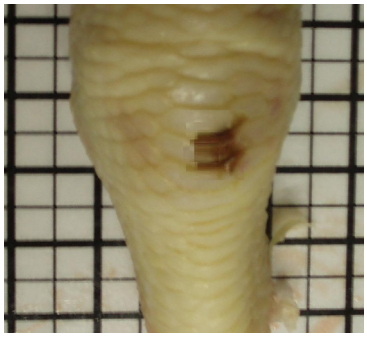
* Appendix 4

Hock burn assessment guide (relating to standard S 4.1)

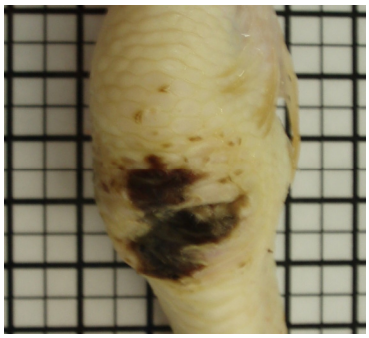
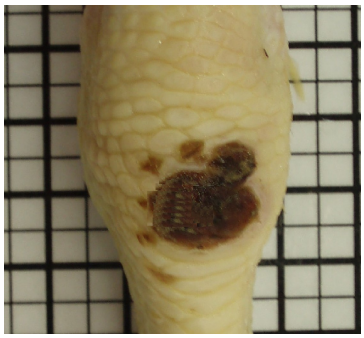
Score 0 (none/minor): No lesion/s or very small (<1 mm) and superficial, slight discolouration in a limited area, mild hyperkeratosis.

Score 1 (mild): Area affected does not extend over hock, substantial discolouration, dark papillae, superficial lesion, no ulceration.






Score 2 (severe): Greater surface of hock usually affected. Deeper lesion/s with ulceration, sometimes haemorrhage, scabs of significant size, severely swollen area.

Appendix 5

Foot pad burn assessment guide (relating to standard S 4.1)

A number of factors have been shown to influence the occurrence of FPD such as litter type and quality, litter depth, water drinker design, ventilation and drinker management, and feed quality.

Score 0 (none/minor): No lesion/s or very small and superficial (1-2mm), slight discolouration in a limited area, mild hyperkeratosis.


Score 1 (mild): Area affected does not extend over entire plantar pad, substantial discolouration, dark papillae, superficial lesion, no ulceration.



Score 2 (severe): Greater surface of plantar pad usually affected, sometimes with lesions on toes. Deeper lesion/s with ulceration, sometimes haemorrhage, scabs of significant size, severely swollen foot pad.



(Pictures supplied courtesy of Dr Lotta Berg, Swedish Board of Agriculture 2008)

Appendix 6

Dirty feather assessment guide (relating to standard S 4.1)

Feathers keep birds warm and help protect them from moisture, dirt and skin infections. Birds will spend a lot of time keeping their feathers in good condition, i.e. 'preened'. If their feathers become wet or soiled with litter (bedding), faeces or dirt then they can lose their protective properties and this can negatively affect bird welfare.

Front

Score 1: minor (light)

Score 2: mild (medium)

Score 3: severe (heavy)

Back

Score 1: minor (light)

Score 2: mild (medium)

Score 3: severe (heavy)

(Pictures supplied courtesy of 2 Sisters Food Group)