Lighting for Broiler Breeders

By: Peter Lewis, PhD

Lighting for Broiler Breeders

By: Peter Lewis, PhD

About the Author

Peter Lewis was awarded a National Diploma in Poultry Husbandry at Harper Adams Agricultural College, UK in 1964, a Ph.D. in 1987 by the University of Bristol for his studies of interrupted lighting for laying hens, and a D.Sc. in 2008 by the University of KwaZulu-Natal in South Africa for more than 25 years of poultry lighting research. He has been a technical advisor for three primary poultry breeding companies (including 10 years with Ross Poultry in the 1960s and early 1970s), lectured in poultry husbandry, and been involved in commercial broiler management in New Zealand. He has been secretary of the UK Branch of WPSA, Assistant Editor of World's Poultry Science Journal, and is currently a director of British Poultry Science. Peter has held research fellowships at the Universities of Bristol and Reading, was an Adjunct Professor at the University of Guelph in Canada, and is now a Research Fellow at the University of KwaZulu-Natal in South Africa where he is researching the responses of broilers and broiler breeders to light. He has more than 100 publications in scientific journals and has presented papers at industry and poultry science symposia and congresses worldwide.

Summary

Broiler breeder lighting has traditionally been based on our knowledge of how to light laying hens. However, recent research has shown that this is not always correct because broiler breeders still exhibit a form of seasonal breeding. This document gives updated information on the responses of broiler breeders to daylength, light intensity, light color and ultraviolet lighting.

The key points are:

- Essential to rear on a short daylength, ideally 8 hours.
- Transfer to a daylength of at least 11 hours at between 20 and 22 weeks, but not to exceed 13 or 14 hours in the laying period.
- Rear spring-hatched birds kept in non-lightproof houses on natural daylengths – do not rear on constant long days.
- Current light intensity recommendations of 10-20 lux (1-2 fc) in the rearing period and 30-60 lux (3-6 fc) in the laying period are correct.
- No need for an increase in light intensity when birds are transferred to the laying house; the brighter light in the laying period is only to maximise nest-box usage.
- No benefit from using other than white light; lamp type is irrelevant and ultraviolet-enhanced lamps give no benefit in the laying period.

Introduction

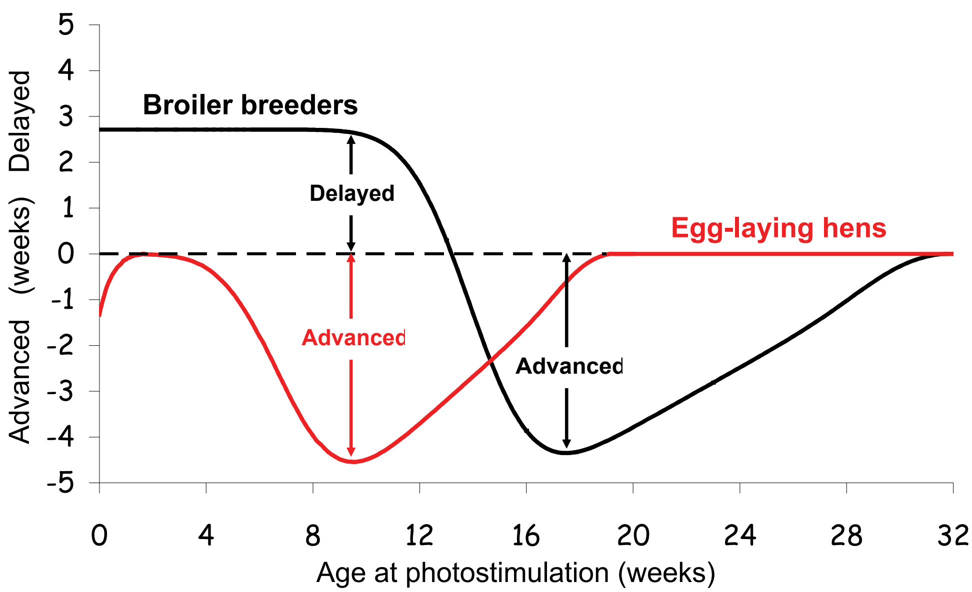
Much of the information in this booklet emanates from research of the photoperiodic responses of Ross 308 and Ross 788 broiler breeders conducted between 2000 and 2008 by Peter Lewis and Rob Gous at the University of KwaZulu-Natal in South Africa. The studies mainly involved broiler breeder females, however, data for turkeys, quail and game birds from other centres have suggested that avian photoperiodic responses are generally similar for both sexes, and so the findings described in this document may be assumed to be equally applicable to male and female broiler breeders. Ross 308 and Ross 788 responded similarly to lighting treatments so the recommendations in this document are equally applicable to both genotypes.

Prior to 2000 there had been few studies of the broiler breeder's response to lighting, and recommendations for their lighting were mainly based on practical experience and our knowledge of how to light laying-hens. However, the research at the University of KwaZulu-Natal since that time has shown that broiler breeders cannot simply be treated as if they were merely large laying hens. Indeed, in many ways, they should be treated more like small turkeys. This is because broiler breeders, unlike modern egg-laying strains, still exhibit photorefractoriness, and this demands that lighting recommendations are specifically designed for them. A striking example of the difference in the response to lighting between broiler breeders and egg-laying hens is the divergent effect that age at photostimulation has on the timing of sexual maturity (**Figure 1**). Whereas a transfer from 8-16 hours at 9 weeks of age induces an advance of 4-5 weeks in sexual development in laying-hens, it results in a delay of almost 3 weeks in broiler breeders. Conversely, a change to long days at 18 weeks has little effect on the timing of sexual maturation in laying-hens, but advances it by about 4 weeks in broiler breeders.

Key points:

- *Broiler breeders cannot be treated as if they are large laying hens.*
- *Broiler breeders, unlike laying hens, exhibit photorefractoriness and should therefore be treated as a type of seasonal breeder.*

Figure 1: Effects of age at transfer from 8 to 16-hour photoperiods on age at 50% egg production for broiler breeders and egg-laying hens.



What is photorefractoriness?
Originally, all domestic fowl were seasonal breeders and exhibited a condition called photorefractoriness; a natural phenomenon that, in its extreme, prevents an animal from breeding in its first year or when environmental conditions are not conducive to the successful rearing of its offspring. The condition exists in both males and females. Seasonal breeding birds are photorefractory when they hatch (juvenile photorefractoriness); that is they are unable to respond sexually to an otherwise stimulatory photoperiod (synonymous with long day) until they have experienced a period of neutral photoperiods (synonymous with short days), such as those that occur naturally in winter. Indeed, sexual development will be markedly retarded and egg production will be significantly reduced if they are reared on long days or are transferred to long days before they have dissipated photorefractoriness (**Figure 2**). This will be the outcome in precipitately photostimulated birds, even if growth is accelerated to achieve a body weight similar to that normally recommended for photostimulation (**Figure 3**). In wild birds and full-fed turkeys, photosensitivity generally occurs after about 2 months of short days. However, because broiler breeders are not fed ad libitum, they require almost 5 months of short days before they become photosensitive.

Figure 2: Egg production of broiler breeders maintained on 16 hours (●), reared on 8 hours and transferred to 16 hours at 10 weeks whilst still photorefractory (●), or reared on 8 hours and transferred to 16 hours at 20 weeks after achieving photosensitivity (●).

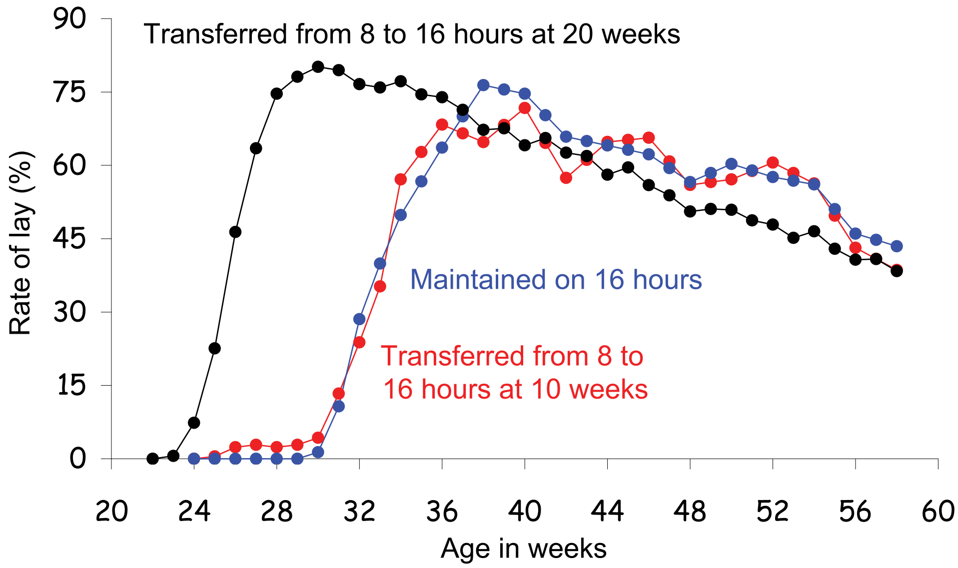
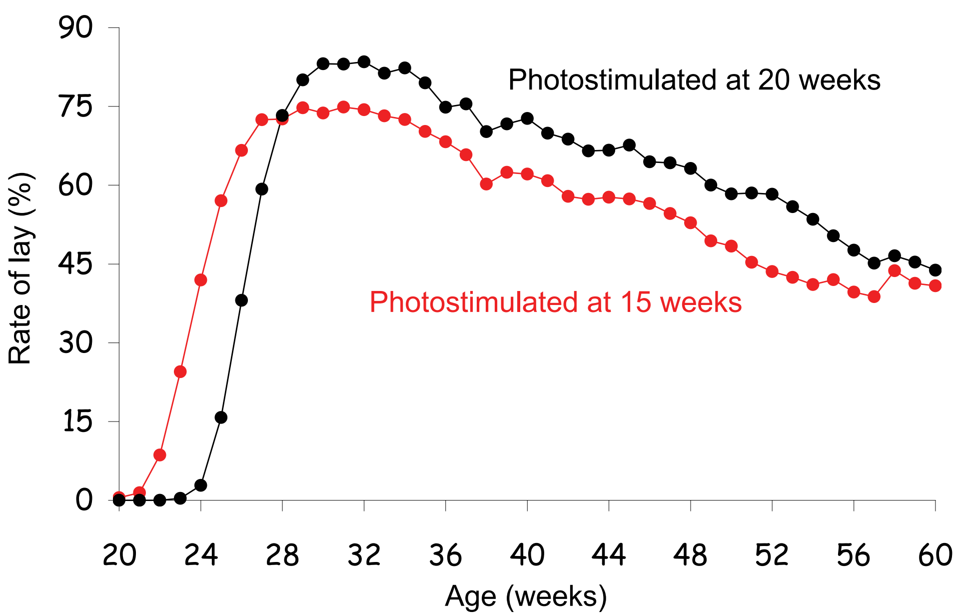
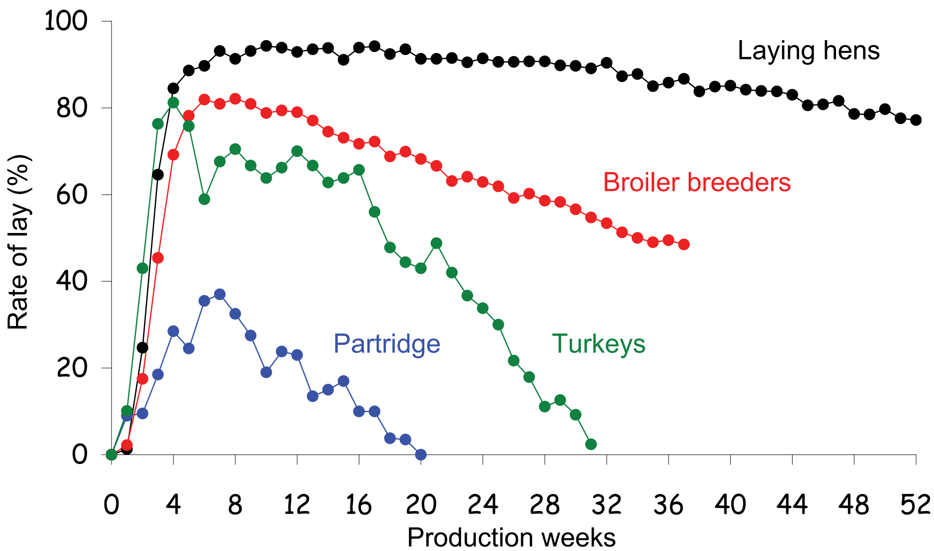


Figure 3: Egg production of broiler breeders reared on 8 hours and photostimulated at an average body weight of 2.1 kg (4.6 lbs) at either 15 weeks (●) or 20 weeks (●).



After prolonged exposure to a stimulatory daylength, an adult form of photorefractoriness develops and the reproductive system shuts down (adult photorefractoriness). It is thought that the mechanism responsible for terminating breeding is, like that for the initiation of sexual maturation, triggered by the initial transfer to long days. Furthermore, there is evidence to suggest that the longer it takes to dissipate juvenile photorefractoriness the sooner adult photorefractoriness will develop. In a species that exhibits the extreme or absolute form of photorefractoriness, such as partridge or pheasant, the onset of adult photorefractoriness occurs within 3 to 5 months of sexual maturation and breeding ceases until the following spring. When a species shows only a relative form of the condition, such as that exhibited by broiler breeders or turkeys, the breeding season is substantially extended, though still markedly shorter than, and inferior to, that of egg-laying hens (**Figure 4**). There is also quite a wide variation in reproductive state between individuals within a flock, especially in the latter half of the laying cycle; some females have a transitory pause in production and some males temporarily become infertile whilst the remainder of the flock continues to be productive. In contrast, modern egg-laying hybrids, because they no longer exhibit photorefractoriness, show few signs of ceasing production after 12 months in lay, with rates commonly exceeding 80% (**Figure 4**).

Figure 4: Typical egg production profiles for laying hens (●), broiler breeders (●), turkeys (●), and partridge (●).



One of the reasons for a bird having superior egg production to its peers is that it has a longer laying cycle (breeding season) and a shorter interval between cycles, and so the intense selection for egg numbers in egg-laying fowl over the past 50 years has virtually eliminated photorefractoriness from modern genotypes of laying hen. In contrast, the less stringent selection for egg numbers in meat-strains of fowl (and turkeys) means that they continue to exhibit photorefractoriness, albeit in a relative form, and to have inferior rates of egg production.

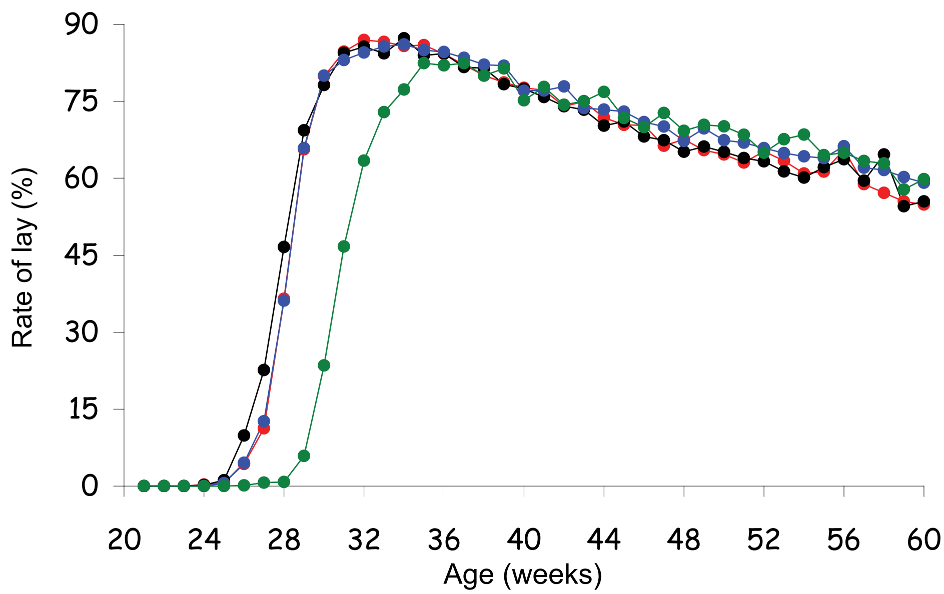
Key points:

- Photorefractoriness is a natural phenomenon which gives rise to seasonal breeding.
- Broiler breeders are hatched photorefractory and are initially unresponsive to a stimulatory daylength.
- Typically grown broiler breeders need about 19 or 20 weeks of short days to become fully photoresponsive.
- Broiler breeders become adult photorefractory after prolonged exposure to long days.

Rearing photoperiod

Research has shown that broiler breeders reared in lightproof housing on a photoperiod of between six and 10 hours and at a light intensity of about 25 lux (2.5 fc) mature at similar ages when photostimulated at about 20 weeks of age. This is because the slower sexual development expected for birds reared on a shorter photoperiod is countered by the larger, more stimulatory increase in daylength experienced when they are transferred to long days; the converse scenario applies to birds reared on a nine or 10-hour photoperiod. However, these findings do not mean that daylength during the rearing period is unimportant, but that daylengths of 10 hours or less exert comparable influences because they are neutral photoperiods and, as a consequence, dissipate juvenile photorefractoriness at similar rates. The situation is very different when broiler breeders are reared on daylengths longer than 10 hours: juvenile photorefractoriness takes longer to dissipate, the birds experience a smaller, less stimulatory increase in daylength when photostimulated, sexual development is noticeably delayed, and overall egg production is significantly reduced (**Figure 5**).

Figure 5: Egg production for broiler breeders transferred from 6 hours (●), 8 hours (●) or 10 hours (●) to 16 hours at 20 weeks or maintained on 16 hours throughout (●).



Although the South African research endorses Aviagen's recommendation to rear broiler breeders on an 8-hour photoperiod when they are housed in light-proofed facilities, it does not support the recommendation to rear Spring-hatched birds on a daylength equal to the longest anticipated natural daylength when they are kept in non-lightproof facilities. Whilst the rearing of ad libitum-fed egg-laying pullets on an increasing daylength leads to precocious maturation, an increased risk of prolapse and a reduction in egg size, these undesirable consequences do not occur in broiler breeders because their sexual maturation is primarily controlled by the feeding regime and not the lighting programme. Furthermore, we have seen that broiler breeders need to dissipate juvenile photorefractoriness before they can respond positively to a long day and that rearing on long days slows up this attainment of photosensitivity (**Figure 5**). A study of the response of broiler breeders to increasing, decreasing or constant 14-hour daylengths during the rearing period showed that all groups matured within 3 days of each other (**Figure 6**) and that the group reared on 14 hours (the longest natural and therefore recommended daylength at a latitude of 30°) subsequently laid 10 eggs less than the other groups to 60 weeks because it had never experienced a neutral photoperiod (≤ 10 hours) and had an earlier onset of adult photorefractoriness. The reason for the similarly late ages at sexual maturity for such contrasting lighting programmes was that none of the groups had experienced sufficient short days to accelerate the dissipation of juvenile photorefractoriness; comparative data from a separate study of birds reared on 8 hours highlight the delay in maturity in **Figure 6**. Without doubt, the correct solution to non-lightproof housing is to make it lightproof so that birds can be reared on short days. Another more radical solution, if light-proofing is not possible, is to relax the feeding programme and allow faster growth during the rearing phase; this will expedite the development of photosensitivity and reduce the delay in sexual development by about 2 days for each 100 g (3.5 oz) heavier body weight at 20 weeks (**Figure 7**). However, it is unlikely that this will be economically feasible in the current climate of high feed costs because broiler breeders allowed accelerated growth consume more feed to point of lay.

Figure 6: Egg production for broiler breeders reared on constant 8-hour (●) or 14-hour daylengths (●), or on increasing daylengths between 10 and 14 hours (●) or decreasing daylengths between 14 and 10 hours (●), and then transferred to 16 hours at 20 weeks.

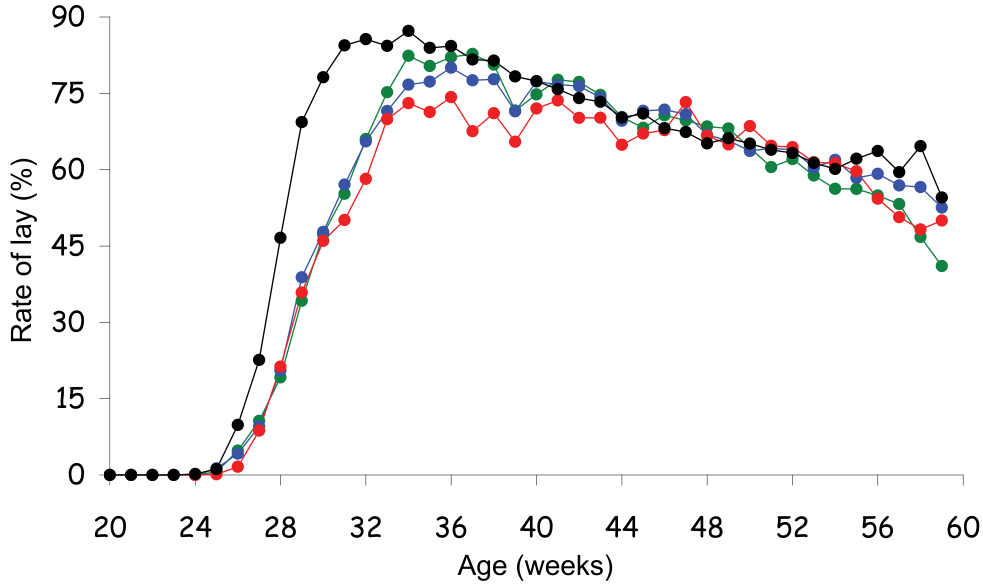
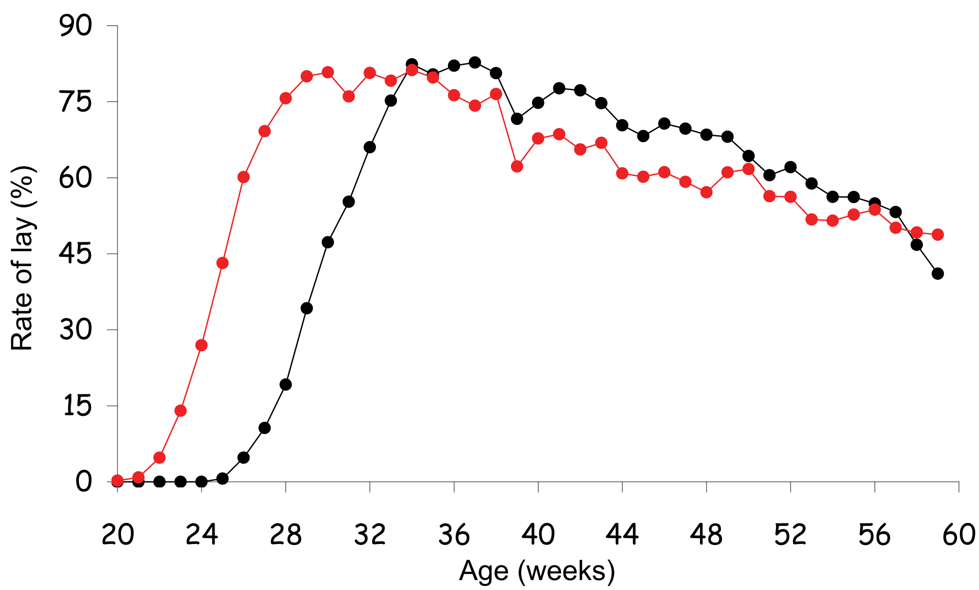


Figure 7: Egg production for broiler breeders grown to an average body weight of 2.1 kg / 4.6 lbs (●) or 3.1 kg / 6.8 lbs (●) at 20 weeks and reared on a daylength increasing from 10 to 14 hours before being transferred to 16 hours at 20 weeks.



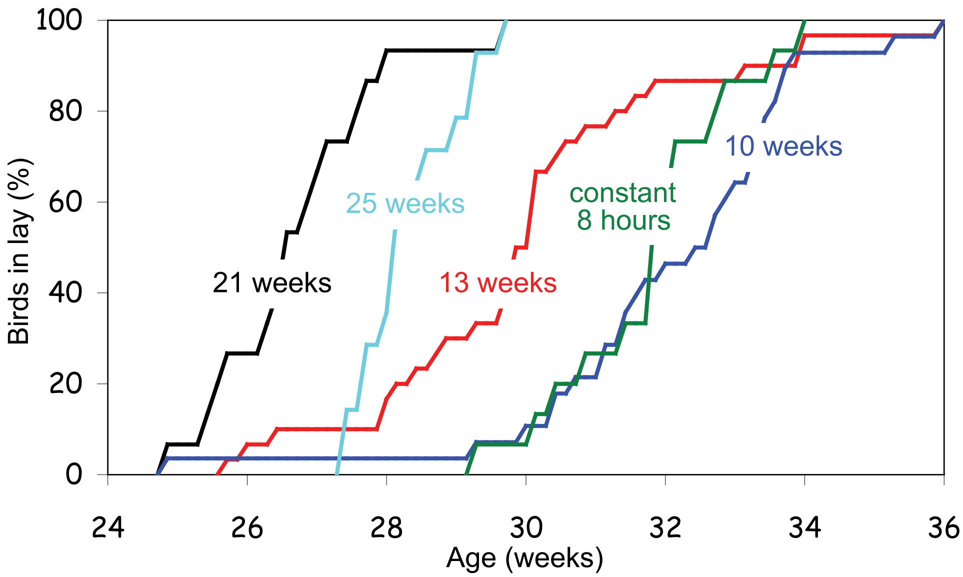
Key points:

- *Broiler breeders must be reared on a daylength of 10 hours or less, ideally 8 hours, to quickly dissipate photorefractoriness.*
- *Broiler breeders must not be reared on long days, even when reared in non-lightproof houses and with naturally increasing daylengths, otherwise sexual maturity will be delayed and egg numbers decreased.*

Photostimulation age

A flock of broiler breeders will not become fully responsive to photostimulation until about 20 weeks of age when reared on 8-hour photoperiods in lightproof housing at a light intensity of between 10 and 100 lux (1 and 10 fc) and to a growth curve similar to that recommended by Aviagen. If they are transferred to long days much earlier than 20 weeks, and so before all birds in the flock have dissipated photorefractoriness, the photoresponsive birds will have their sexual development accelerated, whilst those that are not photoresponsive (still photorefractory) will have their sexual development retarded. The result will be a flock that is sexually uneven, has a suboptimal peak rate of lay, and is nutritionally very difficult to manage. Data in **Figure 8** for broiler breeders grown on a typical growth curve demonstrate the disastrous effect of photostimulating too soon. Whereas birds transferred to long days at 21 weeks had a 5-week advance in maturity, a 5-week spread in individual ages at first egg, and all birds maturing before un-photostimulated controls held on 8 hours, photostimulation at 13 weeks resulted in only a 2-week advance in maturity, but, more seriously, a very wide spread of ages at first egg, and a proportion of the flock retarded. When birds were transferred to long days at 10 weeks, less than 5% of the flock were photoresponsive, individual maturities were even more widely spread, and more than half of the birds had their sexual maturation delayed.

Figure 8: Development of sexual maturation in broiler breeders grown to an average body weight of 2.1 kg (4.6 lbs) at 20 weeks and left un-photostimulated on 8 hours or transferred to long days at 10, 13, 21 or 25 weeks of age.



A postponement of photostimulation to 23 weeks or later will produce a flock that, despite having a narrow spread of individual ages at first egg and no delays in sexual development, has an increasingly later sexual maturity (**Figure 8**) and, as a consequence, a reduction in total egg production and an increase in egg weight. This is because there are close relationships between age at sexual maturity, total eggs, settable eggs and average egg weight to 60 weeks: egg numbers are reduced by 2-3 eggs (**Figure 9**) and average egg weight is increased by 0.7 g (**Figure 10**) for each 1-week older age at 50% lay. When sexual maturation is retarded by photostimulating either too soon or too late, more feed is required to get a flock to point-of-lay, which, together with the reduction in the number of eggs, results in a less efficient conversion of feed into egg.

Figure 9: Effect of age at 50% egg production on total eggs produced to 60 weeks of age. Data from studies conducted at the University of KwaZulu-Natal.

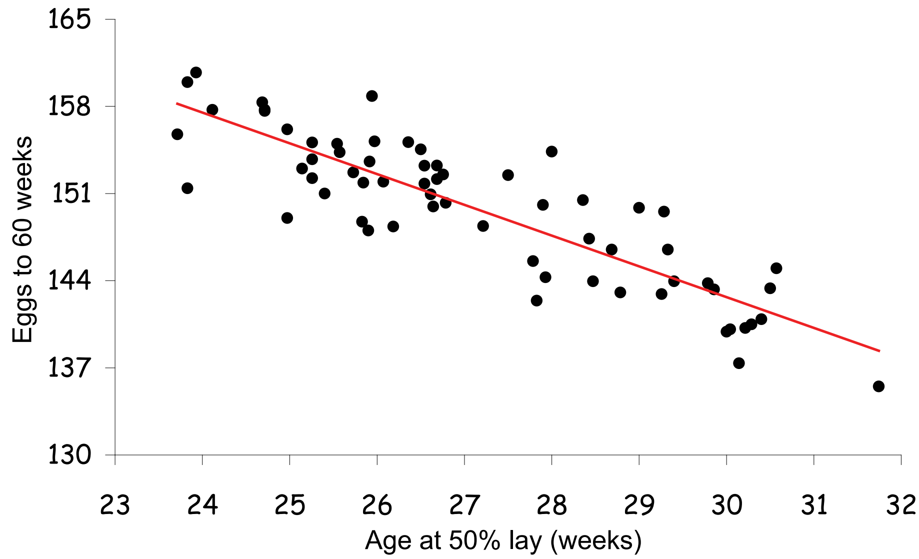
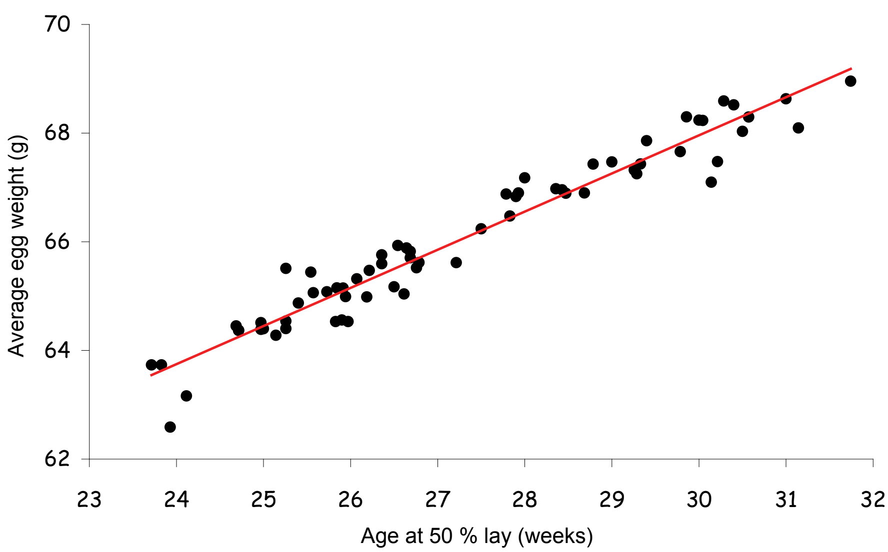


Figure 10: Effect of age at 50% egg production on average egg weight to 60 weeks of age. Data from studies conducted at the University of KwaZulu-Natal.



The findings of the research at the University of KwaZulu-Natal show that birds should be photostimulated at between 20 and 22 weeks of age.

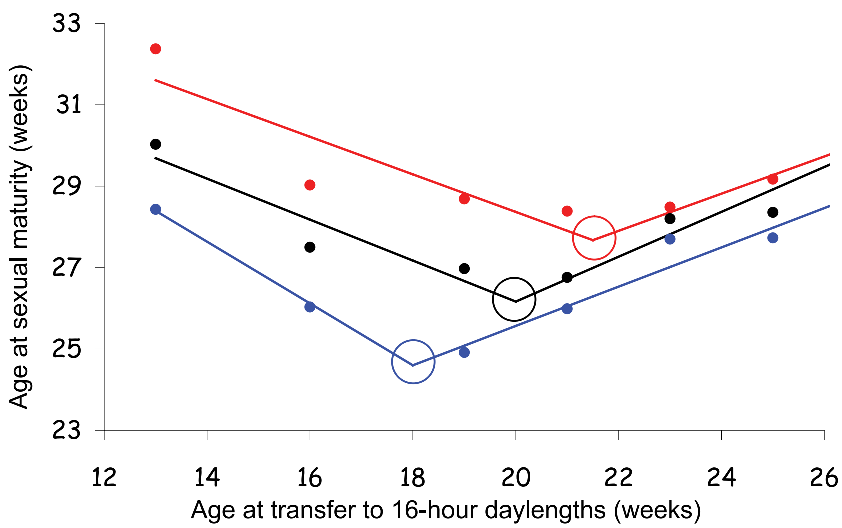
Key points:

- Photostimulating broiler breeders before they are photoresponsive (19 to 20 weeks) retards sexual development.
- Broiler breeders should be photostimulated at between 20 and 22 weeks.
- Delaying photostimulation beyond 22 weeks delays age at 50% lay.

Body weight at photostimulation

The rate at which photorefractoriness is dissipated when birds are reared in lightproof housing at between 10 and 100 lux (1 and 10 fc) is proportional to growth and so the minimum age at which a flock of broiler breeders can be successfully photostimulated will depend on its body weight; faster growth permitting earlier stimulation and slower growth necessitating later photostimulation (**Figure 11**). However, no flock should be transferred to long days before all birds in the flock have become photoresponsive, and that, with typical broiler breeder body-weight targets, is unlikely to be that much earlier than 20 weeks. When a flock's growth differs significantly from the Aviagen target, the minimum age for photostimulation should be delayed by about 4 days for each 100 g (3.5 oz) that body weight is below target at 20 weeks, but may be advanced by 4 days for each 100 g (3.5 oz) that it is above target. Although broiler breeders may respond to photostimulation before 20 weeks, the findings from the studies conducted at the University of KwaZulu-Natal have shown that there is no economic advantage from growing birds more quickly than that recommended by Aviagen just to facilitate earlier photostimulation. Although faster growth allows earlier photostimulation, advances sexual development and increases total egg production to a given age (**Figure 3**), more feed is required to get the flock to point of lay, more abnormally large eggs are produced and more eggs are laid on the floor, so fewer settable eggs are produced and the efficiency with which feed is converted into eggs is reduced. The research work in South Africa has also shown that Aviagen's recommendation to grow birds to reach average body weight of between 2.0 and 2.2 kg (4.4 and 4.8 lbs) at 20 weeks is optimal, though sexual maturity will be delayed by 2 days for each 100 g (3.5 oz) that a flock is below and advanced by 2 days for each 100 g (3.5 oz) that it is above target body weight at 20 weeks. The only possible justification for an acceleration of growth beyond that recommended by Aviagen is the need to expedite the dissipation of juvenile photorefractoriness when birds are reared on long days or when Spring-hatched birds are exposed to increasing or decreasing natural lighting conditions. The decision is, however, an economic one of higher feed costs versus delayed maturity and fewer eggs.

Figure 11: Average age at sexual maturity for broiler breeders photostimulated at various ages between 13 and 25 weeks and with an average body weight of 1.91 kg / 4.2 lbs (red), 2.19 kg / 4.8 lbs (black) or 2.54 kg / 5.6 lbs (blue) at 20 weeks. The circles indicate the youngest age at which a flock may be successfully stimulated.



Key points:

- Broiler breeders should be photostimulated at between 2.0 and 2.2 kg (4.4 and 4.8 lbs) body weight.
- Slower growing broiler breeders take longer to become photoresponsive, should have their photostimulation delayed, and will have a later age at 50% lay.
- Faster growing broiler breeders become photoresponsive more quickly, may be photostimulated at a younger age and so reach 50% lay sooner, but will require more feed to reach sexual maturity.

Photoperiod in lay

The age at which a flock of broiler breeders reaches 50% egg production, when it has been reared on a neutral photoperiod (10 hours or less) and transferred to a longer photoperiod, is highly dependent upon both the photoperiod to which is transferred and the age at which this occurs. The influence of the age at photostimulation has been discussed in an earlier section, where it was concluded that the appropriate time is between 20 and 22 weeks. Assuming that all birds in the flock have become photosensitive by these ages, the rate at which a final photoperiod induces sexual development may be described by a graph called a photoperiodic response curve. Such a curve is drawn in **Figure 12**, and from it and the initial egg production data in **Figure 13** it can be seen that photoperiods can be divided into two distinct classes according to their ability to induce sexual development: neutral photoperiods, also called short days, which have minimal influence over sexual maturation, and stimulatory photoperiods, which significantly accelerate it. The shortest photoperiod that is able to significantly initiate sexual development is termed the critical daylength, and that which maximizes it, the saturation daylength. In practical terms, these are generally accepted as being 11 hours and 13 hours respectively for birds reared on eight hours and photostimulated at about 20 weeks. Photoperiods longer than the critical, but shorter than the saturation, daylength accelerate sexual development, but not maximally, and are considered to be only mildly stimulatory. The data in **Figure 13** show that in addition to the age at 50% egg production being influenced, the photoperiod to which the birds are transferred also determines the rate at which daily egg production increases to peak; more-stimulatory photoperiods induce steeper increases because sexual development within the group is more uniform.

Figure 12: Advance in sexual maturity for broiler breeders reared on eight hours and transferred to a neutral photoperiod (black symbols), or stimulatory (red symbols) photoperiod at 20 weeks of age. The blue line is the photoperiodic response curve.

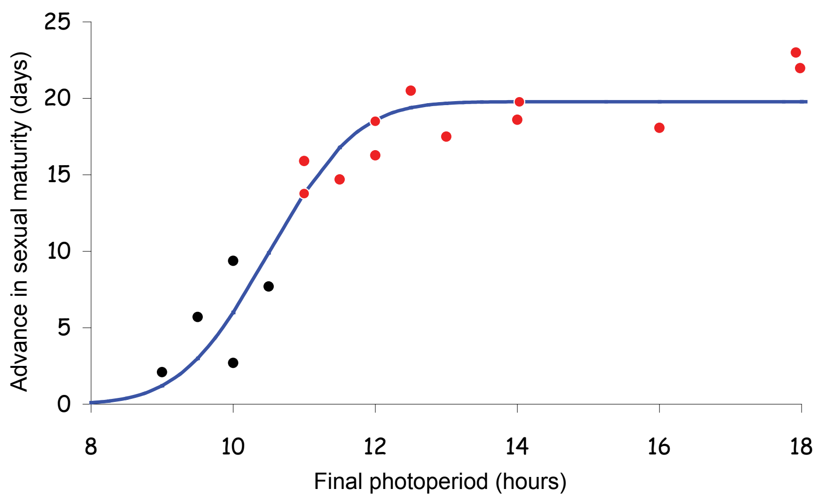
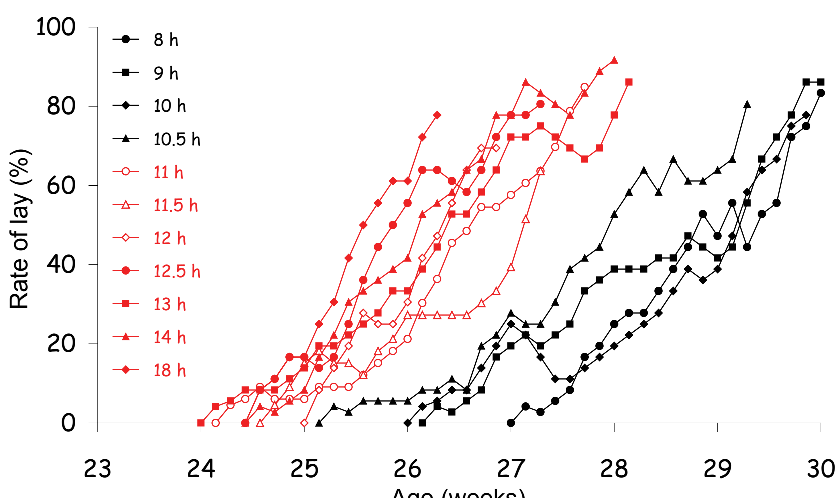


Figure 13: Initial rates of lay for broiler breeders reared on 8 hours and transferred to a neutral (black symbols) or stimulatory (red symbols) photoperiod at 20 weeks.



In the section on photorefractoriness we noted that prolonged exposure to long days results in the development of an adult form of the refractory condition. However, if broiler breeders are transferred to a photoperiod that is shorter than the saturation daylength, that is mildly stimulatory, there will be a delay in the onset of the condition and a consequential improvement in the persistency of lay; and so broiler breeders transferred to 11 or 12 hours at 20 weeks generally have superior rates of lay to others transferred to 16 hours (**Figure 14**), resulting in the production of 5-10 more eggs to 60 weeks. It has been suggested that there may be merit in making the initial transfer to a mildly stimulatory photoperiod and delaying further increases until later in the laying cycle to counteract the reduction in photoperiodic drive. Unfortunately, not only does this not work, irrespective off when the increases are given or their size and frequency, but it has the opposite effect in that it accelerates the decline in rate of lay, most likely by hastening the onset of adult photorefractoriness. Although the research in South Africa supports the Aviagen recommendation to transfer from 8 hours to 11 or 12 hours at 20 or 21 weeks, depending on a flock's body-weight uniformity, it neither supports the advice to continue increases to a 15-hour maximum nor the suggestion that further increases to 16 hours may be beneficial when rates of lay are not increasing satisfactorily. This lighting strategy results only in a more rapid decline in egg production because birds on longer daylengths become photorefractory more quickly and use more energy for daily maintenance (each extra hour of daylength uses 1% more energy and reduces the amount of energy available for production). Longer daylengths are also associated with poorer shell quality, and this might conceivably lead to inferior hatchability.

Broiler breeders maintained on 11 or 12 hours during the laying period have better egg production than birds given a 16-hour day (**Figure 14**), however, on such short photoperiods, egg-laying will generally begin before the lights come on (**Figure 15**), and this will increase the likelihood of eggs being laid on the floor. Notwithstanding that 11 or 12 hours may be suitable for birds kept in cages, 13 or 14 hours may be better recommendations for birds kept on the floor. In production units fitted with automatic nests the installation of dim lights in the nest boxes set to come on 2 hours before the main house lights may be a practical solution where early egg-laying is a problem.

Current research at the University of KwaZulu-Natal is looking at the responses to various photoperiods between 11 and 14 hours to identify the most appropriate for use during the laying period.

Figure 14: Rates of lay for broiler breeders reared to a body weight of 2.2 kg (4.8 lbs) and transferred from 8 hours to a final photoperiod of 11 hours (●), 12 hours (●) or 16 hours (●) at 20 weeks.

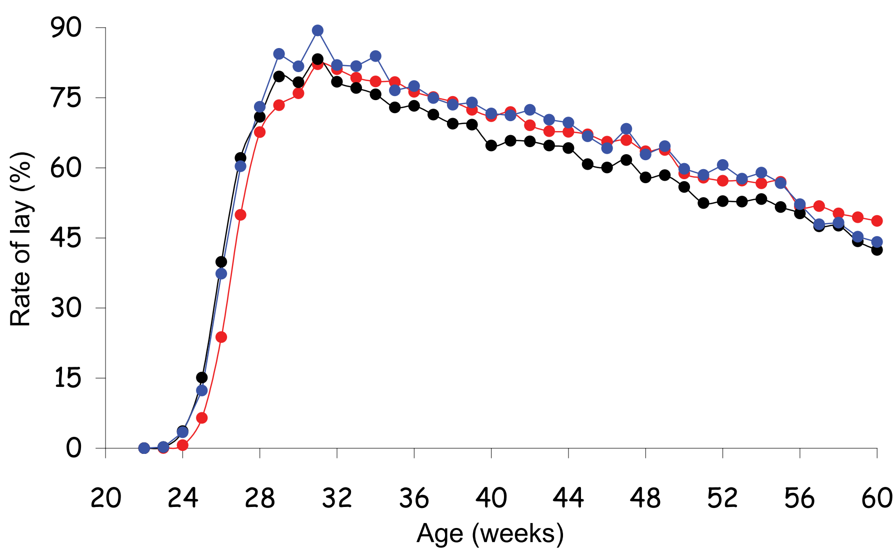
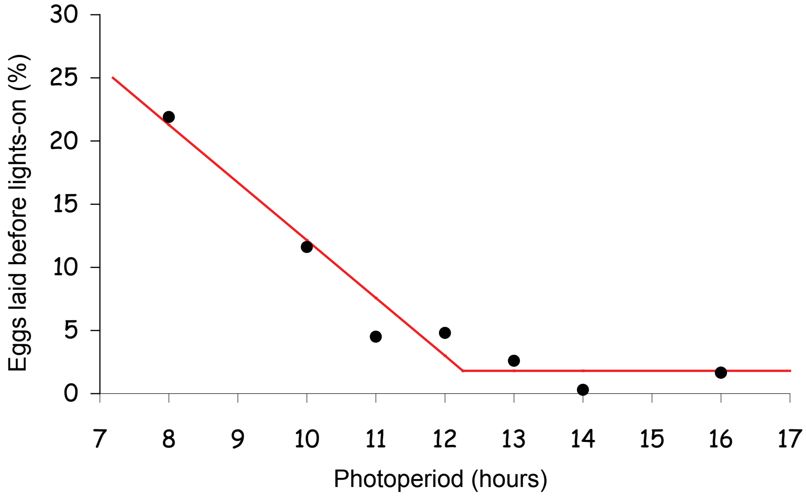


Figure 15: Proportion of eggs laid before lights-on for broiler breeders given a photoperiod of between 8 and 16 hours.



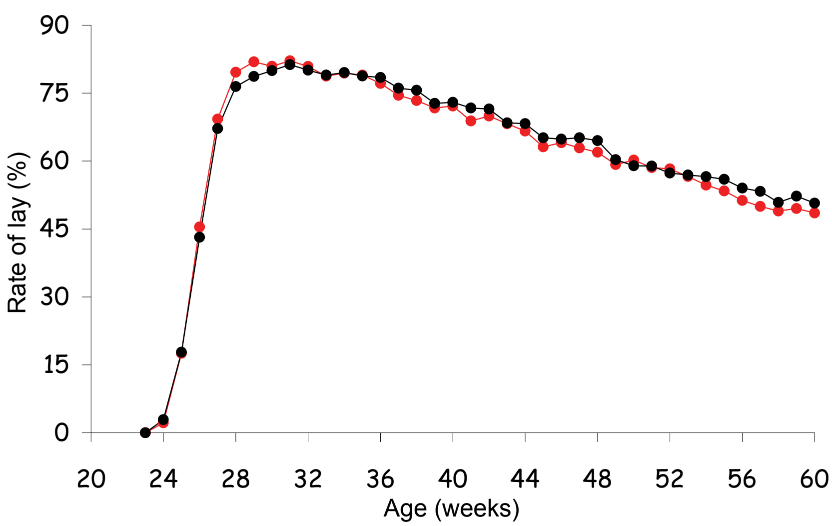
Key points:

- Mildly stimulatory photoperiods (11 and 12 hours) give better egg production than 16 hours.
- Longer daylengths are associated with poorer shell quality.
- Daylength needs to be more than 12 hours to ensure that egg-laying does not start until after the lights come on – an important consideration for birds kept on the floor.

Abrupt or step-up transfers

Lighting programmes for broiler breeders invariably involve an initial increase to 11 or 12 hours followed by a series of 30-minute or 1-hour increases to reach a 15 or 16-hour maximum. However, such a step-up regimen is more for the benefit of the producer than the bird because research with egg-laying hens, broiler breeders and turkeys have consistently failed to show any benefit from giving a gradual increase compared with a single abrupt increase to the desired daylength. Whereas a single abrupt increment tends to result in a slightly steeper increase in egg production and higher peak rate of lay (indicative of a more sexually uniform flock), and a step-up programme usually has marginally better persistency, there will be no significant difference in egg production for the complete laying cycle (**Figure 16**).

Figure 16: Rates of lay for broiler breeders transferred in a single abrupt increase from 8 hours to 16 hours at 19 weeks (●) or initially to 12 hours at 19 weeks followed by 1-hour weekly increments to reach 16 hours at 23 weeks (●).

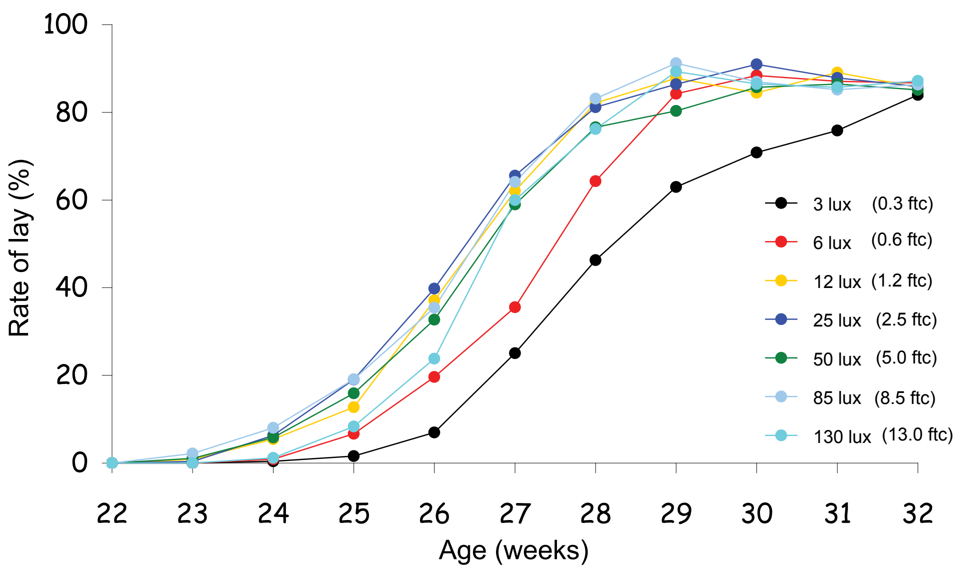


Key points:

- A single abrupt increase in daylength results in similar egg production to a gradual step-up program.
- Abrupt increments induce higher peak rates of lay, but step-up programs result in better persistency.

Light intensity (illuminance)
Research findings have shown that illuminating broiler breeders with a light intensity (synonymous with illuminance) of at least 15 lux (1.5 fc) at bird-head-height during the rearing period will result in a satisfactory level of performance in lay. However, to optimize the timing of sexual maturation and the rise to peak rate of lay (**Figure 17**), and to maximise overall egg production (**Figure 18**), illuminance in the laying period does not need to be any brighter than 7 lux (0.7 fc); a threshold very similar to the 5-10 lux (0.5 - 1 fc) concluded for laying hens. Furthermore, as is the case with laying hens, the response to illuminance in the laying period is independent of that experienced during the rearing period. This means that it is immaterial whether the light intensity is increased, decreased or held constant when broiler breeders are transferred from the rearing to the laying facilities, provided the laying house illuminance is 7 lux (0.7 fc) or brighter. The findings also question the correctness of beliefs that light intensity and daylength for broiler breeders must be increased simultaneously and that it is the combination of increasing daylength and light intensity that stimulates their sexual maturation.

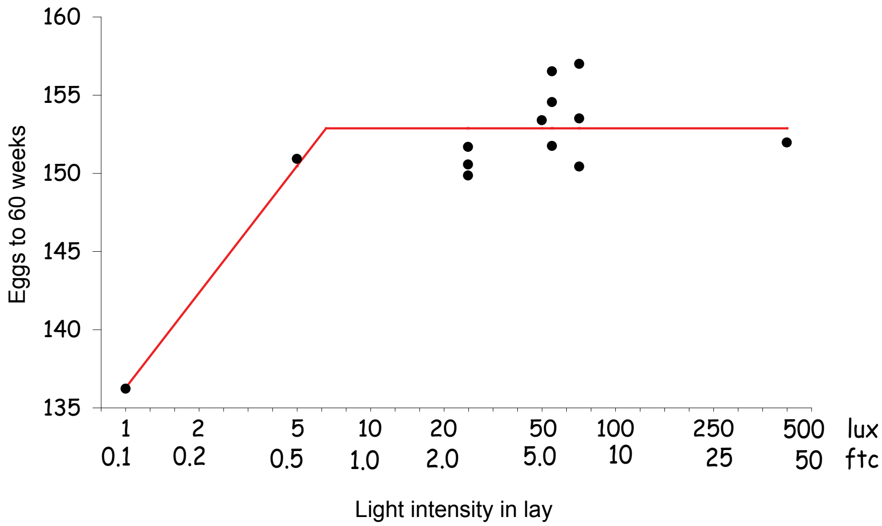
Figure 17: Rates of lay for broiler breeders transferred from a daylength of 8 to 12 hours and to various light intensities between 3-130 lux (0.3-13 fc) at 20 weeks.



Although the research showed that there is no need for illuminance in the laying period to be brighter than 7 lux (0.7 fc) to maximise reproductive performance, a South African study has shown that birds illuminated at 25 lux (2.5 fc) lay significantly more eggs on the floor than others given light at 55 or 70 lux (5.5 or fc). This indicates that when broiler breeders are kept on the floor, which is generally the case, light intensity needs to be considerably brighter than the biological threshold of 7 lux (0.7 fc) to minimise floor-egg-laying and maximise hatching egg production. Aviagen's current recommendation to rear at an intensity of between 10 and 20 lux (1 and 2 fc) and to transfer to between 30 and 60 lux (3 and 6 fc) for the laying period therefore seems to be the correct advice for birds housed on the floor. However, the research refutes the suggestion that egg numbers may be improved by further increasing the laying-house illuminance to between 100 and 150 lux (10 and 15 fc).

Floor-egg-laying is not a problem in cages and so electricity can be saved by illuminating caged broiler breeders in the laying period at an intensity lower than the 30-60 lux (3-6 fc) recommended for floor birds. There will, however, still be a need to comply with prevailing welfare regulations. Welfare codes commonly stipulate that illuminance should be such that it allows all birds to see one another and for them to be seen clearly, to investigate their surroundings visually, and to show normal levels of activity. It would be prudent, therefore, to adopt the 20 lux (2 fc) minimum illuminance advocated for the laying period by some welfare organizations as the recommended figure for lighting broiler breeders in cages.

Figure 18: Eggs produced to 60 weeks for broiler breeders transferred from 8 to 12 hours and to various light intensities between 1-500 lux / 0.1-50 fc ('x' axis is a log scale) at 20 or 22 weeks.



Key points:

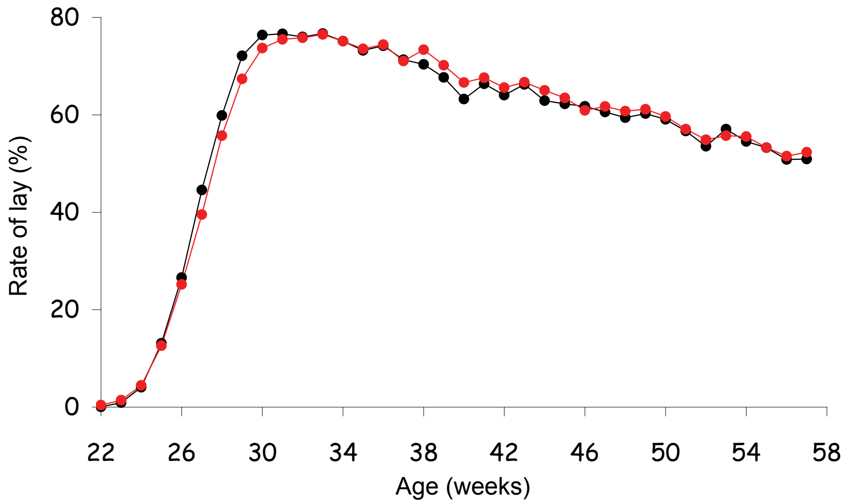
- A minimum of 15 lux (1.5 fc) in the rearing period optimises sexual development and subsequent egg production.
- The response to illuminance in the laying period is independent of that in rearing.
- A minimum of 7 lux (0.7 fc) in the laying period optimises age at sexual maturation, peak rate of lay and egg numbers, but 30-60 lux (3-6 fc) is recommended for birds kept on the floor to reduce floor-egg-laying.
- Caged birds may be given an intensity lower than 30-60 lux (3-6 fc), but a minimum of 20 lux (2 fc) is recommended to satisfy welfare concerns.

Color (wavelength)

There are no specific reports of the response of broiler breeders to colored light (wavelength). Some lamp manufacturers claim that red compact fluorescent lamps beneficially influence egg production and shell quality, but the claims are not endorsed by scientific research and appear to be erroneously based on research conducted more than 50 years ago when Mallard drakes were stimulated with colored light from truly monochromatic sources. Light from colored fluorescent lamps has a wide spectrum and is far from monochromatic, and so it must be concluded that there is no reliable evidence that colored fluorescent light gives any benefit to broiler breeder performance over white light. Responses to light from colored LED (light emitting diode) lamps, which have a very narrow spectral emission, have yet to be assessed in broiler breeders. Nevertheless, it must be remembered that white light includes all colors of light, including red, so there is no need to replace white lamps with red lamps to provide the birds with red light, particularly if they are replacing incandescent lamps which already emit more than 70% of their light in the red band.

In contrast to us, birds are able to see in the UV-A part of the ultraviolet range of radiation (shorter wavelengths than light). Broiler breeder plumage, though appearing to be uniformly white to us, has varying UV-A reflective markings that allow birds to identify each other as individuals. Although it is known that broiler breeders use this facility in mate selection, its effect on fertility is only speculative. UV-A radiation penetrates very poorly to the part of the brain that controls sexual activity (hypothalamus) and so it is likely that UV acts principally on the retina of the eye to stimulate behavioral responses and is minimally involved in reproductive performance. Data from recently completed research conducted in South Africa supports this suggestion (**Figure 19**).

Figure 19: Rates of lay to 57 weeks for broiler breeders illuminated with white light from compact fluorescent lamps (●) or white and UV-A light from 'Bird lamps' (●) at 25 lux (2.5 fc).



Key points:

- No evidence that coloured light is relevant to broiler breeder management.
- Ultraviolet radiation is involved in recognition but not in reproductive performance.

Light source (lamp type)

There is no scientific evidence that light source has any consistent effect on any aspect of reproductive performance in broiler breeders.

Key point:

- No evidence for any particular type of lamp.

Seasonal influences in non-lightproof houses

Broiler breeders that are reared in non-lightproof housing and hatched in the spring (often called 'out-of-season' flocks) mature later than, and have inferior egg production to, 'in-season' flocks that are hatched in the summer and autumn and become sexually mature in the spring. The main reason is that spring-hatched birds have no experience of short days during rearing and this slows up the dissipation of photorefractoriness, delays sexual maturation and, as a consequence, reduces egg numbers. Rearing spring-hatched flocks in 'brown-out' curtain-sided housing on short, artificial daylengths produces some improvement in performance, but it is still unlikely to be as good as that of flocks hatched in the summer or autumn which experience genuine short days during the rearing period. Consideration should therefore be given to light-proofing rearing houses at latitudes where there is a pronounced seasonal fluctuation in performance.

Key points:

- Spring-hatched broiler breeders have inferior performance to birds hatched at other times of the year, principally because they experience no short days during rearing.
- Broiler breeders kept on artificial short daylengths in curtain sided houses suffer less than birds in open-sided houses from seasonal fluctuations in performance.

GLOSSARY

Adult photorefractoriness	**the condition that accelerates the decline in egg production at the end of the laying period**
Daylength	**the period of light provided in each 24-hour cycle**
Illuminance	**synonymous with light intensity**
Juvenile photorefractoriness	**the condition that stops a bird responding to a long day in the rearing period; broiler breeders are hatched photorefractory**
Light intensity	**the brightness of light, usually measured at bird-head-height in lux**
Long day	**a sexually stimulatory daylength (≥ 11 hours)**
Neutral day	**a daylength (≤ 10 hours) that does not stimulate sexual maturity**
Night	**the period of darkness provided in each 24-hour cycle**
Photoperiod	**synonymous with daylength**
Photorefractoriness	**the inability to respond to a stimulatory daylength; synonymous with seasonal breeding**
Photostimulation	**the transfer from short to long days to accelerate sexual maturity**
Short day	**a sexually neutral daylength used in rearing**
Stimulatory day/photoperiod	**synonymous with long day**

NOTES

Aviagen Incorporated
Cummings Research Park
5015 Bradford Drive
Huntsville, Alabama 35805
USA

tel +1 256 890 3800
fax +1 256 890 3919
email info@aviagen.com

Aviagen Limited
Newbridge
Midlothian EH28 8SZ
Scotland UK

tel +44 (0) 131 333 1056
fax +44 (0) 131 333 3296
email infoworldwide@aviagen.com

www.aviagen.com

0809-AVN-022