ISA Recommendation

# Recommendation of
# Lighting Environment of Layer Farming

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Technical Committee on Standardization

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# Foreword

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# Technical requirements for lighting environment of layer farming

## 1 Introduction

Light environment is an important factor affecting the growth and egg production of layers. With appropriate parameters, light environment can greatly improve its the growth rate of layers and egg quality. Especially in the era of high development of modern poultry breeding technology, it is urgent to optimize and standardize the breeding light environment technology.

This document specifies the general technical requirements of lighting environment of layer, including terminology, definitions, classification and test requirements.

## 2 Scope

This document specifies the general technical requirements of lighting environment of broiler, including terminology, definitions, classification and test requirements.

This document is applicable for special tasks requiring different light colors/spectrums, illuminances and photoperiods and for changing the production capacity of layers, providing reference for the formulation of related technical documents, test methods, detection rules and technical documents for the control of LED light environment in layers farming.

## 3 Terms and Definitions

### 3.1 Layer farming

#### 3.1.1 Layer

Breeds of chickens raised artificially for human consumption of eggs.

#### 3.1.2 Layer farming

Layer farming refers to the farming of chickens specially bred for human consumption of eggs. The main purpose of raising layers is to improve egg quality and maintain or increase egg production.

#### 3.1.3 Farming stage

According to the characteristics of livestock and poultry production use, the production cycle is divided into different ages or several production stages, and different environment and nutrition supply measures are implemented according to each stage.

#### 3.1.4 Illumination mode

##### 3.1.4.1 Artificial illumination mode

The illumination of layer coops are is compeletely unaffected by impervious to natural light , and is dependent on with artificially light sources providing light throughout the broiler farming phase.

##### 3.1.4.2 Natural combined with artificial illumination mode

Layer coops receive light through translucent windows or roof, mainly using illuminated by natural light during the day and artificial light at night to fill the light.

### 3.1.5 Layer cage

Laminated layer cages (Type H). Layer cages arranged in cascade arrangement; stepped layer cages (Type A). Layer cages arranged in tiered arrangement.

### 3.1.6 Egg quality

Refers to the external characteristics of the egg (size, shape, cleanliness, gloss) and the quality of the content (the consistency, color, egg yolk size, egg yolk shape, egg yolk color, air chamber size, smell, microbial status, drug residue, etc.) of the egg.

## 3.2 Illumination

### 3.2.1 Natural light

Natural light is the optical radiation produced by nature usually refers to the sunlight and the light diffused by the moon at night.

### 3.2.2 Artificial light

Artificial light id the optical radiation produced by manmade devices such as electric light sources.

### 3.2.3 Optical Radiation

Electromagnetic radiation at wavelengths between the region of transition to X-rays ( $\lambda \approx 1$ nm)and the region of transition to radio waves ( $\lambda \approx 1$ mm).

[CIE S 017:2020 ILV: International Lighting Vocabulary]

### 3.2.4 Spectrum

Display or specification of the monochromatic components of the radiation considered

NOTE 1 There are line spectra, continuous spectra, and spectra exhibiting both these characteristics.

NOTE 2 This term is also used for spectral efficiencies (excitation spectrum, action spectrum).

[CIE S 017:2020 ILV: International Lighting Vocabulary]

### 3.2.5 Photoperiod

Natural or artificial cycle of light and darkness to which living organisms may be exposed.

Layers involved in a natural or artificial cycle in which day and night alternate.

NOTE: For example, the natural cycle of daylight at the equinox, the ratio of daylight duration (L = 12h) to night duration is expressed as LD = 12:12.

[CIE S 017:2020 ILV: International Lighting Vocabulary]

### 3.2.6 Illuminance uniformity [$U_o$]

Ratio of minimum illuminance to average illuminance on a surface

Unit: 1

Equivalent term: “uniformity ratio of illuminance”

[CIE S 017:2020 ILV: International Lighting Vocabulary]

**3.2.7 Flicker**

Perception of visual unsteadiness induced by a light stimulus the luminance or spectral distribution of which fluctuates with time, for a static observer in a static environment.

NOTE: The fluctuations of the light stimulus with time include periodic and non-periodic fluctuations and can be induced by the light source itself, the power source or other influencing factors.

[CIE S 017:2020 ILV: International Lighting Vocabulary]

**3.2.8 Flicker index**

<of a source run on alternating current>

***I*F**

Quotient of the above-average luminous energy to the total luminous energy over a period of time.

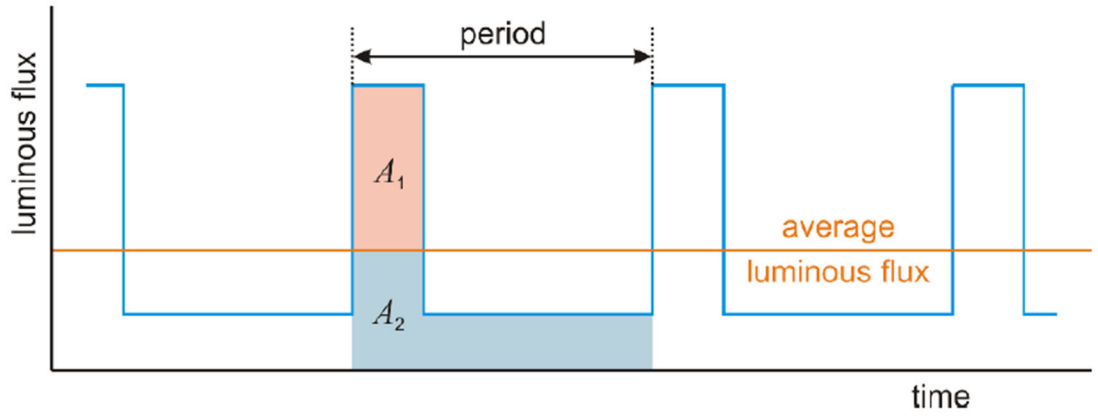
NOTE 1: The above-average luminous energy is the luminous energy calculated from the amountthat the instantaneous luminous flux exceeds the average luminous flux. When the instantaneous luminous flux is less than the average luminous flux, the above-average luminous energy is zero, i.e. it does not add negatively.

NOTE 2: For the region under the curve of a graph of the instantaneous luminous flux versus time, the flicker index is equivalent to the ratio of the area above the average luminous flux to the total area. This is expressed mathematically as

$$I_{F=}\frac{A_1}{A_1+A_2}$$

where A1 is

the area above the average luminous flux and A2 is the area below the average luminous flux as indicated in the following figure:




[ CIE S 017:2020 ILV: International Lighting Vocabulary]

**3.2.9 Lamp luminous flux maintenance factor [ $f_{LLM}$ ]**

Quotient of the luminous flux of a lamp at a given time in its operational life and the initial luminous flux

NOTE 1: The lamp luminous flux maintenance factor has unit one.

NOTE 2: Initial luminous flux of lamps is usually declared at 1 h for incandescent and 100 h for discharge lamps.

[ CIE S 017:2020 ILV: International Lighting Vocabulary]

# 4 Classification of farming stages

Layer farming is generally divided into three stages: 0 to 6th week is the posthatch period, 7th-18th week is the growing period and from 19 week to the end of faming is the laying period.

# 5 Technical requirements

## 5.1 General requirements for light environment (Spectral, illuminance, and Photoperiod requirements)

Under the same illuminance, it is advisable to use light products with peak wavelength ranging from 500 nm to 565 nm (green light) to promote weight gain and sexual maturity of chicks in the growing period (7~18 weeks). Light products with peak wavelength ranging from 625 nm to 740 nm (red light) could be used to increase the egg production during laying period (after 19 weeks).

This document mainly enumerates the technical requirements of all artificial light for the layer farming that account for a relatively high proportion in the world at the current stage (until 2021). The farming requirements for other breeds can refer to this document, based on the requirements of each breed.

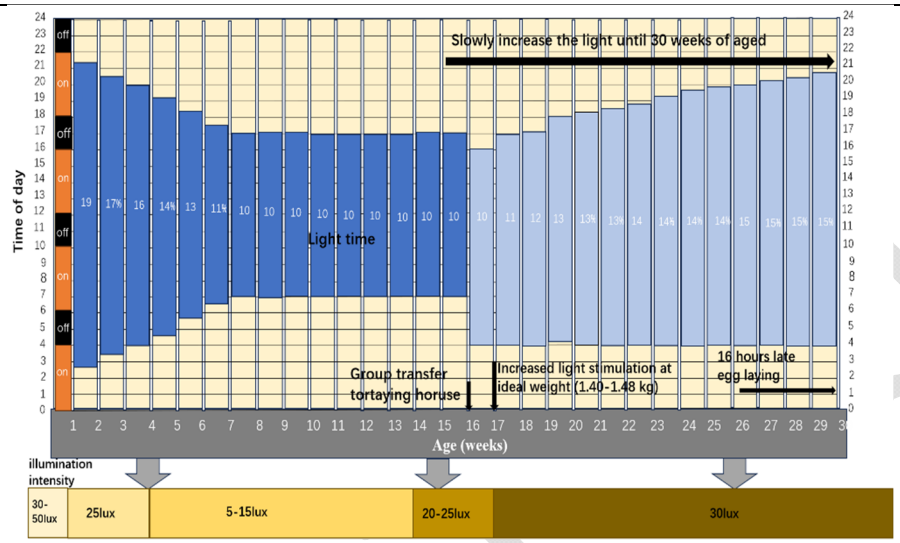
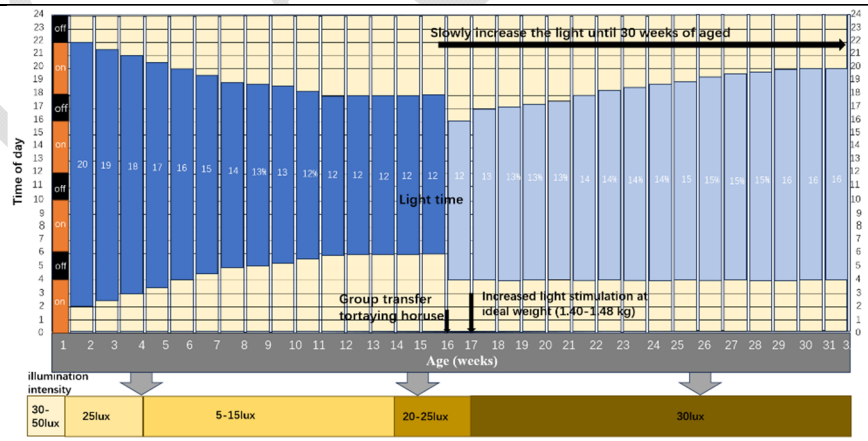
For the influence of natural light, the natural combined with artificial illumination mode is complicated to formulate the lighting program. Please refer to Appendix A.

**Table 1 Technical requirements for lighting in layer farming**

| Variety | Artificial illumination mode | | | | | Natural combined with artificial illumination mode |
|---|---|---|---|---|---|---|
| | Week age | | Day age | Illumination time (h) | Illumination (lx) | |
| Jinghong No. 1 | Posthatch period | 1 | 4~7 | 22 | 30~50 | See Appendix A.1 |
| | | 2 | 8~14 | 19 | 25 | |
| | | 3 | 15~21 | 17.5 | 25 | |
| | | 4 | 22~28 | 16 | 25 | |
| | | 5 | 29~35 | 13 | 10~15 | |
| | | 6 | 36~42 | 10 | 10~15 | |
| | Growing period | 7 | 43~49 | 10 | 5~10 | |
| | | 9-18 | 50~126 | 9 | 5~10 | |
| | Laying period | 19~22 | 127~154 | 19 weeks The length of light duration is 10 hours, after that, it will increase by 1 hour per week until 22 weeks | 5~10 | |
| | | 23~29 | 155~203 | 23 weeks, the light duration is 13.5 hours, after that, every week will increase by 0.5 hours to 22 weeks | 5~10 | |
| | | 30~eliminated | 204~eliminated | 16 | 5~10 | |
| Roman powder | Posthatch period | 1 | 1~3 | 24 | 20~40 | See Appendix A.2 |
| | | 1 | 4~7 | 16 | 20~30 | |
| | | 2 | 8~14 | 14 | 10~20 | |
| | | 3 | 15~21 | 13 | 10~20 | |
| | | 4 | 22~28 | 12 | 4~6 | |
| | | 5 | 29~35 | 11 | 4~6 | |
| | | 6 | 36~42 | 10 | 4~6 | |
| | Growing period | 7 | 43~49 | 9 | 4~6 | |
| | | 8~17 | 50~120 | 8 | 4~6 | |
| | | 18 | 121~126 | 8 | 10~15 | |
| | Laying period | 19 | 127~133 | 9 | 10~15 | |
| | | 20 | 134~140 | 10 | 10~15 | |
| | | 21 | 141~147 | 11 | 10~15 | |
| | | 22 | 148~154 | 12 | 10~15 | |
| | | 23 | 155~161 | 12.5 | 10~15 | |
| | | 24 | 162~168 | 13 | 10~15 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 25~elimina ted | 169~elim inated | 14 | 10~15 | |

**Table 2 Technical requirements for lighting in layer farming (continued 1)**

| Variety | Artificial lighting mode | Natural combined with artificial illumination mode |
|---|---|---|
| Hylan Brown |  | See Appendix A.3 |
| Hyline Grey |  | See Appendix A.4 |

### 5.2 Illuminance uniformity

5.2.1 In the broiler coop, $U_0$, the ratio of the minimum illuminance to the maximum, should not be less than 0.5.

5.2.2 In the broiler coop, $U_1$, the ratio of the minimum illuminance to the average, should not be less than 0.7.

### 5.3 Flicker index

Stroboscopic value, the flicker frequency of the lighting products, in the chicken house should not be less than 300Hz.

Note: The visual sensitivity of poultry is 2 to 3 times that of the human eye, and the safety stroboscopic value of the human eye is over 100Hz.

### 5.4 Lamp luminous flux maintenance factor

Clean the lamps and the environment regularly. The maintenance factor should not be lower than 0.7.

## 6 Measurement methods of light environment indicators (Illumination system parameter measurement)

### 6.1 Spectral distribution

Instrument: spectroradiometer

Direct measurement: Use a spectroradiometer to measure the spectrum of light emitted by LED lamps.

### 6.2 Illumination

Equipment: Illuminance meter.

In the direct measurement method, the near cage position and the far cage position are taken from each layer of chicken cages, and the surface of the bottom of the cage feeder trough is used as the monitoring point. Take 4-layer layer cage for example, no less than 8 monitoring points should be introduced. The placement height of the illuminance meter is based on the average eye height of layers in different growth periods or the bottom surface of the trough. Special periods should be determined according to the actual situation.

### 6.3 Illumination uniformity

Equipment: Photometer

Illumination uniformity $U_0$ = minimum illuminance value in the layer cage / average illuminance value in the layer cage.

Illumination uniformity $U_1$ = minimum illuminance value in the layer cage / maximum illuminance value in the layer cage

Measurement method: Measure the maximum illuminance and minimum illuminance according to the method 6.1.2. The average illuminance was used to calculate the uniformity

of illumination.

### 6.4 Flicker index

Equipment: flicker photometer

Measurement method: the application of direct measurement method, the LED lamp in the working condition, with the stroboscopic measuring instrument directly for the determination of stroboscopic value.

## Bibliography

# Appendix A

# Common requirements for the famring light environment of common layer faming natural combined with artificial illumination mode

### A.1 Jinghong NO.1

The influence of natural sunlight and seasonal factors should be considered in open chicken coops during the posthatch period in different seasons. In order to avoid sexual maturity, natural illumination and artificial illumination time are presented to formulate a farming lighting program that combines natural light and artificial light It should be formulated following the 4 situations.

**a) Sunshine duration increase gradually (spring chicks)**

Find out the longest sunshine duration in the local weather table during the 139 day farming period, and the chicks should be illuminated 23 to 24 hours per day by adding artificial illumination from Day 1 to 3. The illumination time (sum of natural and artificial illumination time) in the follow 10 days should be gradually reduced to the longest sunshine duration of the 139 days, and lasts to Day 139. From Day 140, half an hour was gained per week until the illumination time (sum of natural and artificial illumination time) increase to 16 hours per day.

**b) Sunshine duration increase firstly and then decrease**

Find out the longest sunshine duration during the growth period in the local weather table and the chicks should be illuminated 23 to 24 hours per day by adding artificial illumination from Day 1 to 3. The illumination time (sum of natural and artificial illumination time) will gradually reduce to the longest sunshine duration during the follow 10 days and lasting until Day 139. From Day 140, half an hour was gained per week until the illumination time (sum of natural and artificial illumination time) increase to 16 hours per day.

**c) Sunshine duration decreasing gradually period (spring chicks) (autumn chicks)**

The sunshine duration decreases continuously from Day 1 to 139. Artificial light should be supplied to chicks during posthatch period. The illumination time (sum of natural and artificial illumination time) is 23 to 24 hours for Day 1 to 3 and decrease 2 hours per week to 10-11 hours per day, the sunshine duration. The illumination time (sum of natural and artificial

illumination time) should be increased half an hour per week to 16 hour by artificial light supplement.

**d) Sunshine duration decrease firstly and then increase**

Find out the sunshine duration in the local weather table of Day 139 during farming period. The illumination time (sum of natural and artificial illumination time) is 23 to 24 hours for Day 1 to 3 and increasing gradually to 18 to 20 hours during follow 10 days. And then the natural illumination time was used until the illumination time achieve the sunshine duration in the local weather table of Day 139 until Day 119. From Day 120, the illumination time (sum of natural and artificial illumination time) should be increased half an hour per week to 16 hour by artificial light supplement. Note: The following methods should be used to determine the time to supply artificial light.

First light-adding method: 1. Follow the principle: The first light-adding time should be determined according to the age and weight of the layers. 2. Generally, artificial light should be supplied when the average body weight of the layers reaches 1420 to 1480 grams at the weekend of Week 16or17. No artificial light could be supplied if the weight of layers does not reach the standard. if so, it is necessary to stimulate the layers feeding and increase the weight of layers before artifical light supplement. However, it should be noticed that the increase of feed volume must be considered before the artificial light supplement. The feed consumption in the week before the artificial light supplement must be increased. The feed consumption should not be decreased even if the average weight of the layers had already exceed the standard. Otherwise, if there is not enough material basis (mainly energy and protein), it is difficult to obtain good egg production performance, due to the sudden surge in egg production after the artificial light supplement,3. The first light-adding time could not be later than 126 days of age. 4. Frequency of the artificial light supplement: The illumination time increases by 1 hour per week to 12 hours. And then, half an hour per week was added until the illumination time research 14 hours per day with the peak of egg production at the same time.. Then, the illumination time increases half an hour every two weeks to 16 hours per day.

**A.2 Luoman pink**

The natural combined with artificial illumination mode can follow the illumination program of the artificial illumination mode.

The influence of natural light should be considered when formulating the illumination program. For example, the sunshine duration gradually increases to about 17 hours in a year and should be the longest at the end of June. Then, to the sunshine duration decreases to 8 hours at the end of December, the shortest time in a year. If layers arer moved to an open-type window-laying coop cannot be darkened, the illumination program must be adjusted according to the sunshine duration at that time. There are two cases: a)the laying starts when the sunshine duration is shortened; b) the laying starts when the sunshine duration is extended. In both cases, no less than 10 hours of illumination time (sum of natural and artificial illumination time) must be presented in the 17th week, and the illumination time increases 1 hour per week to 14 hours until the 21th week of farming program.

Artificial light sources should not be turned on before 04.00 in the morning (Beijing time). The

illumination program in spring is affected by the prolonged of sunshine duration, gradually extending to about 17 hours per day. And when the sunshine duration decreases from July, the 17 hour per day for illumination time should be ensure until the end of the whole production period.

E.g:

At 4 am: turn on the lights and turn off the dimmer when the illuminance is greater than or equal to 50 to 60 lx.

Turn on the dimmer when the illuminance is less than or equal to 50 to 60 lx and turn off the light at 9 pm.

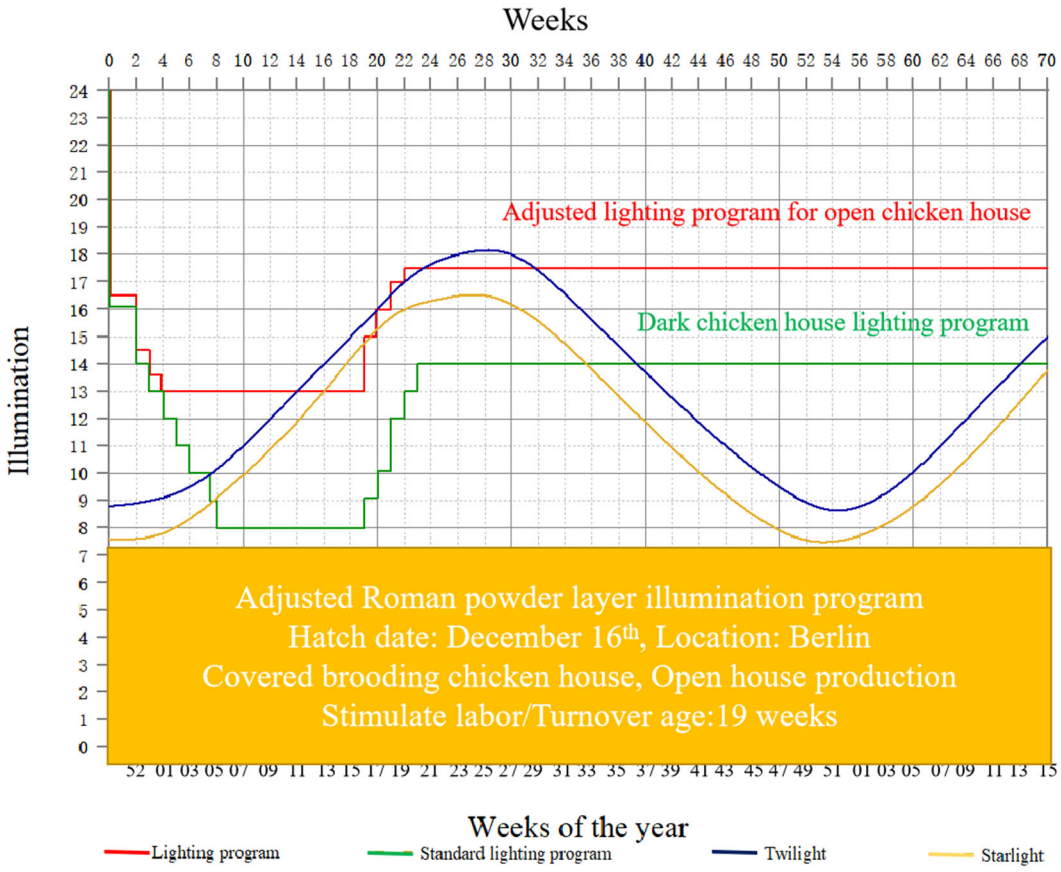



**Figure A.1 Illumination program of Luoman pink layer**

The above program should be adjusted according to the condition of the layer flocks, the starting of laying (egg production rate, egg weight) and the facilities of the layer coops. If the circadian rhythm is different from the above due to the business reasons, the dawn/dusk time ›uld not be too different from the above time considering the circadian rhythm of the hen. ɛ actual application could be presented using the calculation software provided by Lohmann, l the calculation and lighting program design should be considered by the basic principles illumination, the area of the farming site, the season and the temperature.

Illumination

### A.3 Hailan brown

Figure A.1 shows a reference for environmental requirements of Hailan brown with natural combined with artificial illumination mode. The actual application of illumination program can be calculated according to the software provided by Hailan Company, according to the basic

Weeks of the year

Lighting program Standard lighting program Twilight Starlight

principles of illumination, the area of the farming site, the season, the temperature and other factors.

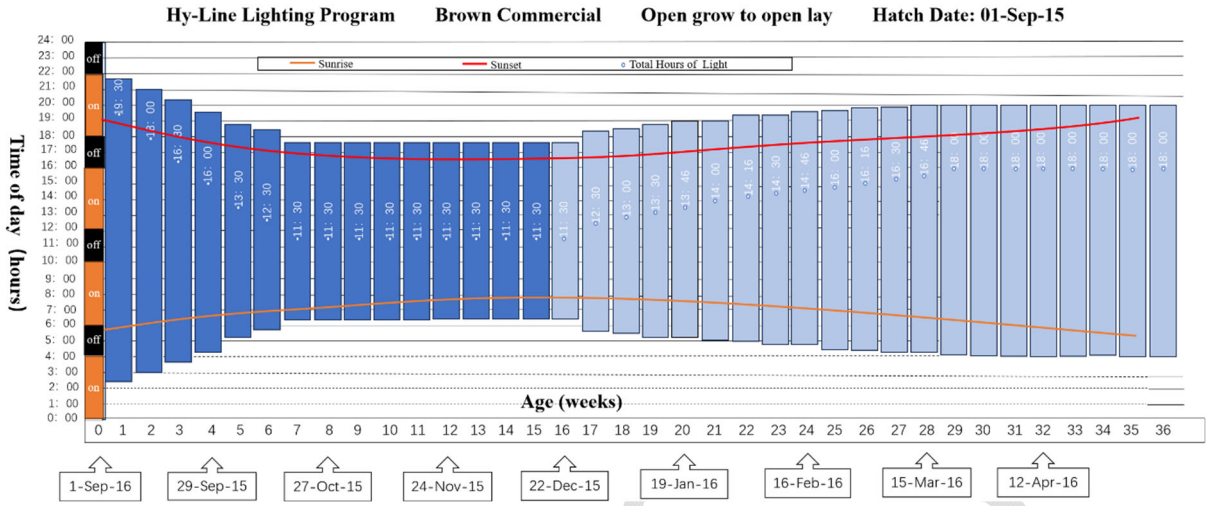



**Figure A.2 Environmental requirments for Hailan brown with natural combined artificial illumination mode**

## A.4 Hailan gray

Figure A.2 provides a reference of the environmental requirements for Hailan gray with natural combined with artificial illumination mode. The actual application should be calculated according to the software provided by Hailan Company. The illumination program can be calculated according to the basic principles of illumination, the area of the farming site, the season and the temperature.

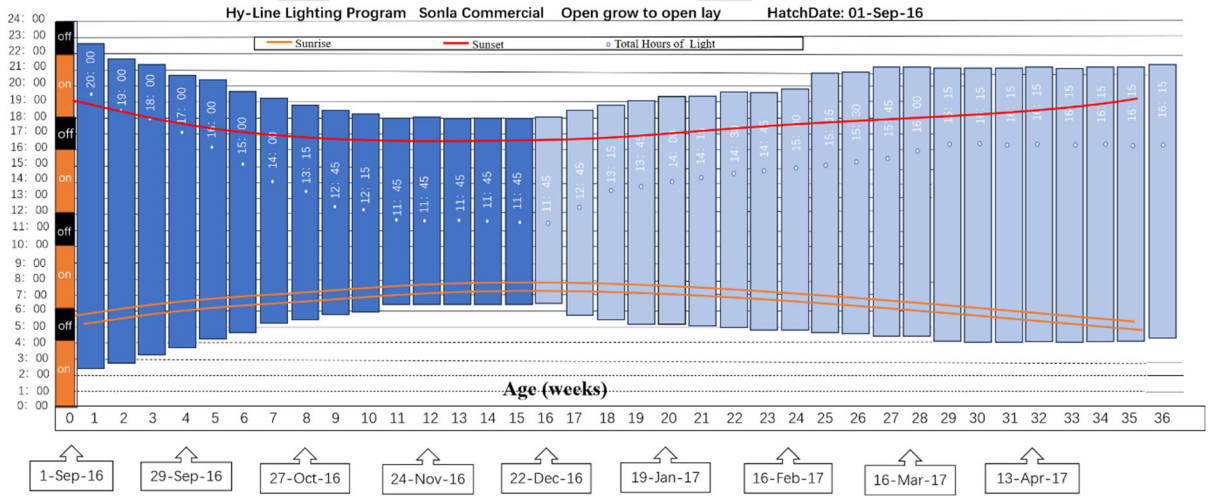



**Figure A.3 A case of environmental requirements for Hailan gray with natural combined with artificial illumination mode**

# Appendix B
# Evaluation of layer farming effect

### B.1 Overview

The following layer farming effect evaluation is not only directly by illumination program, but also affected by multiple factors such as temperature, humidity, and immunity.

### B.2 Evaluation Index

#### B.2.1 Survival rate

Survival rate = number of live animals on marketing period / number of live animals entering the coop of the same batch × 100%.

The annual survival rate is generally required to be no less than 95%.

#### B.2.2 Egg production rate

Weekly egg production rate = weekly egg production of the flocks / number of live animals in captivity × 100%.

After 17th week, the first collecting eggs should be start in follow 10 to 15 days. It takes about 20 days from the first collecting eggs to the first laying of production (50%). It would take 18 days from the first laying of production (50%) to 90%, and 15 days is necessary from 90% to the peak (95-97%). The production rate, above 93%, would be maintained for more than 10 weeks, and above 90% could be maintained for more than 20 weeks.

Note: The laying rate of layers is affected by many factors such as illumination, feed, temperature, and so on. However, illumination is an important factor but not the only factor. The above evaluation criteria should be used to evaluate the effect of the illumination program on the premise that other factors meet the relevant standards.

#### B.2.3 Feed to egg ratio

Feed to egg ratio = weekly layer flock feed volume/weekly layer flock egg production

Feed to egg ratio will drop to about 2.5:1 when the egg production rate increases to 90%. Then the feed to egg ratio continues to decrease slowly to 2.2-2.3:1 in 32th week. After that, the feed to egg ratio increases slowly due to the fatigue of laying and health reasons. It will increase to 2.4-2.5:1 when the laying hens eliminated in 72th weeks. The feed to egg ratio is below 2.4:1 during the entire feeding period of 18-72 weeks.

Note: The feed to egg ratio of layers is affected by many factors such as illumination, feed, temperature, and so on. However, illumination is an important factor but not the only factor. The above evaluation criteria should be used to evaluate the effect of the illumination program on the premise that other factors meet the relevant standards.

#### B.2.4 Egg quality

Egg quality: egg weight, egg white height, egg yolk color, egg yolk height, egg quality, and so on. An egg quality analyzer can be used for the determination of the parameters. Egg quality comply with the requirements and standards of different kinds of eggs.