Lighting in pig buildings: The review

Contents

The information in this booklet was compiled by Dom Charman, Independent pig specialist and AHDB.

LED lights portfolio

AHDB review of lights currently available to pig farmers

Overview

In late November 2017, AHDB Pork contacted businesses identified as being potential suppliers of light emitting diode (LED) lights to the British pig industry. The email that was sent contained a survey asking for information on specific lights supplied, including:

- Name of light (make and model)
- Product code/number
- Presentation of light (e.g., tube, strip)
- Wiring layout/plug-and-play, etc.
- Installation methodology
- LED manufacturer (if applicable)
- Rated lumen output
- Rated power consumption
- Actual power consumption
- Operating voltage of luminaire
- Approximate lifetime of the unit
- Ingress protection (IP) rating (e.g., 65, 67, 68)
- Luminaire file for dialux, etc. available
- Is the light dimmable?
- Is the spectra producer variable?
- Recommended mounting height
- Approximate cost to equip a 400 place finisher room (supply/fit separated)

Suppliers were also asked to provide a sample of the light to be placed in a pig unit for various measurements. Four suppliers sent lights. The information in this guide is taken from those tests. Other suppliers clearly exist in this sector, but only those who supplied lights (on loan) to be tested have been assessed.

While there are a variety of standardised tests to determine light output, light distribution and other factors, a test was devised to explore how the lights performed in a real pig building. It is important to understand that, while consistent, the test was limited to measurements taken in one pig building at one point in time, albeit with repeated measurements taken for each reading. Measurements also had background light subtracted (via an in-built function of the equipment being used).

A fully slatted, negative pressure ventilated pig building was used. The building had recently been cleaned and disinfected and allowed to dry. A rig was set up to allow lights to be mounted at either the manufacturer's recommended mounting height, or if no mounting height was specified, the lights were mounted 3 m above floor level. Lights were mounted in one pen. The passageway division for this pen and the pen opposite were removed to allow a full 5 m of measurement distance. For more detail please see the Methodology section in the Appendix. The tests were conducted on 27 March 2018 and, as such, some lights covered in the study may either be no longer available or have been updated by the manufacturer.

Results

Table 1 shows the key light output and power consumption figures listed by the manufacturers for each light tested. Table 1 also shows the reference number for each type of lamp used throughout the report.

Table 1. Listed output and power consumption figures for lights tested

Reference number	Supplied by	Light provided	Luminous flux	Rated power consumption (W)	Luminous efficacy (lm/W)
1	LSLCo UK	1.8 m LED farm linear light	3850	35.0	110
2	HATO Agricultural Lighting	Extreme LED	2900	28.0	104
3	East Riding Farm Services	Porci LED pig light	2200	23.5	94
4	Greengage Lighting	ALIS bard lamp wide	1100	10.0	110

While the lights vary in their luminous flux or total light output when compared on the basis of the amount of light provided per watt of energy consumed, they are within a similar range of 94–110 lumens per watt (lm/W).

Spectrum

Figure 1 shows spectrum measurements taken at varying distances from the lamp (in this case, a pair of ALIS lamps). Each line is a different distance measurement. The figure shows that spectra do not vary greatly at different distances from this lamp. The same was found to be true for each of the four lamps tested.

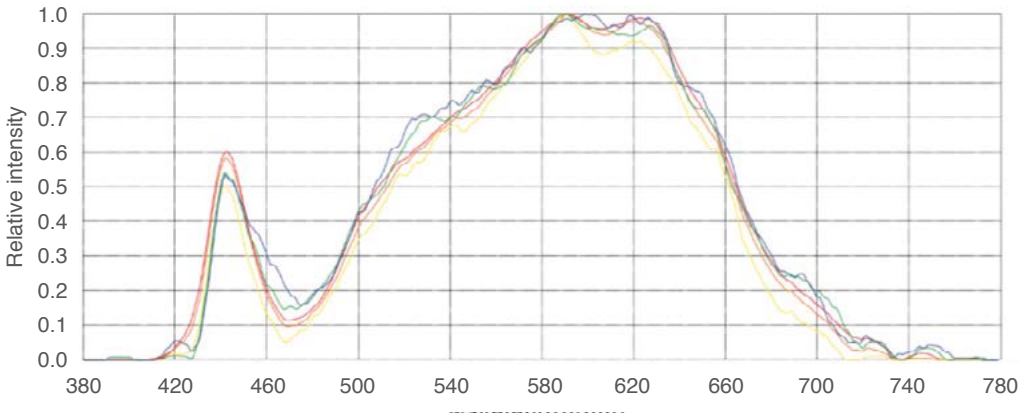

Figure 1. Comparison of spectra at varying distances for the ALIS lamp

Figures 2, 3, and 4 show the AHDB measurements of each light at various distances. The values for lamp 4, the ALIS lamp, are per pair of lamps because this was the recommendation based on the lighting design provided. This allows a fairer comparison to be made with the other three strip-type lamps.

Lumens and lux

UK legislation states that, in artificially lit buildings, pigs must be provided with a minimum of 8 hours light at 40 lux.

Lux is a measure of intensity over surface area. As lux is derived from measuring lumens it is "weighted" for the human eye, i.e. it is a measurement based on how much of the light might be used by the human eye. In this sense perhaps lux is not the best measurement for light that is useful for pigs (as their eyes differ from those of humans) but for the time being lux is the unit most easily measured and is the unit quoted in both legislation (globally, not just in the UK) and is also the unit historically used for measuring the level of light used in pig research on the subject.

Figure 2 shows how the lux value for each light compares at a range of distances. While each lamp has a different start point in terms of total light output directly under the lamp, the fade of these lights at 2.5 m and 5 m results in an almost identical lux level. Figure 2 shows how the lux level will alter further away from the lamp and highlights the value of properly planning lighting in buildings to achieve uniformity and desired lux levels as evenly as possible.

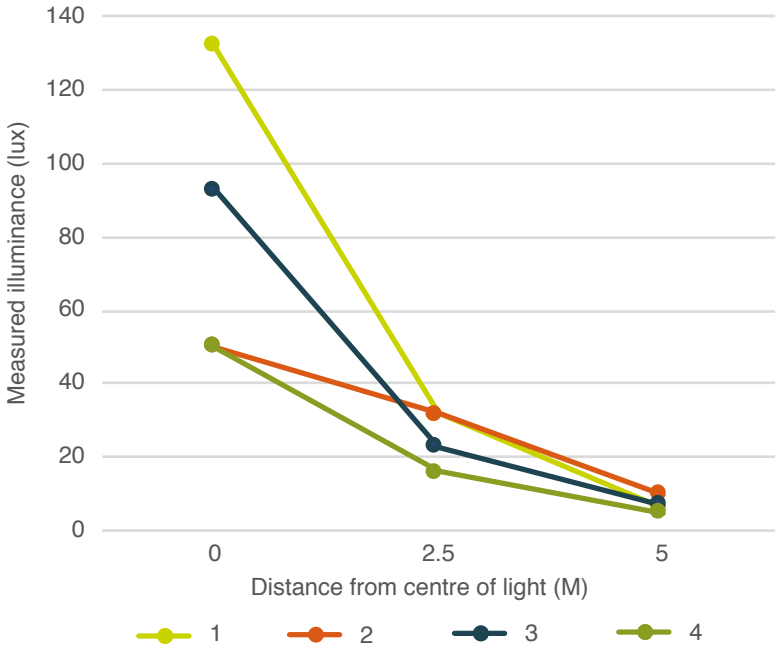

Figure 2. Lux at varying distances for each lamp

Peak Wavelength (λp)

Peak wavelength (measured in nanometer – nm) is the most intense wavelength supplied by a light source. An alternative measurement known as dominant wavelength (λD) is also used, however this is weighted for the human eye and as such may not be applicable to pigs.

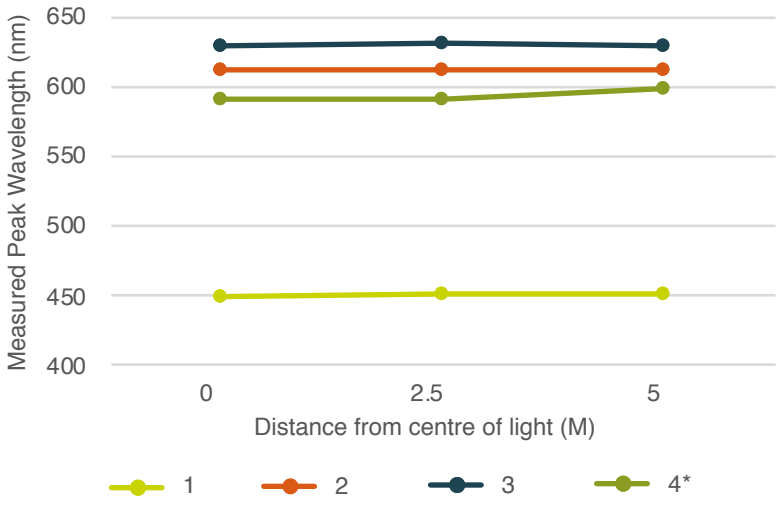

Figure 3. λP for each lamp at varying distances. The asterisk indicates the measure is a pair of lamps

Figure 3 shows the peak wavelength for each lamp at each stated distance. The wavelength for each lamp varies, but this does not alter greatly as the distance from the lamps increases. This suggests that the perceived colour of the light is unlikely to vary with distance from the lamp. Lamp 1, which showed the lowest λP, was bluer and was considered to be 'cool' white. Lamps 2 and 4 showed a more orange or 'warm' white type of light. The light from lamp 3 was noticeably green. Despite having the highest λP that was well into the red part of the spectrum, lamp 3 has a λD (at 0 m) of 523 nm, which falls clearly into the green portion of the light spectrum, explaining why it appeared green.

Scotopic to Photopic light ratio (S:P Ratio)

The eyes of all mammals, including pigs, have two types of cells, cone cells and rod cells. Cone cells provide photopic or day vison and allow different colours to be seen. Rod cells provide scotopic or 'night' vision. In simplified terms, S:P ratios provide a measure of how much 'rod-visible' light is available.

While the impact of S:P ratios on pigs is unknown, it is possible that pigs, compared with humans, may rely more on rod cells to perceive their environment. This is because pigs, which evolved under relatively low light levels under forest canopies, lack long wavelength cone cells and have only short and medium wavelength cones.

S:P ratios are also affected by how much of a lamp's total output falls within each band of short, medium or long wavelength lighting. Since human scotopic vision falls more within the short and medium wavelengths, the scotopic values of luminous flux from a lamp may be more representative of a pig's perception.

Figure 4 shows the S:P ratio for each lamp at varying distances. As for λP, the S:P ratio for each lamp does not alter much with distance. As might be expected, the two lamps with 'warmer' light temperatures, or which are more orange, show lower S:P ratios that those with greener or bluer light outputs.

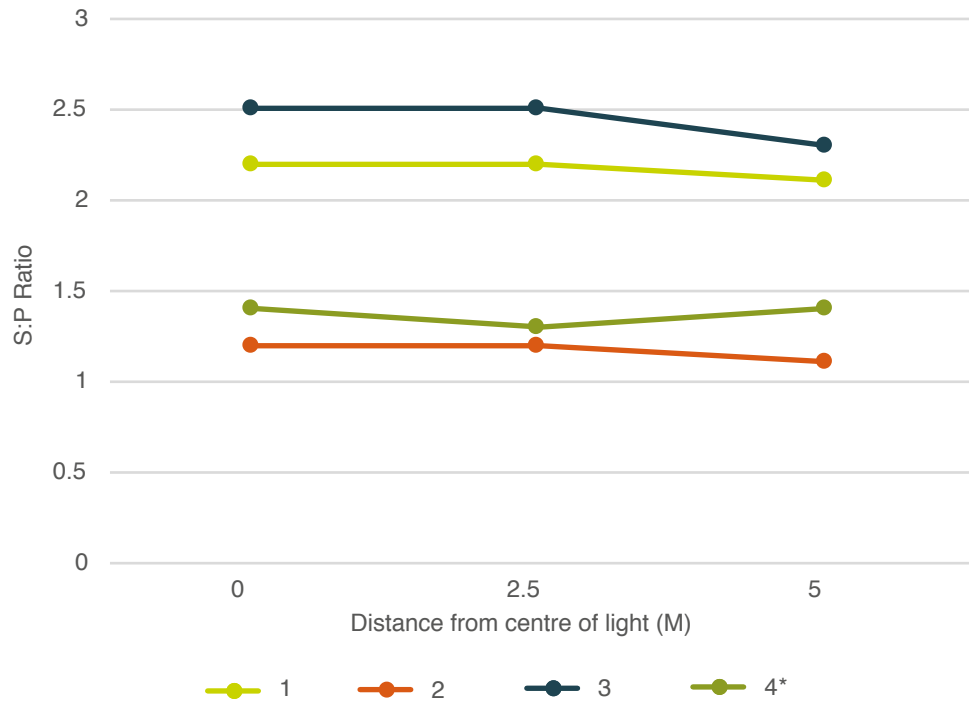

Figure 4. S:P ratio for each lamp at varying distances. The asterisk indicates the measure is a pair of lamps.

Lighting survey responses

Manufacturers' responses to the AHDB lighting survey (for those who supplied lights for assessment) are shown on the following pages. The price quote to light a single 400 place finisher is based on a standard model (shown in the index). Suppliers were asked to quote for an average of 150 lumens of light across the building, unless they felt a lower or higher lighting level would be of particular benefit to the pigs.

The quote for ALIS lights includes all of the necessary control gear and cabling, whereas the other three quotes are for lamps only – this should be taken into account when comparing costs. It is also important to consider the lifetime of the lamp when assessing return on investment (ROI). Costs were correct at the time of testing (28 March 2018).

Luminaire files for lighting design software are available for all of the lamps assessed. All companies supplied lighting designs to show where lights should be placed within a building to achieve a desired lux level.

All manufacturers who supplied lamps also provided detailed installation guidance, which varies by lamp used, type of attachment (i.e., surface mount or catenary wire) and by building type.

The wavelength profiles of the lights tested come from the measurementstaken by AHDB at 0 m.

Selecting LED lights

1. What is the ROI of each system being considered?

Taking into account the capital cost, installation cost, running costs and the lifetime of the system (which, for the systems tested, range between 30,000 hours and 100,000 hours).

2. For an existing building, will one system integrate better?

Either physically into the building or into ventilation controllers, power supplies, etc., which are already in situ.

3. What pre-sales support is available?

Specifically, can the manufacturer provide detailed lighting guidance and lighting designs? Many lighting companies offer such services.

4. How complex is the system?

In terms of installation (i.e., plug and play versus hard-wired systems) or maintenance and day-to-day running. Some controllers can be complex.

At what height does the system mount? Will staff be able to install/service/repair the system using a simple stepladder, or will other equipment be needed to complete installation and servicing?

5. Can existing systems be visited?

A producer who is already using a particular system may have valuable input about its reliability and running costs and may have anecdotal evidence of its effect on production or behaviour.

6. What warranties and other after-sales support are offered?

Table 2. Summary of lights tested

Supplier	LSLCo UK Ltd	HATO Agricultural Lighting	East Riding Farm Services Ltd	Greengage Lighting Ltd
Product name	LED farm linear light	Extreme LED	Porci LEDs full colour spectrum pig light	ALIS barn lamp (wide beam)
Picture	 1	 2	 3	 4
Product code/#	LSL LSD LL35A	Barcode 5665	5FCSLED	ALS0003
Presentation of light	Tube	Tube	Tube	Single clip-on induction luminaires
Wiring layout/plug and play, etc.	Single unit hard-wired, then daisy chain/plug and play	No info	Daisy chain/plug and play	Induction lighting system – light clips to cables
Installation methodology	Surface mounting or catenary wire system; plug and play system for each light's power.	Tube lights, surface mounting or mounting to catenary wire; wiring each light requires electrician.	Surface mounting or catenary wire, plug and play system for each lights power.	Lights clip onto induction cable system which is self-supporting or attached to a catenary wire (based on the cable 'run' length)
Manufacturer:	San'an	Osram	Epistar chips	Citizen
Rated lumen output (luminal flux)	3,850 lm	2,900 lm	2,200–2,400 lm	1,100 lm
Rated power consumption (Watts)	35.0	28.0	23.5	10.0
Actual power consumption (Watts)	35	28	23	9.8 to 10.2
Operating voltage of luminaire (V)	220–240 (AC)	220–240 (AC)	237	System supply, 230; luminaire, 34 per lamp
Approximate lifetime of the unit (hours)	40,000 (–30°C to +40°C)	45,000	30,000/50,000	100,000
IP rating	67	67	67	66
Luminaire file for dialux available	Yes	Yes	Yes	Yes, .LDT and .IES files available
Dimmable	Yes	No	Yes	Yes
Variable spectra	No	No	No	No
Recommended mounting height (m)	2.3–4.0	Depends on housing system	2+	Typically 1.5–3.5 but application dependent
Approximate cost to equip a 400 place finisher room (supply on, ex-VAT)	£2,098 (luminaires only, separate costs for controllers and cabling)	£1,637 (€1811) (luminaires only, separate costs for controllers and cabling)	£1,275 (luminaires only, separate costs for controllers and cabling)	£5,940.25 (includes all control equipment and power supplies/ cabling)

Conclusion

Results from AHDB's surveys and light assessments are detailed in Table 2 and Figures 2, 3 and 4. Limited scientific work in this field, and the relatively recent proliferation of LED lighting for pig units, makes it impossible to draw firm conclusions about which lights might be better suited for pig units. However, the graphs and tables provide a baseline for producers to consider, in collaboration with their vet, nutritionist, building supplier, electrician or independent lighting specialist.

Appendix

Methodology

Measurements were taken at floor level, in the centre of the lit area and at 90° to the light/rig, at 0.0 m from the light (directly below it) and at 1.0, 2.5, 4.0 and 5.0 m from it. An Asensetek Light Passport paired to a smart phone was used to collect lighting data, including intensity (in both lux and photosynthetic photon flux density), scotopic to photopic ratio and spectrographs.

Figure 5 shows a computer rendering of the test set-up, with the light surrounded by a yellow box. For illustrative purposes, this light is lamp 1, provided by LSLCo UK. Figure 6 presents the same image as Figure 5, with isolines and false colour on the floor showing the calculated light distribution to help visualise the testing procedure.

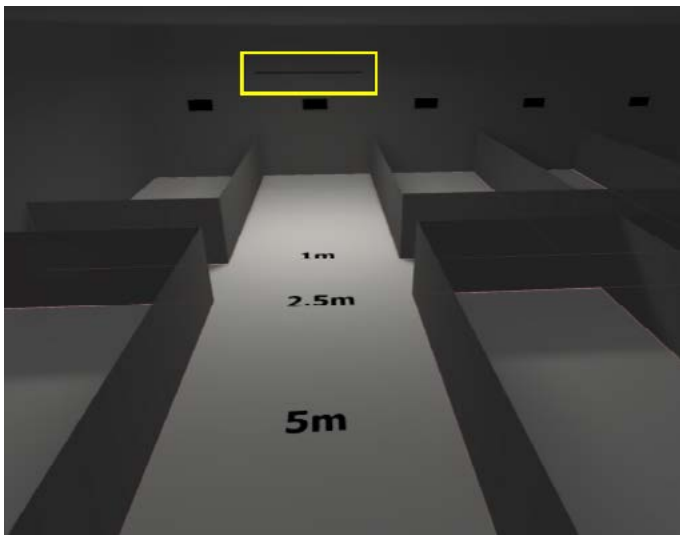

Figure 5. Test rig computer rendering

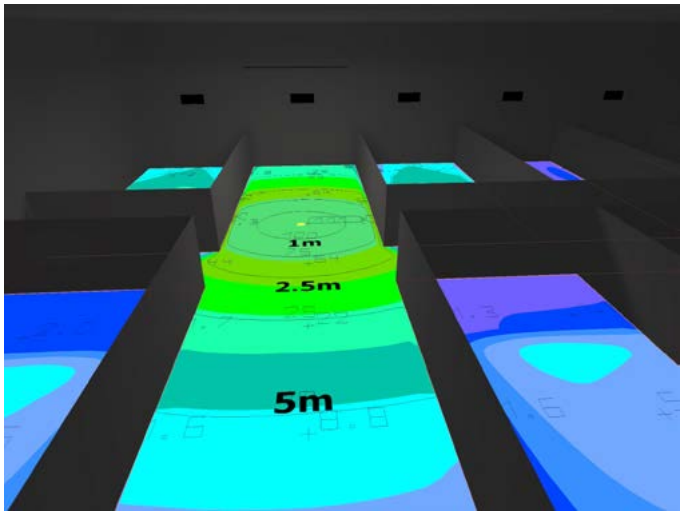

Figure 6. Test rig image including isolines and false colour to show light distribution

Figure 7 shows the test rig, as it was set up on the test pig unit. The large yellow arrow shows the direction of the test, with the arrow pointing from 0.0 m to 5.0 m. Figure 8 shows a plan view of the model of the theoretical finisher building on which lighting suppliers based their quotes.

Figure 7. **The test rig on a working pig unit, with a single ALIS lamp mounted at the recommended mounting height**

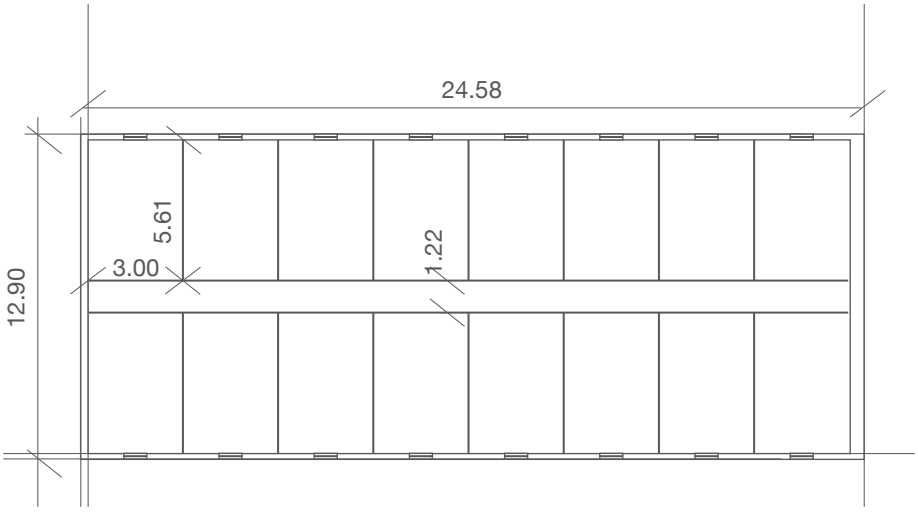

Figure 8. Plan view of a 400 place finisher model on which lighting suppliers based their quotes. Measurements are listed as metres (m)

Glossary

CQS (colour quality scale) – Tests to measure (on a scale of 0–100) how well a light source allows a human eye to perceive colour. A CQS of 100 means the light source allows the human eye to render colour perfectly. CQS tests cover a wider range of colours than CRI (see below) and are considered by some to be a more accurate way of measuring LED light sources

CRI (colour rendering index) – An older system than CQS, CRI tests measure (on a scale of 0–100) how well a light source allows a human eye to perceive colour. A CRI of 100 means the light source allows the human eye to render colour perfectly.

Dominant wavelength (λD) – The wavelength that most closely represents the colour of light perceived by the human eye

LED (light emitting diode) – A type of semiconductor light source that emits light when a current flows through it

Lumens – A measurement of light output, i.e. the output of light from a lamp

Lux – A measure of light intensity. 1 lux is equal to 1 lumen per square meter

Peak wavelength (λP) The wavelength that has the highest relative intensity in a measured light source

Photopic – 'Day vision' enabled by cone cells

Scotopic – 'Night vision' enabled by rod cells

Produced for you by:

AHDB Pork
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

T 024 7669 2051
E comms@ahdb.org.uk
W ahdb.org.uk
@AHDB_Pork

If you no longer wish to receive this information, please email us on **comms@ahdb.org.uk**

50004 0622