

ENERGY-SAVING USAGE IN LIGHTING

Farm lighting



Poultry facilities require a light level of 20 lux.

Good lighting is a fundamental requirement for the efficient operation of a farm. It is required for both farmers and in the case of animals, for stock. For example, research on the performance of dairy stock indicates that enhanced lighting levels can improve lactation

and growth. For humans, it supports visual acuity, performance and safety both through higher lighting levels and better colour rendering. But lighting is also costly to provide and run, so choosing the most suitable fitting layout and control equipment is important.

Lighting output and level

These are specific in units of lumens and lux.

The difference between the units lumen and lux is that lux takes into account the area over which the luminous flux is spread (**Table 1**). A flux or luminous power of 1,000 lumens, concentrated into an area of one square metre, lights up that square metre with an illuminance of 1,000 lux. The same 1,000 lumens spread

out over ten square metres produces a dimmer illuminance of 100 lux. Mathematically, $1\text{lx} = 1\text{m}^2$. Lux is not a linear scale, so a doubled lux level does not appear as twice the brightness to the eye. In fact, you have to increase lux levels by four to double the perceived light level, or by 16 to double it again.

Natural lighting

Natural lighting can make a very big contribution to dairy buildings, both in cubicle housing and for parlours and other areas. Providing 10-15% roof light area will be enough to provide between 100 lux and 500 lux through natural lighting, depending on the time of the year. The key to sustaining this is to maintain the cleanliness of the roof lights. Transparent wall sections are also effective. Naturally lit buildings need to be well ventilated to counteract the effects of heat build-up from solar gain.

Artificial lighting

Even with the best natural lighting resource, artificial light has to be used to guarantee light in all conditions, times of day, and times of year. Artificial lighting is costly to provide so it is always best to make the most of natural light and use artificial light to provide the rest.

Table 1: Light levels of different sources.

Condition	Light level (lux)
Bright sunlight	80,000
Overcast day	5,000
Bad light stops play	1,000
Modern office	500
Twilight	10
Road lighting	5
Full moon	0.2
Starlight	0.02

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Tasks and lighting requirement

Table 2 gives some guidance on lighting levels and desirable light properties. There are few definitive standards in this area, so this table contains figures from practical experience and from similar practice references.



Fluorescent lighting is ideal for the milking parlour pit.

Table 2: Lighting levels and properties.

Applications	Lux level required	Colour rendering	Uniformity	Control	Comments
Widespan livestock building	50-80 lux for general use. 170-200 lux for photoperiod yield effect.	Low to medium	Medium	Timed with light-level sensing. Fluorescents can use light-level driver dimming.	High-pressure sodium metal halide lights or multiple fluorescent fittings.
Milking	500 lux for pit	Good	Very good	Timed with manual override	Fluorescent lights will punch light through the mass of pipes and fittings and will give even, shadowless light.
Bulk tank area	200 lux	Good	Medium	Proximity	Fluorescent lights are most commonly used.
Outside areas	20-50 lux	Low to medium	Low	Timed/light level	High-pressure sodium or metal halide lights are the best compromise between cost and performance.
Office or workshop	300-500 lux	Good	Good	Proximity	Fluorescent lights are most commonly used.
Poultry	20 lux	Good	Good	Timed	Fluorescent or compact fluorescent – white warm.
Crop storage	50-70 lux	Medium	Medium	Proximity or manual	High-pressure sodium, metal halide lights or multiple fluorescent fittings.

Lighting types

There is a wide range of lighting sources to choose from (Table 3) and each type has its own unique set of characteristics. These include: capital cost; efficiency; longevity; colour; appearance; temperature; shadow

potential; and, start-up time. It is important to try to consider the relevance of these when choosing the right lamp type. The quality of the fitting and its ability to avoid being impacted by ammonia gases is very

important, which LEDs are very prone to. LED retrofits work economically on pig and poultry farms, but a retrofit on most farms has to be justified, as lights are not on a lot of the time.

Table 3: List of lamps which can be effectively used in farm lighting.

Category	Type	Overall luminous efficacy (lm/W)	Overall luminous efficiency	Colour appearance /rendering	Life (hours)	Comments
Incandescent	100-200W tungsten incandescent (230V)	14	2.1%	White/good	1,000	Cheap to buy. Expensive to run. Being phased out for small bulbs.
	100-200-500W tungsten halogen (230V)	17	2.5%	White/good	2,000	Cheap to buy and widely used for yards. Expensive to run if operated for long hours. Best used on a proximity sensor.
Light-Emitting Diode (LED)	7W LED to 15W	55.1-81.9	8-12%	White/good	50,000	Currently very expensive to buy and less efficient than most discharge lamps. Newer types promise high efficiencies. Very directional. Most efficient in cold temperatures.
	7W LED PAR20 (110-230V)	60.0	8.8%	White/good	50,000	
	Theoretical limit	260-300	38.1-43.9%	White/good	50,000	
Fluorescent	T12 tube with magnetic ballast	60	9%	White/good	8,000	Old type of tube 38.1mm in diameter – being phased out.
	9-32W compact fluorescent	46-75	8-11.45%	White/good	5,000	Natural replacement for tungsten bulbs, with lots of new designs – some dimmable.
	T5 or T8 tube with electronic ballast	80-100	12-15%	White/good	15,000	Workhorse for commercial buildings where good-quality low shadow-efficient light is needed. Newer ballast types more efficient and dimmable.
Gas discharge	Metal halide Lamp	65-115	9.5-17%	White/good	15,000	White appearance. Alternative to sodium. Takes a few minutes to warm up.
	High-pressure sodium lamp	85-150	12-22%	Yellow/medium	20,000	Yellow appearance. The most popular light for wide-span buildings. Takes a few minutes to warm up.
	Low-pressure sodium lamp	100-200	15-29%	Harsh/yellow/bad	25,000	Monochromatic yellow light. Very basic light for use outside. Takes a few minutes to warm up.

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Lighting design

This is important as it will determine the performance of the lighting for the life of the system. It is therefore worth getting some professional help to get the lighting design right:

- consider the way lighting is used on an everyday basis: where is the right place

for the switches?; and, is it possible to get different lighting levels by simply grouping and switching the lights in banks?;

- are lights in a position where they can be readily cleaned and where the bulbs can be safely changed?;

- consider reflectivity of roofs and walls – colouring surfaces white or a light colour can increase the lighting level dramatically; and,

- fittings in most cases will have to be water and dust proof – make sure the ones you choose are up to standard.

Energy-saving opportunities in lighting

Table 4: Lighting questionnaire – relates to office and workshop areas but applies generally.

Are light fittings maintained and cleaned? Dirty fittings can reduce output by 50%. Clean lights mean fewer fittings required. Potential savings of up to 50%.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Have you considered improved lighting design? Lighting has improved massively over recent years; it is now often possible to light offices well at 2.5 watts per m ² per 100 lux, or less with modern fluorescent tubes, efficient reflectors and electric high-frequency ballasts. Medium payback.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Do you use appropriate light levels? For general offices, a minimum illumination of 500 lux is required. For pack houses where general materials handling and trimming operations are carried out then 300 lux should be sufficient. Higher intense light at 1,000 lux may be required for inspection and colour discrimination.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Have you replaced tungsten lamps with fluorescent? Over a period of 8,000 hours' use, the cost of using fluorescent lighting will be less than half that of tungsten filament lighting. Short payback.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Have you replaced 38mm diameter fluorescent tubes with 26mm ones? They use 8% less electricity. The 26mm tubes also cost slightly less to buy and can be used as a direct replacement for existing lamps in most switch start light fittings with modification.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Do you use high-pressure sodium lamps? For high-ceiling rooms, high-pressure sodium lighting (SON) is often preferred to fluorescent lighting. With higher wattage, fewer fittings are needed, and the result is a more economic installation. For precision work, care must be taken to avoid excessive glare from high-intensity lights. Where mercury discharge lamps are used, consider replacing with compatible SON lamps or replace luminaries completely. This will give much better light output and lower running costs. SON lighting is very efficient and has long lamp life.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Do you have high-frequency ballast fluorescent tubes? Fluorescent fittings with high-frequency ballast are the most efficient type of lighting for offices. They are more expensive to buy than conventional fluorescent fittings, but cheaper to run and have several other advantages: they eliminate the mains-induced flicker; give fast and reliable starting; and, more stable operation, which extends lamp life and light output.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Have you got zoned switching arrangements? The largest wastage of energy in lighting comes from the use of lights unnecessarily by lighting areas that are unoccupied and using lights when daylight is adequate. By applying localised task lighting, lights can be selectively used when work is required. The choice of lamp itself can be made more suited to the task required, for example, the use of a blue green lamp such as colour 96 for lighting of potato inspection tables. Large savings can be made if the lights are wired so that those closest to windows can be switched separately from those farthest from windows.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Can you fit automatic switch controls? Rather than rely on manual switching, it is possible to install automatic lighting control such as passive infra-red (PIR) or time locks.	Yes <input type="checkbox"/>	No <input type="checkbox"/>

Further information

For further information please contact Barry Caslin, Teagasc, Rural Economy Development Programme at:
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The following resource is also helpful:

 www.seai.ie

www.teagasc.ie/ruraldev


AGRICULTURE AND FOOD DEVELOPMENT AUTHORITY
 www.teagasc.ie

Fact sheet produced by Barry Caslin, Teagasc, Rural Economy and Development Programme.