

FARM ENERGY

Indoor lighting for livestock, poultry, and farm shop facilities

Introduction

Indoor lighting for farm facilities is critical to safe and efficient production. Lighting systems should be designed to meet minimum lighting requirements in the most energy efficient and economical manner. This publication gives an overview of lighting types that are suited for livestock, poultry, and farm shop facilities.

Types of lighting

When selecting the proper lighting for an indoor application, consider not only energy efficiency, but also the initial cost of ballasts and fixtures and the rated life of bulbs. Keep in mind that dirty bulbs and fixtures can reduce light levels, and the environment within farm facilities (moisture, temperature, dust) generally shortens bulb life to less than its estimated "rated life."

Incandescent bulbs use electrical resistance to produce light. Most of their energy is given off as heat rather than light, therefore, they are the least efficient type of lighting. Although inexpensive to purchase, over time their inefficiency and short life make them a costly lighting source. These bulbs will be phased out of production during the next few years.

Compact fluorescent lights (CFL) can be direct replacements for incandescent bulbs because they require no wiring changes. They typically use 75% less energy than incandescent bulbs and last approximately 10 times longer. CFLs normally will not operate below 0°F and require about 1 minute to reach full light output. CFLs installed in livestock and poultry facilities should be rated for damp environments; however, bulb life may be shortened by placing

them in globes or enclosures, due to increased temperatures. CFLs are best suited for facilities where lights stay on for extended periods, since frequent on/off cycles shorten their life.

Cold cathode fluorescent lights (CCFL)

typically last two to three times longer than other CFLs, start at lower temperatures, are compatible with many types of dimmers, and can be turned on and off frequently without significantly shortening bulb life. They are more expensive and slightly less energy efficient than CFLs.

Light emitting diodes (LED) use semiconductor diodes, electronic devices that permit current flow in only one direction, to produce light. They are up to five times more efficient than incandescent lighting and long-lasting, with ratings up to 100,000 hours. LEDs emit directional lighting rather than the 360-degree illumination provided by other bulbs. They currently have limited application in livestock and poultry housing, due to their susceptibility to moisture, heat, and dust. However, new LED products are being developed and some have been tested successfully in broiler housing.

Tube fluorescent bulbs are available in three diameters. T5 and T8 bulbs are 0.6 inch and 1 inch in diameter, respectively. The most commonly used is the T12 bulb (1.5 inches in diameter); however, its manufacture is being phased out because it is the least efficient tube fluorescent bulb. T8 systems are four times more efficient than incandescent lights and 30% more efficient than T12 tubes. They are best suited for applications where they are mounted less than 12 feet above the floor.

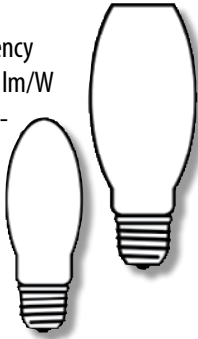


In livestock and poultry housing, standard output tube fluorescent bulbs should be mounted with electromagnetic ballasts in waterproof, gasketed fixtures. T5 bulbs are shorter and more efficient than T8 bulbs. Both T8 and T5 bulbs tend to retain the original light output longer than T12 bulbs. However, T5 bulbs are not recommended for use in vapor-tight fixtures and should be limited to clean-dry environments. High output versions of tube bulbs will start as low as -20°F, but are less efficient than standard output bulbs.

High intensity discharge (HID) lamps include metal halide and high pressure sodium vapor lamps. These typically are easy to install and maintain and are well suited for high bay applications (ceilings higher than 12 feet). However, they require a few minutes to warm up before they reach full light output, so they are not ideal for short-cycle lighting. They should be replaced when light output begins to fade appreciably or when they continually shut off and restrike while power is still on.

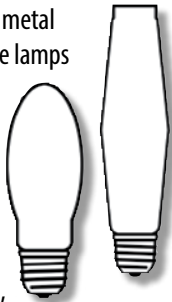
Metal halide (MH)

bulbs generally have efficiency ratings between 60 and 80 lm/W and are available in a pulse-start or standard version. Pulse-start bulbs typically are more efficient and can have 50% more lamp life than the standard version. MH are not instant-on lights, requiring 1 to 3 minutes to reach full light output. They must also cool down 5 minutes before re-starting.



High pressure sodium vapor (HPSV)

lighting is more efficient than metal halide lighting. However, these lamps emit a yellow-orange light that may not be desirable for livestock facilities where true color observation is critical to monitoring animal health. They work well at cold temperatures and are typically used outdoors.



Minimum Illumination Levels

Table 1 shows recommended minimum lighting levels for various farm facilities. You cannot simply order light bulbs to provide a given number of foot-candles. To design a lighting system or select bulbs to provide the recommended illumination level, you must know the area to be covered, the lumen rating of the bulb, and the coefficient of utilization (CU). The CU accounts for the amount of light that actually reaches and reflects from the work surface or floor. A good guideline is to use 0.5 for CU. Example 1 shows how to calculate the required lumens per bulb for an existing system. Example 2 shows how to calculate the number of bulbs required in a new system.



Example 1 (existing system): A swine nursery currently uses incandescent lights. There is one light fixture for every 10' x 10' pen. What size compact fluorescent light (CFL) is needed to provide 5 fc (lumens/square foot)?

$$\frac{\text{Desired illumination (fc)} \times \text{area per bulb (sf)}}{\text{CU}} = \text{lumens/bulb}$$

$$\frac{5 \text{ fc} \times (10' \times 10')}{0.5} = 1,000 \text{ lumens/bulb}$$

A 1,000 lumen CFL would provide 5 fc when it is first installed. Over time it will produce less light, and accumulated dirt also will reduce the effective output.

Example 2 (new system): A new calf housing barn is being constructed and it is decided to use 24 Watt T8 fluorescent light bulbs with an output of 1,400 lumens to achieve a light level of 10 fc. How many double fixtures will be needed if the barn is 40' x 100'?

$$\frac{\text{Desired illumination (fc)} \times \text{total area (sf)}}{\text{lumens/bulb} \times \text{CU}} = \text{no. of bulbs}$$

$$\frac{10 \text{ fc} \times (40' \times 100')}{1,400 \text{ lumens/bulb} \times 0.5} = 57 \text{ bulbs or } 29 \text{ double fixtures}$$

This could be calculated using various bulb choices to come up with the optimal selection. The fixtures would be spaced evenly to provide full light coverage.

Table 1. Recommended minimum lighting levels for various facilities and applications.¹

Usage	Minimum Light Level (fc) ²
Swine	
Breeding/Gilts	15
Gestation	5
Farrowing	10
Nursery	5
Grower - Finisher	5
Poultry	
Broilers (0 - 2.5 weeks)	1 - 3
Broilers (2.5 to market)	0.5 - 2
Layers (0 to 6 weeks)	1 - 3
Layers (6 to mature)	0.5 - 1
Turkeys (0 - 8 weeks, hens)	3 - 5
Turkeys (grow out hens)	3 - 5
Turkeys (0 - 8 weeks, toms)	3 - 5
Turkeys (grow out toms)	1 - 3
Cattle	
Lactating dairy (freestall barn)	20 - 30
Dry cows	5 - 10
Milking parlor	20
Holding area	3
Cow udder	40 - 50
Calf housing and veal	10 - 20
General Use	
Office	50
Office task lighting	75 - 100
Machinery storage	3
Shop machinery repair	50
Shop rough benchwork	50
Shop detailed benchwork	100

¹ Adapted from "Agricultural Wiring Handbook". 15th Edition, 2009. Rural Electricity Resource Council and "Wiring Handbook for Rural Facilities". 3rd Edition, 2006. Midwest Plan Service.

² In lumens/square foot; photoperiod for livestock and poultry can influence production efficiency.



Cost Comparison

A cost comparison of lighting systems should include initial cost, operational cost, and bulb life. Bulb life is difficult to fully assess due to the shortened life that most bulbs will experience as a result of exposure to moisture, dust, and heat in livestock and poultry buildings. The example below shows a simple cost comparison. As a conservative estimate, the rated life was reduced by 50%. In addition there may be expenses associated with bulb disposal or recycling. Only incandescent bulbs should be discarded without recycling.

Example: A livestock facility currently is equipped with 100 W incandescent bulbs. Lights are used 8 hours per day, every day (2,920 hrs/yr). Compare the costs of replacing these bulbs with 23 W CFLs that produce roughly the same light output.

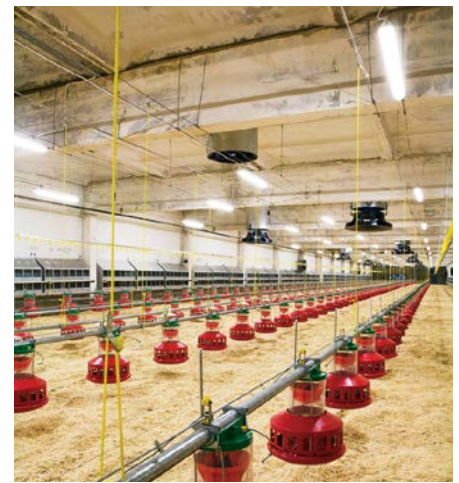
Type of Lamp	CFL	Incandescent
Input Wattage	23 W	100 W
Lumen Output	1,600 lm	1,580 lm
Efficiency	69.5 lm/W	15.8 lm/W
Hours	2,920 hrs/yr	2,920 hrs/yr
Energy Use	67.2 kWh	292 kWh
Utility Cost	\$0.10/kWh	\$0.10/kWh
Energy Cost/yr	\$6.72	\$29.20
Rated Lamp Life	12,000 hrs	1,500 hrs
Assumed Life ¹	6,000 hrs	750 hrs
Bulbs/yr ²	0.49 bulbs/yr	3.9 bulbs/yr
Cost per bulb	\$3.19	\$0.45
Bulb cost/yr	\$1.56	\$1.75
Annual Operating Cost ³	\$8.28/fixture/yr	\$30.95/fixture/yr
Savings	\$22.67/fixture/yr	
Payback ⁴	0.14 yrs or 1.7 mo	

¹ Actual life varies from rated life based on exposure to dust, heat and moisture; 50% is a conservative estimate.

² Bulbs/yr = hours/yr ÷ assumed life

³ Annual operating cost = energy cost/yr + bulb cost/yr

⁴ Payback = cost per bulb ÷ savings



Summary

Several lighting types are suitable for providing efficient lighting to indoor agricultural applications. The impact of dust and humidity on some lighting types make them less practical; they will have a shorter life in livestock and poultry housing than when used in cleaner facilities such as shops or offices. Lamps should provide adequate lighting to meet basic needs of the activities within the facility in a safe manner. When examining the cost, include up-front cost as well as operational costs. Appropriate disposal measures should be considered.

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