

Managing Light in Dairy Barns for Increased Milk Production

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Milk production can be increased by managing dairy cows' exposure to light. *Photoperiod* is defined as the duration of light exposure within a 24-hour period. A long-day photoperiod (LDPP) means exposure to 16–18 hours of continuous light followed by 6–8 hours of continuous darkness. A short-day photoperiod (SDPP) is defined as continuous exposure to 8 hours of light followed by a continuous 16-hour period of darkness. In practice, SDPP is anything less than 12–13 hours of light.

Lactating cows exposed to LDPP consistently show an 8–10 percent increase in milk production (on average, 5 lb milk/cow/day) regardless of their original production level. The LDPP should begin immediately after calving, and the increased milk production becomes fully apparent 3–4 weeks later.

Additionally, cows exposed to SDPP during the dry period produce more milk than do those exposed to LDPP during the dry period when both groups are exposed to natural photoperiod during the subsequent lactation. The SDPP during the dry period “resets” the cow's sensitivity to longer photoperiods in the subsequent lactation.

Photoperiod does not significantly influence protein, lactose, fat, or total solids concentration in milk.

How the photoperiod response works

Light reception occurs in the eye's retina. Light inhibits an enzyme used in melatonin synthesis in the pineal gland. Thus, as photoperiod increases, the duration of high levels of melatonin in the blood decreases. Melatonin concentration in the blood influences the concentration of some hormones in the blood, for example, insulin-like growth factor-1 (IGF-1). Scientists believe changes in the concentration of IGF-1 play a role in the effect of photoperiod on milk production, as IGF-1 has been shown to increase milk yield.



Light in dairy barns can be manipulated to increase milk production. The key is to provide lactating cows with exposure to 16–18 hours of continuous light followed by 6–8 hours of continuous darkness.

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The dark period is needed to cue relative day length and maintain the photoperiodic effects. Constant exposure to light does not cause the desired response.

Designing and operating a lighting system

Light intensity is measured in footcandles (FC) and lux (lx). One FC = 10.8 lx. For the “light” period, light intensity should be at least 15 FC at a height of 3 feet from the stall floor. Keep the barn as dark as possible during the “dark” period—no more than 1 FC. It is not necessary to leave a night-light on, as cows are able to find water and feed in the dark. If cows must be observed or moved during the dark period, use low-intensity red lights (7.5W bulbs at 20- to 30-ft intervals).

Metal halide (MH) or high-pressure sodium (HPS) lights are two energy-efficient ways to light freestall barns. HPS lights cost more, but have lower operation and maintenance costs and a 10 percent longer life.

Light must be distributed evenly throughout the barn, avoiding “spotlighting” and dark corners. Placing fixtures at an appropriate height can help achieve uniform distribution. Mounting height typically is 14–35 feet, depending on wattage. As mounting height decreases, more fixtures of lower wattage are required to minimize spotlighting and dark areas. Spacing of lights typically is 1.5 times the mounting height. See Table 1.

To calculate the number of lights required for a barn, use the following formula:

$$\text{Number of fixtures required} = \frac{\text{Square footage of barn} \times 15 \text{ FC} \times K}{\text{Lumen output per lamp}}$$

- 15 FC (footcandles) is the minimum intensity required for the light period.
- The K is a constant that accounts for light reflected in and escaping from the barn. Use K=2 in enclosed barns and K=3 in open-sided freestall barns.

And heifers...

Photoperiod control also can be used to improve heifer performance. Heifers exposed to long-day photoperiod (LDPP) exhibit increased growth rates, earlier puberty, and increased mammary development. Therefore, exposing heifers to the same photoperiod as lactating animals gives additional positive production responses.

For example, a 10,000-square-foot open-sided barn lit by 250-watt (20,500-lumen) metal halide lights requires 22 fixtures.

Remember that lumen output per lamp varies. Use the manufacturer’s specifications when calculating the number of fixtures.

Use a light meter to regularly test light intensity and the distribution of light in the barn. Light meters are available from electrical suppliers for \$75–125.

A photocell and timer can decrease annual energy cost and increase lamp life. Place the photocell where it is exposed to light of similar intensity as that inside the barn, such as under a side eave outside. It should not be exposed to the barn’s artificial lighting. When sunlight provides the required 15 FC, the photocell will turn off the lights. Setting the photocell with a time delay evens out the effect of the sun and clouds on barn lighting. The timer will turn the lights and photocell on and off according to preset times.

A common mistake is to place lights only above the feedbunk and not evenly throughout the entire freestall barn. A cow typically is at the feedbunk 3–4 hours per day and resting in a freestall 9–14 hours per day. If the

Table 1.—Mounting height and lamp life of various types of light fixtures.

Lamp type	Lumens	Mounting height (ft)	Lamp life (hr)
Metal halide			
250 watts	20,500	14–24	18,000
400 watts	36,000	20–35	18,000
High-pressure sodium			
250 watts	27,500	14–24	20,000
400 watts	50,000	20–35	20,000

lighting is inadequate in the freestall, where the cow spends most of her time, she will not be exposed to the required photoperiod.

It can be a challenge to provide 6 hours of uninterrupted darkness for cows milked three times per day. It might be necessary to extend the lighting system to the holding pen.

Effect of photoperiod management on profit

Using photoperiod management to increase milk production is profitable. Generally, a new lighting system will pay for itself within 6 months to 1 year, depending largely on labor cost for installation.

Increased milk production will cause increased dry matter intake (DMI). DMI will increase by approximately 1.5–2 lb per cow per day, depending on the

increase in milk production. The increase in feed costs will be significantly less than the increase in revenue from milk.

Table 2 shows expected annual profit for a typical 250-cow freestall barn across a range of milk prices. To calculate expected annual profit for your operation, use the on-line worksheet listed under “For More Information.”

For more information

The Web site <http://il-traill.outreach.uiuc.edu/photoperiod> has additional information on photoperiod, worksheets to assist producers in light design and cost analysis, and other contact information.

Additional Extension publications on dairy production are available at:

- Oregon State University—eesc.orst.edu
- Washington State University—pubs.wsu.edu
- University of Idaho—info.ag.uidaho.edu

Table 2.—Effect on profit of a photoperiod system, based on a range of milk prices.

Milk price ^a	\$14.00	\$13.00	\$12.00	\$11.00	\$10.00	Your estimate \$ _____
INCOME						
Milk response ^b	5	5	5	5	5	_____ lb
Extra milk income ^c	\$0.70	\$0.65	\$0.60	\$0.55	\$0.50	\$ _____
COSTS						
Installation ^d	\$0.03	\$0.03	\$0.03	\$0.03	\$0.03	\$ _____
Feed ^e	\$0.11	\$0.11	\$0.11	\$0.11	\$0.11	\$ _____
Electricity ^f	\$0.04	\$0.04	\$0.04	\$0.04	\$0.04	\$ _____
Total added costs	\$0.18	\$0.18	\$0.18	\$0.18	\$0.18	\$ _____
PROFIT						
Net profit	\$0.52	\$0.47	\$0.42	\$0.37	\$0.32	\$ _____
Profit/month ^g	\$3,900	\$3,525	\$3,150	\$2,775	\$2,400	\$ _____
Annual profit ^h	\$39,000	\$35,250	\$31,500	\$27,750	\$24,000	\$ _____

^aMailbox price per cwt

^bAverage response (lb) per cow per day

^cPer cow per day

^dAssume 250-watt metal halide lights, with \$135 cost per fixture, \$65 installation cost per fixture, and a 5-year useful life

^eAssume 1.8 lb increase in dry matter intake @ \$0.06/lb to support a 5-lb increase in milk production

^fElectricity to power supplemental lighting 8 hours per day

^gFor a 250-cow barn

^hAssumes response only 10 months each year

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