

## THE MANAGER

## DAIRY RESEARCH

By Jackson Wright

Evaluation of cost benefits and effective light of LED and T8 fluorescent lighting

# Lighting for Increased Milk Production

Cornell University PRO-DAIRY is conducting a study to evaluate which lighting systems have the most impact on manipulating photoperiod and milk production per cow.

The study will review the energy savings and effective light provided by LED lighting and T8 fluorescent lighting systems.

Previous research shows that lactating dairy cows exposed to 16 to 18 hours of light (long-day photoperiod or LDPP) increase milk production by approximately 5.1 pounds per cow per day. Although the mechanism behind this effect

is unclear, it is thought that LDPP suppresses the release of melatonin, which in turn increases the release of prolactin and insulin-like growth factor I. Both are associated with improved mammary function. Interestingly, this response is consistent across various levels of production and suggests that manipulating photoperiod can be a valuable management strategy for many dairy producers.

Despite these exciting findings, implementing LDPP can be challenging on commercial dairy farms because lactating cows need to be exposed to 16 to 18 hours of light, followed by 6 to 8 hours of uninterrupted darkness. Moreover, lights need to be strategically placed so that all areas of the barn achieve a minimum light level of 150 to 200 lux (or 15 to 20 foot candles) at cow level. This often requires assistance from a lighting engineer to determine if the fixtures selected can achieve the specified light levels based on size of the barn, number of fixtures, light output per fixture and mounting height.

Common light fixtures found on dairy operations are T8 fluorescent, metal halide, high pressure sodium, and, more recently, light emitting diode (LED). Each fixture has a unique set of benefits and drawbacks. For instance, fluorescent lights are energy efficient and can provide adequate light output. They are also relatively inexpensive and usually pay for themselves within two years of installation. On the other hand, fluorescent fixtures require maintenance, perform poorly under cold or hot conditions, and contain mercury which could be disastrous should a bulb break around lactating cows. High intensity discharge (HID) fixtures, such as metal halides and high pressure sodium fixtures can provide ample light at ground level when ceiling



Figure 1. A cow with a calibrated light and activity monitor (Dimesimeter; Figuero et al., 2012) attached to her right ear tag. The dimesimeter can measure light levels for a cow at eye level.

## FYI

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Figure 2. A 220W LED Luminaire installed in Barn "A". Thirty-two luminaires were installed in Barn "A" to meet the required light levels to expected to stimulate milk production according to 2012 research on photoperiod performance by Geoffrey Dahl.

heights are greater than 12 feet. However, these fixtures require a long pre-heat or start-up time. Finally, LED lights can provide high energy efficiency with a reported 100,000 hour operating life. This is significantly longer than the reported 20,000 hour operating life of fluorescent and HID fixtures. Moreover, LED lights are expected to have lower maintenance costs, contain no mercury, and provide instantaneous reliable light. However, LED fixtures are expensive compared to the other fixtures.

These unique attributes can make it confusing to select fixtures best suited for dairy operations. When considering implementing LDPP, LED fixtures may provide an edge. Consider this: lighting performance is often measured based on lumens/watt. This can be misleading for dairy producers because lumens represent effective light for the human eye. Dairy cows perceive light differently than humans, meaning a light fixture can provide ample lumens/watt, but may not provide light in the appropriate spectrum to stimulate milk yield. For instance, high pressure sodium fixtures provide high lumens/watt, however, light output from these fixtures is biased towards longer wavelengths that cows cannot perceive. Fluorescent fixtures provide ample effective light for the cow. However, under cold conditions, light output of fluorescent fixtures can decrease by more than 40%. Cold conditions are typical in most barns during winter months, precisely when supplemental lighting from light fixtures is required. LED fixtures can provide light in the same spectrum as sunlight and are more reliable under cold conditions. These two considerations suggest LED fixtures may be best suited for implementing LDPP. However, this scenario needs to be investigated under barn conditions.

In the PRO-DAIRY study, three nearly identical barns under the same management were updated with LED or T8 fluorescent fixtures. Barn "A" was updated with LED fixtures on an 18 hour lighting interval, Barn "B" was updated with T8 fixtures on an 18 hour lighting interval, and Barn "C" was updated with T8 fluorescent on a conventional lighting interval. Throughout the study PRO-DAIRY, NYSERDA and RPI Lighting Research Center will monitor milk production, energy usage and light brightness at cow eye level in each experimental barn for one year. An economic analysis will then be performed to account for the initial cost of the fixtures, fixture performance, operating life, expected energy savings, and milk production, to determine which lighting system is the most cost effective for dairy producers.

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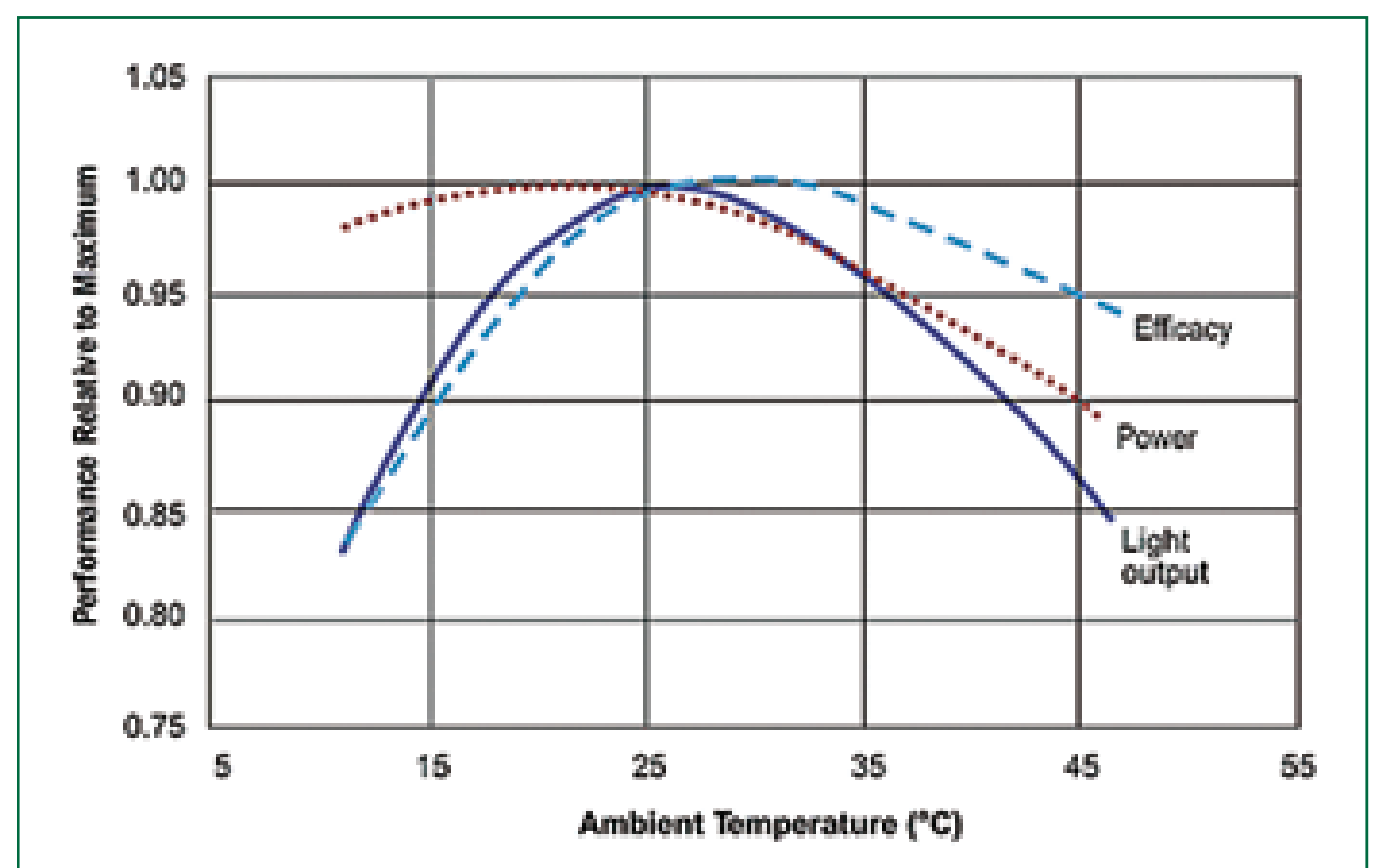


Figure 3. Temperature response characteristics of a typical fluorescent lamp (<http://www.lrc.rpi.edu/programs/nlpip/lightinganswers/hwclf/hwclf-thermal-performance1.asp>).

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