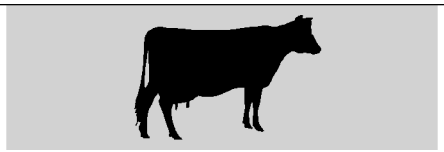
The Professional Animal Scientist 21 (2005):521–523



# CASE STUDY: Supplemental Light for Lactating Dairy Cows[1]

**M. J. VANBAALE*,[2], D. V. ARMSTRONG*, M. A. ETCHEBARNE†, PAS, R. M. MATTINGLY†, and J. B. FISCALINI†**

*Department of Animal Sciences, The University of Arizona, Tucson 85721; and †Fiscalini Dairy Farm, Modesto, CA 95358

## Abstract

*Ninety-eight multiparous and 60 primiparous Holsteins were utilized in an extended lighting trial to investigate effects of photoperiod on milk yield. After parturition, all animals were housed in one pen until 20 d in milk under normal daylight/nightlight conditions (**NL**). On d 21, animals were randomly assigned to two treatment groups receiving supplemental light (**SL**) or NL. While in freestalls, all cows in the SL groups were exposed to 17 h of natural light plus SL > 15 foot candles (FC) and 7 h of light <5 FC in the freestall area. The light exposure for the NL groups followed the normal sunrise-sunset pattern for the north 40th parallel of sunrise (0530 to 0730 h) and sunset (1700 to 1900 h), an average of 12 h of light. There was no milk production difference observed between primiparous animals assigned to SL or NL (33.0 vs 32.9 kg/d; P=0.81) treatments. However, multiparous cows in SL groups produced more milk (50.2 kg/d) than the multiparous groups on the NL treatments (46.6 kg/d). Exposure to increased lighting enhanced milk production in multiparous cows but had no effect on primiparous animals. Feed intakes were similar for the multiparous animal groups exposed to increased day length. Because no physiological measurements were obtained, the causes of the increase in milk yield are not known, but increased lighting is an effective management practice that can be used to improve milk production on high-producing dairy herds in the San Joaquin Valley of California.*

(Key Words: Photoperiod, Dairy Cattle, Supplemental Light.)

## Introduction

Long-day photoperiod (**LDPP**, 16 to 18 h of light) is galactopoietic in dairy cows and has been shown to increase milk yield by 6.5% in dairy cows (Dahl et al., 1997, 2000). Studies involving lactating dairy cows exposed to extended light have shown that manipulation of the daily light-dark cycle increased milk yield by 2 to 3 kg/d, and there was little or no change in milk composition. A daily lighting regimen of 16 h of light, 8 h of darkness (16L:8D) increased milk yield 8 to 10% in Holstein cattle compared with production of cows exposed to natural Michigan winter photoperiods of 9 to 12 h of light/d (Peters et al., 1978, 1981). Photoperiod has been used successfully by a number of producers. However, the endocrine mechanism underlying this response is not known.

There does not appear to be a stage of lactation effect in response to LDPP, and there is no evidence that LDPP alters mammary growth during lactation or pregnancy. The increase in milk yield caused by LDPP has been shown to be additive to increased milk yields because of exogenous bovine somatotropin and increased milking frequency (Miller et al., 1999). Furthermore, studies evaluating effects of LDPP during the dry period on milk yield in subsequent lactations do not show any positive effects of LDPP. On the contrary, Komaragiri et al. (1997) and Aharoni et al. (2000) reported that short-day photoperiod treatment of pregnant cows resulted in greater milk yield in the subsequent lactation, thus indicating that manipulation of light exposure has potential for increasing milk yield in cattle. The objective of our study was to determine whether LDPP was an effective management practice that could be used to increase milk production on a high-producing dairy herd in the San Joaquin Valley of California.

## Materials and Methods

Ninety-eight multiparous and 60 primiparous Holstein animals were utilized in an extended lighting trial to investigate the effect of photoperiod on milk yield. After parturition, all animals were housed in one pen until 20 d in milk under normal day-

[1]This work was partially supported by the University of Arizona Experiment Station #AZRT-137024-R-24-132.

[2]To whom correspondence should be addressed: vanbaale@ag.arizona.edu

**TABLE 1. Ingredient and nutrient composition of experimental diets.**

| Item | Mature cows | First lactation |
|---|---|---|
| Ingredient | (% of DM) | |
| Corn silage | 22.7 | 21.1 |
| Flaked corn | 12.2 | 11.5 |
| Flaked barley | 5.2 | 4.9 |
| Canola meal | 13.5 | 14.1 |
| Whole cottonseed | 9.7 | 10.1 |
| Alfalfa hay | 8.9 | 8.7 |
| Soy hulls | 6.8 | 7.1 |
| Almond hulls | 6.1 | 6.3 |
| Wheat millrun | 3.32 | 3.5 |
| Beef tallow | 1.0 | 1.0 |
| Sudan grass | 4.3 | 4.5 |
| Molasses (21% CP) | 1.4 | 1.5 |
| Trace mineral/vitamin premix[a] | 2.5 | 2.6 |
| Blood meal | 2.0 | 2.1 |
| Megalac®[b] | 0.7 | 1.0 |
| Nutrient | | |
| DM, % | 60.9 | 62.3 |
| CP, % | 17.5 | 17.8 |
| Rumen undegradable protein, % of CP | 35.5 | 35.5 |
| $NE_L$, Mcal/kg | 1.7 | 1.7 |
| Fat, % | 5.8 | 6.2 |
| NDF, % | 36.9 | 36.9 |
| ADF, % | 24.4 | 24.5 |
| Nonstructural carbohydrates | 33.2 | 32.7 |

[a]The composition of the trace mineral/vitamin premix is made up of the following percentages of each ingredient: ≥33.3 $CaCO_3$, 17.9 $NaHCO_3$, 8.1 $KCO_3$, 34.729 NaCl, 5.6 MgO, 0.12 Fe, 0.04 Cu, 0.25 Zn, 0.004 I, 0.006 Co, and 0.001 Se. Contributed 7.0 KIU of vitamin A, 1.1 KIU of vitamin D, and 18.7 IU of vitamin E/kg of diet DM. Ration provided by M. A. Etchebarne, Dairy Nutritionist, Modesto, CA.

[b]Arm & Hammer Animal Nutrition Group (Princeton, NJ).

light/nightlight conditions (NL). On d 21, animals were randomly assigned to two treatment groups receiving supplemental light (SL) or NL. Diets for both treatments were balanced for 52 kg of milk/d, and cows were fed a total mixed ration to provide 100% of the nutrient requirements of dairy cattle (NRC, 2001) daily at 0600 and 1600 h (Table 1).

There were two groups of 49 multiparous and two groups of 30 primiparous animals assigned to SL or NL. While in freestalls, both multiparous and primiparous cows in the SL groups were exposed to 17 h of natural light and SL >15 foot candles (FC) and 7 h of light <5 FC in the freestall area. The light exposure for the NL groups followed the normal sunrise-sunset pattern common for the north 40th parallel of sunrise (0530 to 0730 h) and sunset (1700 to 1900 h), an average of 12 h of light and darkness. Light intensity was measured every 2 wk at 2200 to 2300 h at two points in the freestall barn (feed manger and outside lane at animal head level) and in the milking parlor holding pen (front, middle, and back). The freestall barns were 31.7 m wide and 274 m long, providing 13.7 $m^2$ per cow.

**Measurements.** Daily milk weights were measured electronically by DeLaval computer software (DeLaval, Inc., Madison, WI) for each cow's milking throughout the 305-d lactation. Monthly milk composition analysis was by the Dairy Herd Improvement Association (Provo, UT.) Pen DMI was monitored and recorded using EZFEED™ Feed Management Software (Valley Agricultural Software, Tulare, CA). Total mixed ration samples were obtained, and wet chemistry analyses were conducted by the DHI New York Laboratory (Ithaca).

**Statistical Analysis.** Data were analyzed using PROC MIXED procedures of SAS® (SAS Inst., Inc., Cary, NC). Previous 305-d mature equivalent milk yields were included as a covariate in the analysis for multiparous cows. Daily milk yields were collapsed into weekly averages. Depen-

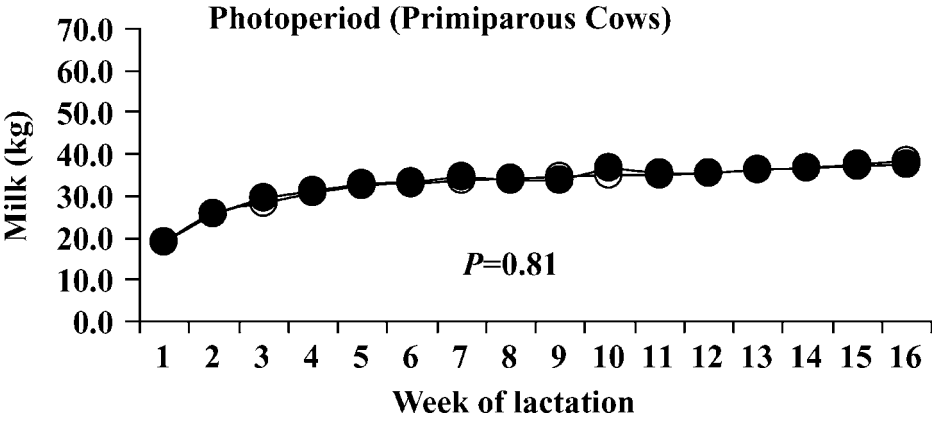



*Figure 1. Effect of photoperiod on milk yield of primiparous dairy cows. Solid symbols = extended light; open symbols = no light.*

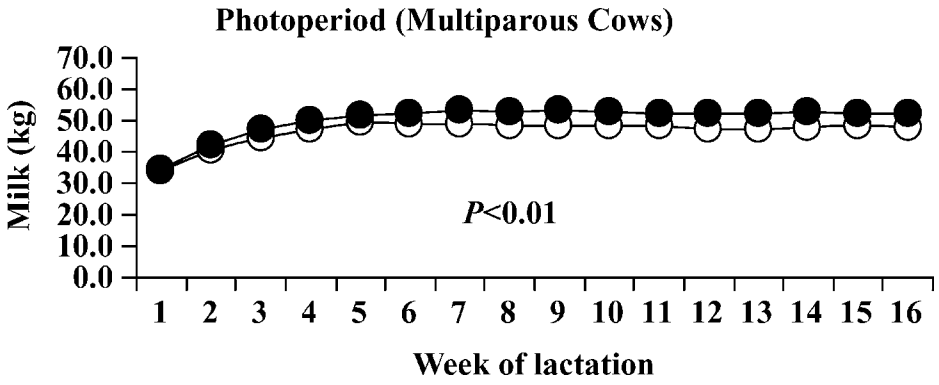



*Figure 2. Effect of photoperiod on milk yield of multiparous dairy cows. Solid symbols = extended light; open symbols = no light.*

dent variables tested were individual cow milk yield and pen DMI. The independent variables for milk yield and DMI included treatment, time, and the respective interactions. Time (week of study) was fit as a repeated measure, and treatment means were separated using the probability of a statistical difference (PDIFF) option for all.

## Results and Discussion

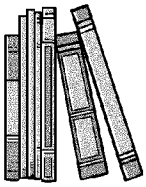
There was no milk yield difference ($P$=0.81) between primiparous animals assigned to SL (33.0 kg/d) or NL (32.9 kg/d) treatments (Figure 1). Multiparous cows in SL groups produced more ($P$<0.01) milk (50.2 kg/d) than the multiparous groups on the NL treatments 46.6 kg/d (Figure 2). Average pen DMI for multiparous (29.3 *vs* 28.4 kg/d) and primiparous (23.4 *vs* 22.4 kg/d) animals exposed to SL or NL were not measurably different. The 3.6-kg production response observed in multiparous cows is consistent with other researchers (Peters et al., 1978, 1981; Dahl et al., 2000) who reported greater milk yields from cows exposed to increased lighting regimens. The increase observed in the current study is most likely not attributed to the slight increase in DMI. However, because milk was measured on individual cows while DMI was measured on a pen basis, the effects of DMI are not possible to elucidate from the current study.

## Implications

Exposure to increased lighting enhanced milk production in multiparous cows but had no effect on primiparous animals. Intakes were similar for the multiparous animal groups exposed to increased day length; however, milk yield was improved. Because no physiological measurements were obtained, it is not known what contributed to the increase in milk yield, but increased lighting is an effective management practice that can be used to improve milk production on high-producing dairy herds in the San Joaquin Valley of California.

## Acknowledgments

The authors thank J. Fiscalini for allowing us to conduct this study and R. Mattingly for his help with the trial.



## Literature Cited

Aharoni, Y., A. Brosh, and E. Ezra. 2000. Short communication: Prepartum photoperiod effect on milk yield and compostion in dairy cows. J. Dairy Sci. 83:2779.

Dahl, G. E., T. H. Elasser, A. V. Capuco, R. A. Erdman, and R. R. Peters. 1997. Effects of a long daily photoperiod on milk yield and circulating concentrations of insulin-like growth factor-I. J. Dairy Sci. 80:2784.

Dahl, G. E., B. A. Buchanan, and H. A. Tucker. 2000. Photoperiodic effects on dairy cattle: A review. J. Dairy Sci. 83:885.

Komaragiri, M. V. S., and R. A. Erdman. 1997. Factors effecting body tissue mobilization in early lactation dairy cows. 1. Effects of dietary protein mobilization of body fat and protein. J. Dairy Sci. 80:929.

Miller, A. R. E., E. P. Stanisiewski, R. A. Erdman, L. W. Douglas, and G. E. Dahl. 1999. Effects of long daily photoperiod and bovine somatotropin (Trobest®) on milk yield in cows. J. Dairy Sci. 82:1716.

NRC. 2001. Nutrient Requirements of Dairy Cattle. (7th Rev. Ed.). Natl. Acad. Sci., Washington, DC.

Peters, R. R., L. T. Chapin, R. S. Emery, and H. A. Tucker. 1981. Milk yield, feed intake, prolactin, growth hormone and glucocorticoid response of cows to supplemental light. J. Dairy Sci. 64:1671.

Peters, R. R., L. T. Chapin, K. B. Leining, and H. A. Tucker. 1978. Supplemental lighting stimulates growth and lactation in cattle. Science 199:911.