Lighting effects in dairy cow housing

- **Reference information from Wilson Agriculture Ltd.**

Key points:

According to research, optimum photoperiod will increase milk yield by **6-10%** on average

- Eventually, cows increase feed intake to support the risen milk yield.
- No effect on protein or solids content while only a very limited decrease in fat content.
- The increase in milk yield amply compensates the effects on fat and feed intake.

Why is there an effect?

Light reception occurs in the eyes retina. Light inhibits an enzyme used in melatonin synthesis in the pineal gland. Therefore, 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.

Why is Wilson Agriculture concerned with this?

- The use of light is cost-effective and has a very short pay-back time.
- Very simple to carry out.
- No extra labor required.
- Improved production and therefore margins on the units we work with.

Requirements for lighting:

For milking cows, calves and heifers

16 hour long day photoperiod; 150-200 lx at the eye level of the cow

8 hour of uninterrupted darkness means less than 5 lx at the eye level of the cow

Dry period

8 hours long at less than 5lx.

16 hours of 150-200 lx

[this will reset the long-day photoperiod and improve the immunity system]

5lx means that you can still see a printed text.

Red night lights may be used to facilitate cow movement and observation during darkness

The intensity of red light has no (or only minor) effects on the cows' perception of darkness, and thus melatonin secretion.

There should be no brighter lights in any part of the barn and cows need 2-4 weeks on average to adjust.

Calculating your lighting requirements:

For accurate calculation, please consult with a qualified electrician. If you want to calculate this yourself here are the details:

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 cubicle bed. Keep the barn as dark as possible during the dark period no more than 1 FC. For night time lighting and for observing 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 cubicle buildings. 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.

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

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

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

- FC (footcandles) is the minimum intensity required for the light period (usually 15 to 20).
- 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 cubicle buildings.

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.

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 feed passage and not evenly throughout the entire cubicle building. A cow typically is at the feed barrier 3-4 hours per day and resting in a cubicle 12-16+ hours per day. If the lighting is inadequate in the cubicle, 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.

Glossary of terms and further notes:

Lux (lx): a metric unit of measure for luminance of a surface. One lux is equal to one lumen per square meter and equals 0.0929 foot candela.

Foot candela (fc): amount of light received by 1 square foot of a surface that is 1 foot from a source of light that is equivalent to one candle.

Lumen (lm): unit of light flow, the measure of the total light output of the light emitter. Eg: a lamp (energy of 1/683 joules per second, measured at a wavelength of 555 nanometers)

LDPP = Long Day Photo Period
SDPP = Short Day Photo Period

A sunny day will produce 100,000 lx.

As lamps age and become dirty, their lumen output decreases.

Most lamp ratings are based on initial lumens (new)

Cows will not ‘see’ the difference!

Different lights for different groups (calving cows, claves, dry cows, milking cows).

Choose the most economical option (cost of changing broken lamps need to be taken into consideration).

Lights need to be easy to change.

Use natural light as well and avoid shadowing elements.

Data on Watt only provides information on how much electricity the lamp will use, but not on the amount of light it will emit.

Type of light source	**Technical aspects**	**Advantages**	**Disadvantages**
Light bulb	10-15 Lumen² per watt	Low cost	Short life expectancy
Neon	Life expectancy: 8000 – 10000 hours; production 60-85 lumen/watt depending on type	Low investment. White light fast glow	Effected by temperature
Sodium vapor lamp	Life expectancy: 24000 hours with 10% reduction of light emission after 10000 hours	Yellow light	Not liked by every customer
High pressure sodium lamps	Life expectancy: 24000 hours with 10-15% reduction of light emission after 10000 hours. Producing 132 lumen per watt	Yellow light	Not liked by every customer
Metal Halide lamps	Life expectancy: 10000 hours with 15-30% reduction of light emission after 10000 hours. 95 lumen per watt	White light which may be a personal preference	Expensive

Further reading and resources:

Ontario - Ministry of Agriculture, Food and Rural Affairs
http://www.omafra.gov.on.ca/english/livestock/dairy/facts/info_photoperiod.htm

Oregon State University:
http://extension.oregonstate.edu/catalog/html/pnw/pnw551/

http://www.milkproduction.com/Library/Articles/Light.htm