Use of Light Levels and Patterns in Dairy Management

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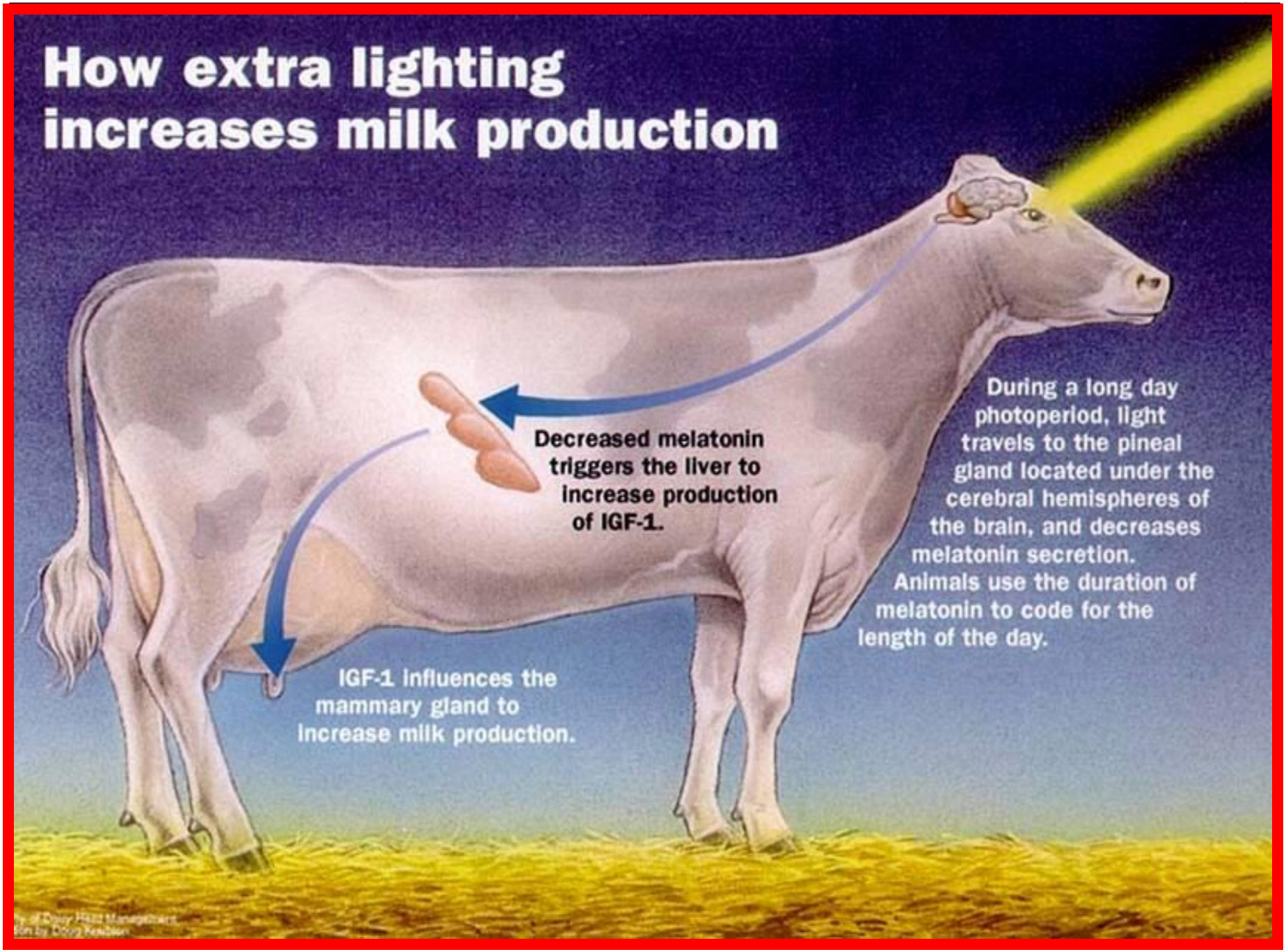
Why is Light Management Important?

- Increase milk production 2-4 kg/d and feed efficiency in cows and heifers
- Increase growth, advance puberty and mammary gland development in heifers
- Improve reproduction (return to first estrus)
- Increase income per cow per year
  a. Long photoperiod for herd +$150
  b. Short photoperiod during dry period +$130
- Conserve energy where applicable


How extra lighting increases milk production
During a long day photoperiod, light travels to the pineal gland located under the cerebral hemispheres of the brain, and decreases melatonin secretion. Animals use the duration of melatonin to code for the length of the day.
Decreased melatonin triggers the liver to increase production of IGF-1.
IGF-1 influences the mammary gland to increase milk production.

How do dairy cattle respond to light?

- Light that enters the eye stimulates a gland in the brain called the Pineal Gland
- The Pineal Gland is an internal clock
- The Pineal Gland is sensitive to the length of the light stimulation called photoperiod
- The Pineal Gland is also sensitive to the light intensity

Photoperiod

- Is defined as the length of light and dark periods each day (long or short days)
- Long photoperiod is typically 16 hours Light and 8 hours Dark (16h L : 8h D) (Summer)
- Short photoperiod is typically 8h L: 16h D (Winter)

Light intensity

- Light intensity (the amount of light) is measured in lumens per square foot or meter
- Foot candle (fc) is a measure of the number of lumens per square foot
- Lux is a measure of the number of lumens per square meter
- One fc = 10.76 Lux

Recommended light intensities in foot candles (fc) at 3 feet off the floor

Freestall feeding, resting, traffic areas		20
Milking parlour:	general	20
	pit	50
Milk room:	general	20
	wash up	100
	bulk tank	100
Utility		20
Office		50
Perceived as dark by cows		1
Enough light to read ear tags		

Types of lamps

- Incandescent standard and tungsten – least energy efficient and short life; good for short periods and frequent on-off
- Fluorescent
  T12 older 1.5” tube - energy inefficient
  T8 1” tube recommended; 30% more energy efficient; produces 5x more light than incandescents; ceilings less than 10 ft
- Pulse start metal halide; high efficiency; best for ceilings over 10 ft high

How to use photoperiod management?

- Lactating cows and heifers and growing heifers on long photoperiod (16 - 18 h light each day) **20** fc uniformly distributed over the feed, resting and corridor areas; many barns are only at 5 fc!
- All cows and heifers MUST have at least 6-8 hours of UNINTERRUPTED dark meaning less than 1 fc or absolute dark with use of low intensity red light 7.5 Watts at 20-30 ft intervals
- Use timers and photosensors for outside light
- It will take 4 weeks to notice difference

24 hour lights on??

- No benefit, likely detrimental and higher cost
- Cows and heifers can not set their internal clock as there is no day-night cycle
- Literature suggests that animals revert to short day type cycle with lower milk production or there is no effect
- 24h light is considered stressful for poultry

Lactating cows and heifers: Impact of on milk production and composition?

- Long days (16h L : 8h D)
- Increased milk yield 2-3 kg/d, regardless of stage of lactation
- No change in milk composition or SCC
- Cows eat more to support higher milk production
- Cows and heifers consistently respond at all production levels – takes about 4 weeks
- Works with 2x or 3x per day milking

Return on photoperiod control

- Ontario Dairy Symposium 7
- 2 L/d yield increase (low end)
- Net return $0.43 per cow/d or $107.50/d for a 250 cow free stall barn
- Net farm income/year increased $32,250
- Pay-off time capital costs – 270 days
- http://www.omafra.gov.on.ca/english/livestock/dairy/facts/info_photoperiod.htm

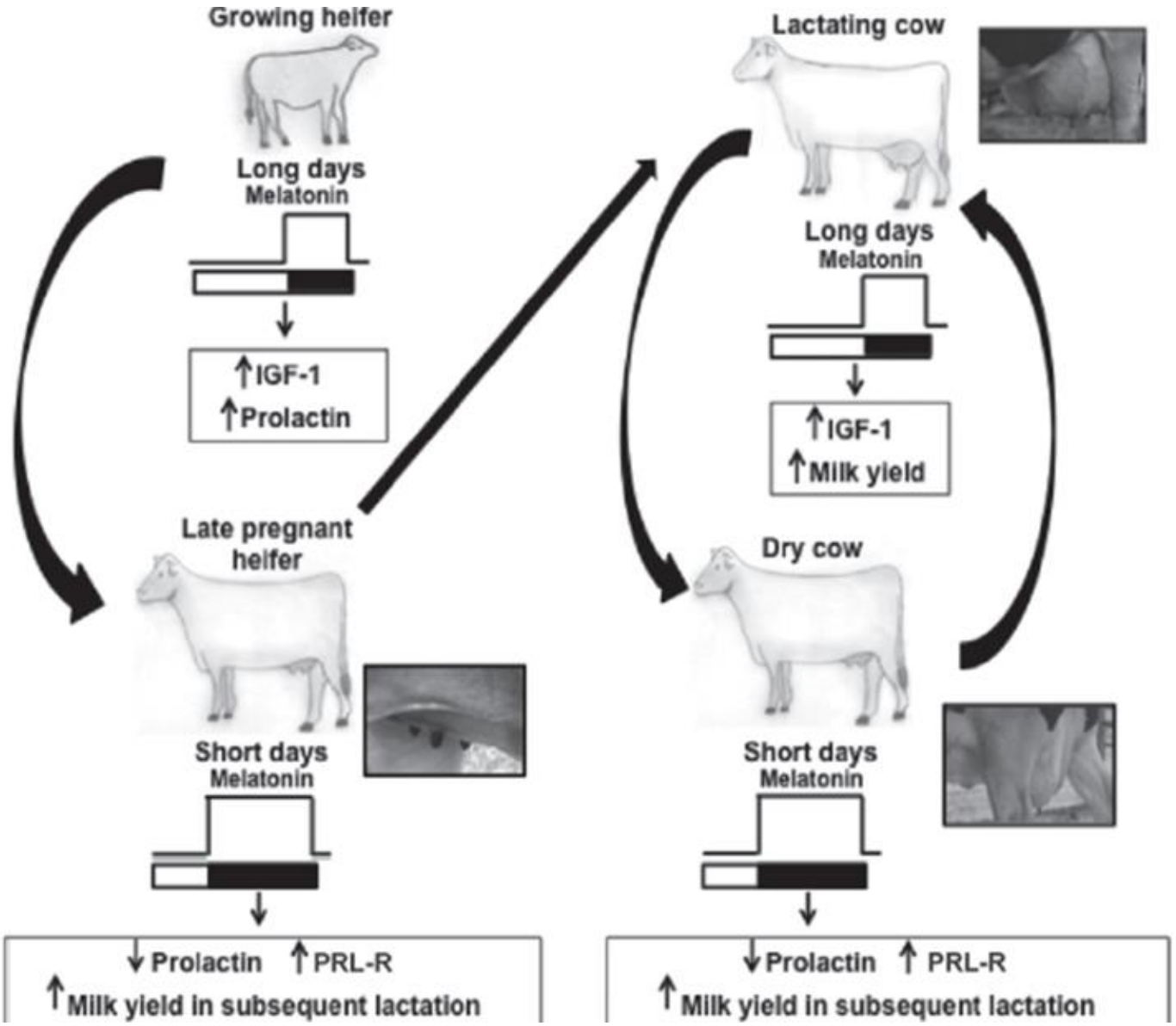
Dry cows and close-up heifers: Short photoperiod management

- Why? Increases milk production 3-4 kg/d for the subsequent lactation
- **Use short day photoperiod** 8h L : 16 h D during the dry period in cows or during close-up in heifers
- The minimum required period prior to calving is unknown but likely 2-3 weeks
- **At calving switch to long day photoperiod** 16 h L : 8 h D
- Facilities for dry cows and close-up heifers must be separate from main herd for dark photoperiod control – building alteration cost (summer black out problem)

Mechanism of action of photoperiod effect?

- Long days in Lactation:
  - Indirectly the pineal gland through various effects stimulates the udder to increase milk production capacity and metabolic activity; cows and heifers eat more in response
- Short days in Dry Period and Close-up:
  - During short days the udder is being primed (low blood PRL →increased # of PRL receptors). With switch to long days at calving the PRL surge will bind to more PRL receptors for greater biological effect and increased milk output

Photoperiod management options for heifers and lactating cows (Dahl et al. 2012).



Calculations

- Total lumens needed

  = [area (sq ft of barn) x (20 foot candles that is needed) x barn constant (2 or 3)]

  Barn constant = 3 for open-sided or curtain-sided barn and = 2 for barn with walls that reflect light

- Total number of fixtures needed

  = (total lumens needed/lamp lumens)

Calculations Barn Example

- 56x112 ft open-sided free stall barn
- Total lumens needed = (6272 x 20 x 3) = 376,320 lumens
- Total number of metal halide fixtures @ 20,500 lumens per 250 Watt fixture = (376,320/20,500) = 18 fixtures evenly spaced

Metal halide lamp lumen output per Watt

- 400 Watts - 36,000 lumens
- 250 Watts - 20,500 lumens
- 150 Watts - 16,000 lumens

Lamp Height?

Typical Mounting Heights and Horizontal Separation Distances to produce 20 fc

T8, 32 W	7-8 ft high	10-16 ft apart
Metal Halide		
175 W	11-14 ft high	24-28 ft apart
250 W*	14-24 ft high	24-30 ft apart
400 W*	20-35 ft high	25-40 ft apart

Literature consulted

- University of Illinois DairyNet:
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  - G. Dahl. Photoperiod management of dairy cattle.
  - J. Rodenburg. Responding to the practical implications of dry cow photoperiod research
- Manitoba Hydro Power Smart Profiles. July 2004. Agricultural Buildings. Dairy producers switching to Power Smart lighting
- MWPS-MidWest Plan Service. 2000. Dairy Housing and Equipment Systems, Lighting, Chapter 10 pp 141-146, Iowa State University
- Dahl, G.E., Tao, S., and Thompson, I.M. 2012. Journal of Animal Science 90:755-760