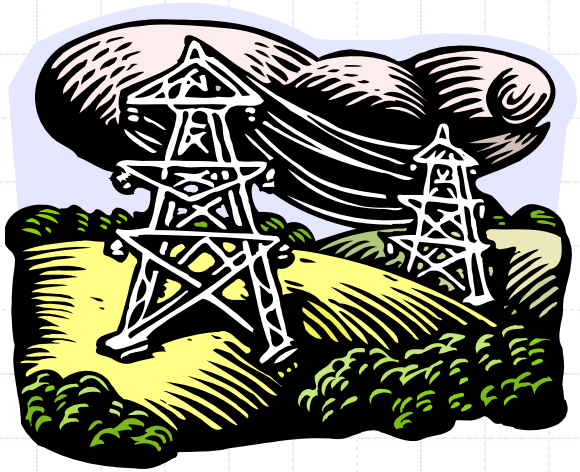
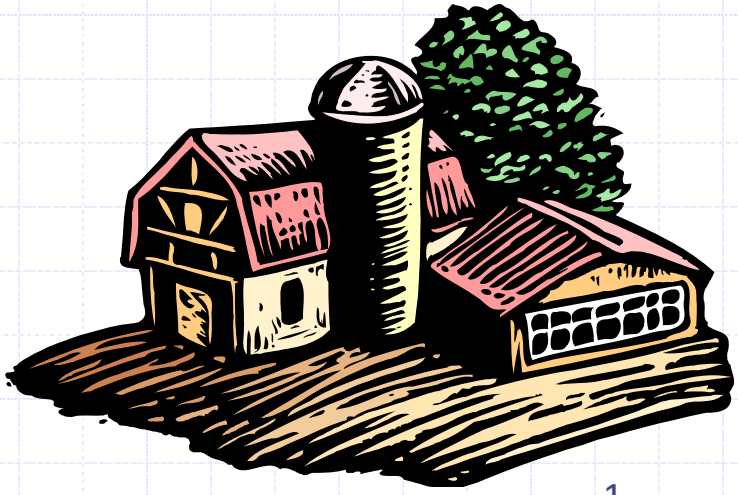
Capturing Energy Efficiencies and Their By-Products on Dairy Farms

Leo Timms

Dairy Extension Specialist

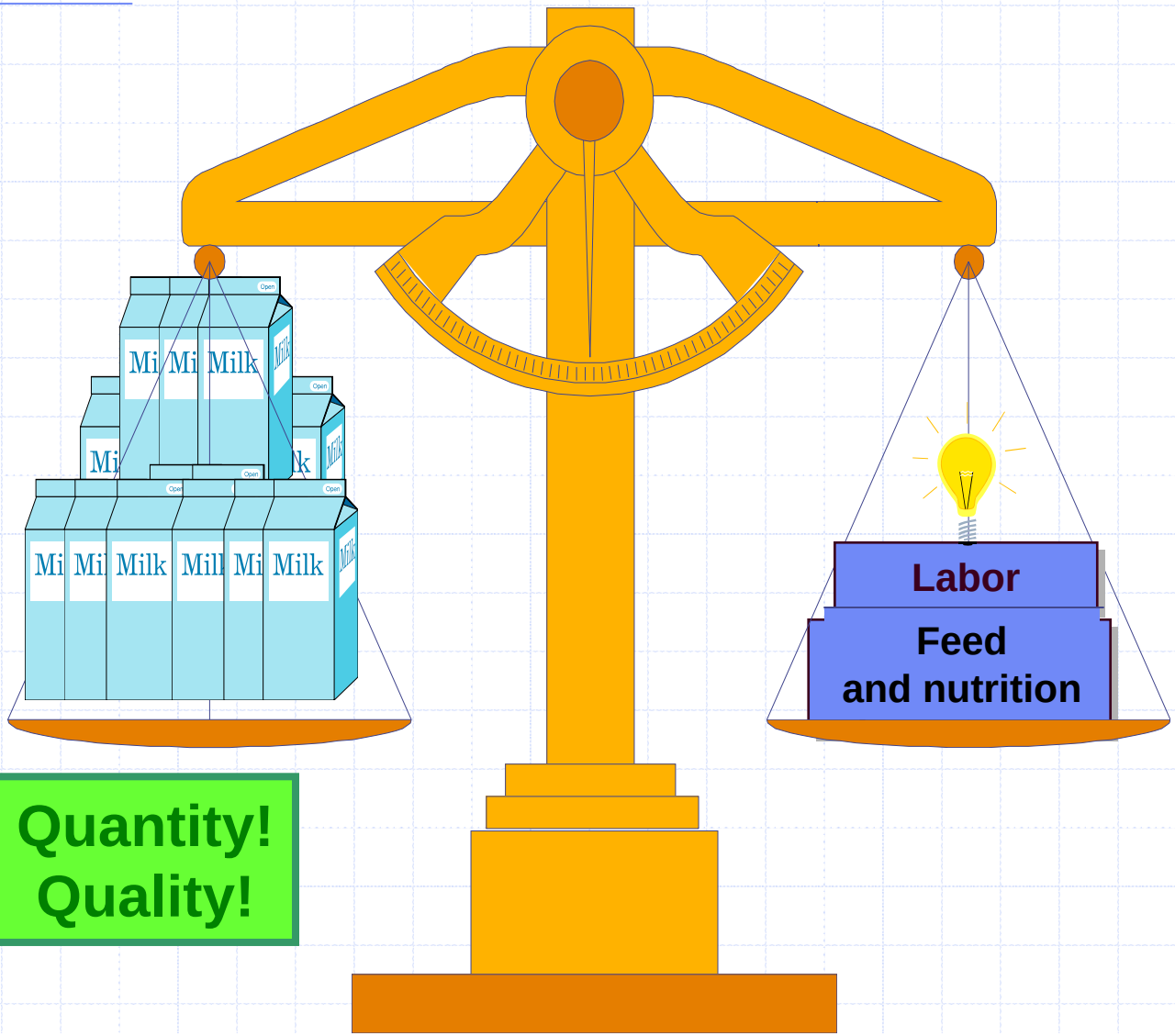
Iowa State University - Ames



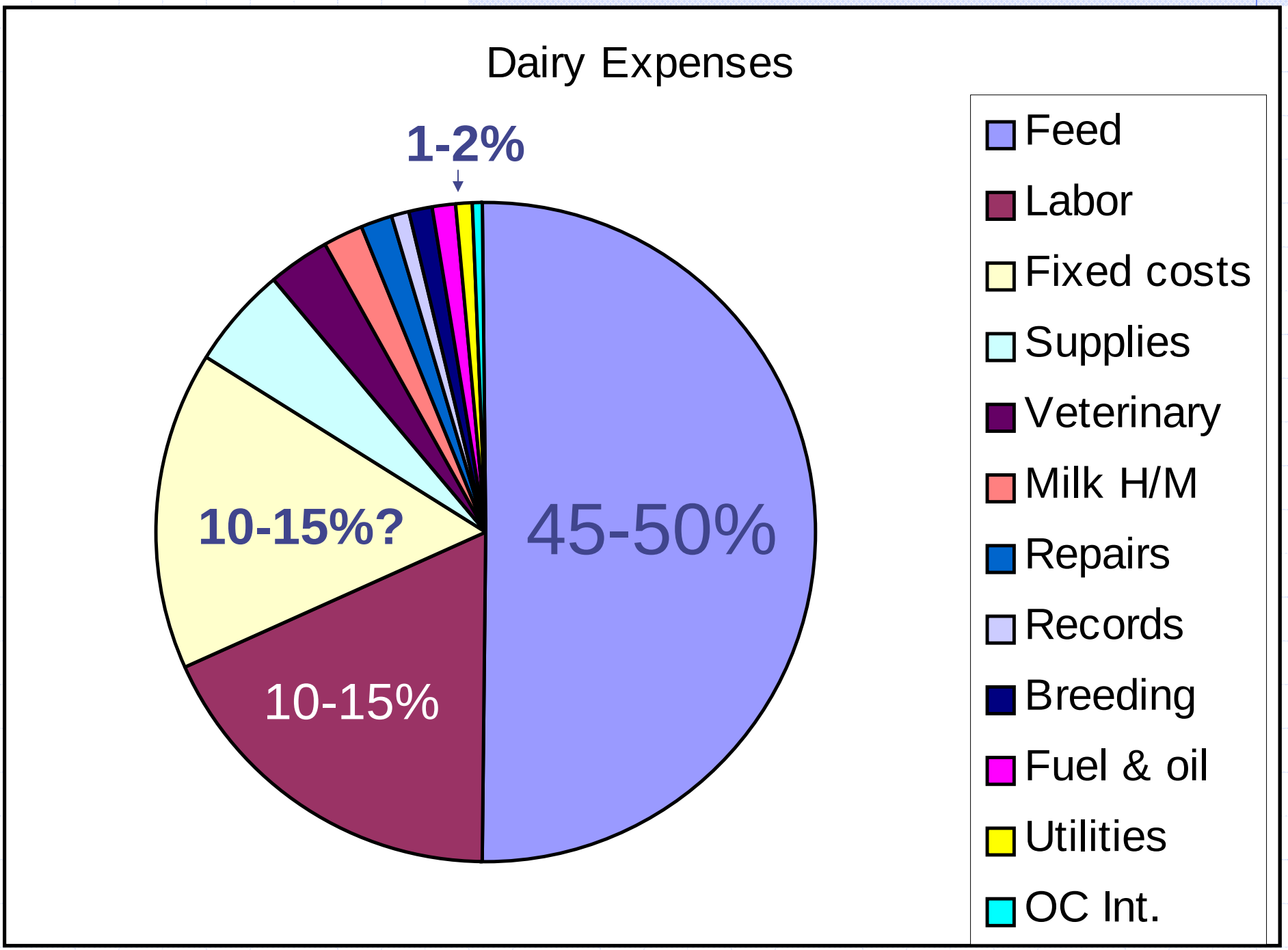


INCOME

EXPENSES

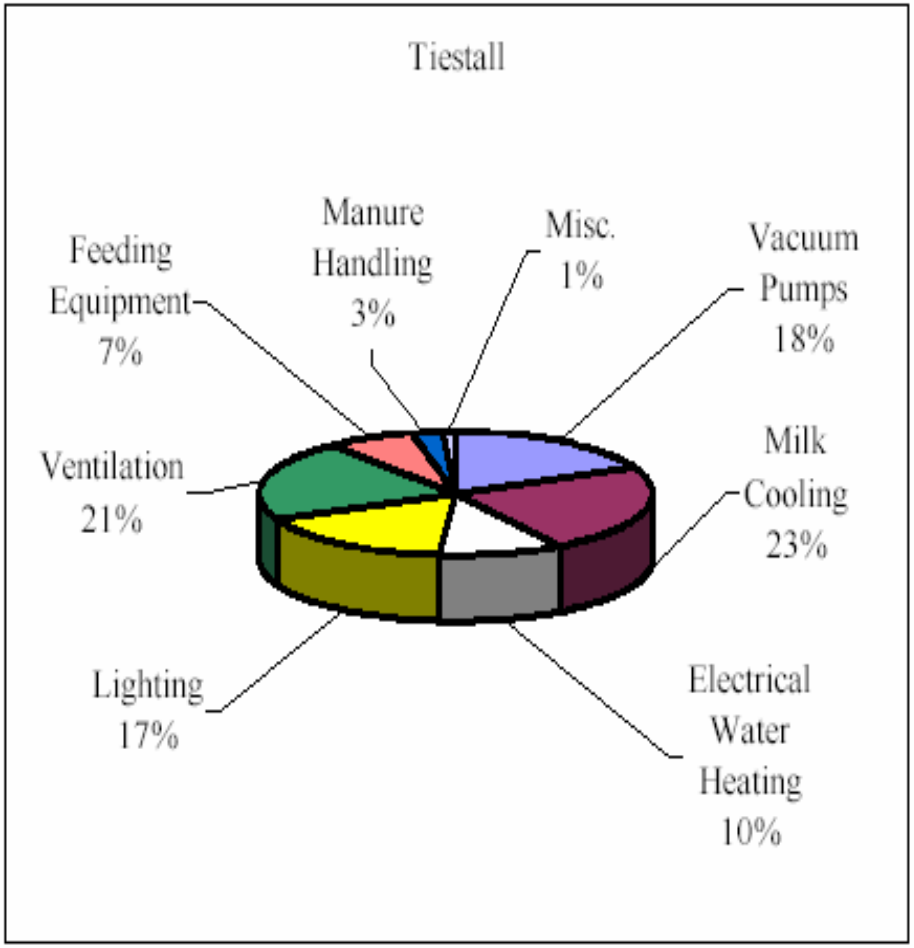


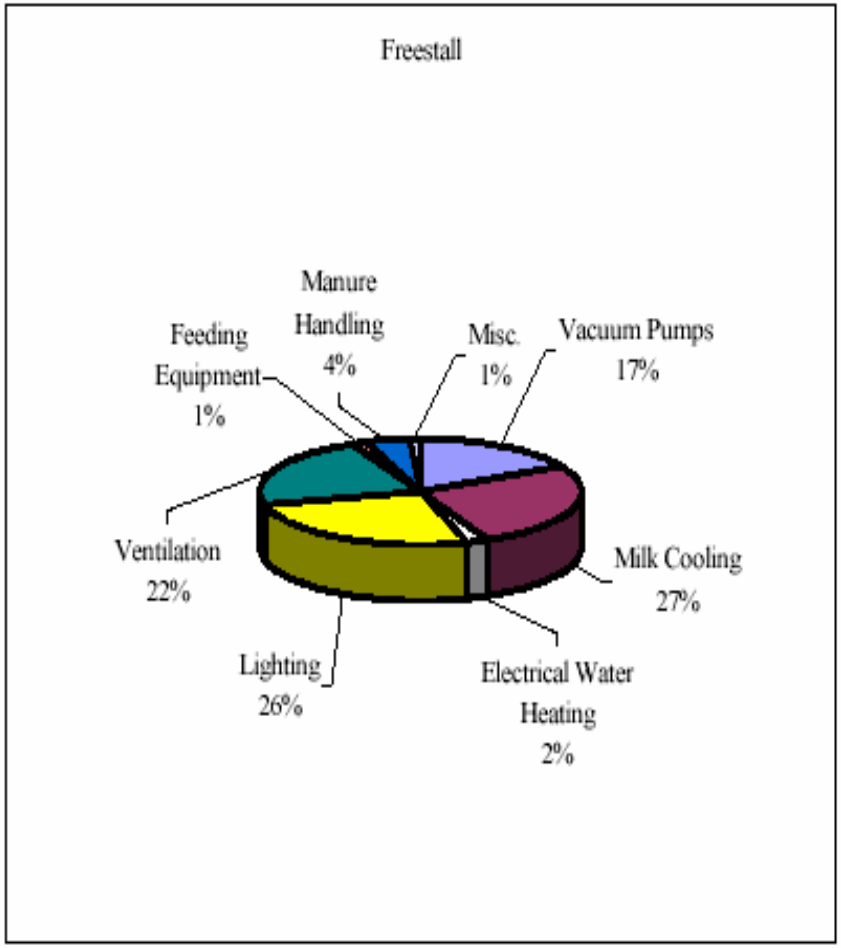
Quantity!
Quality!


Dairy Expenses
1-2%
10-15%?
45-50%
10-15%
Feed
Labor
Fixed costs
Supplies
Veterinary
Milk H/M
Repairs
Records
Breeding
Fuel & oil
Utilities
OC Int.

THE MANY FACES OF THE IOWA DAIRY INDUSTRY

NYS Dairy Farm Survey





Source: Dairy Farm Energy Audit Summary, NYSERDA, July 2003

Energy Conservation ***By-Products*** in Dairies

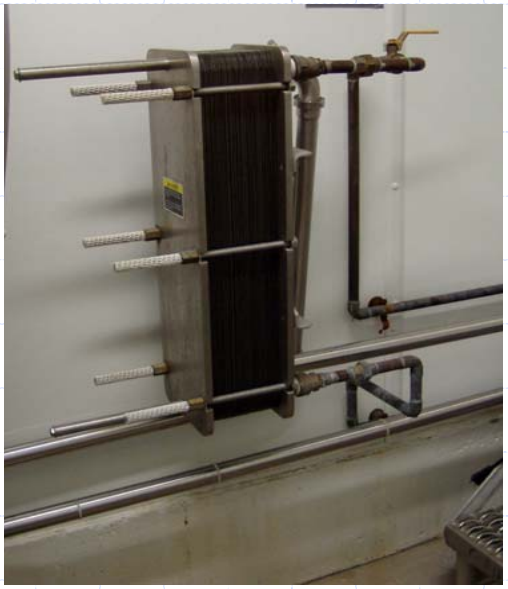
- Refrigeration
- Vacuum systems
- Water Heating
- Ventilation
- Lighting
- Water Fountains

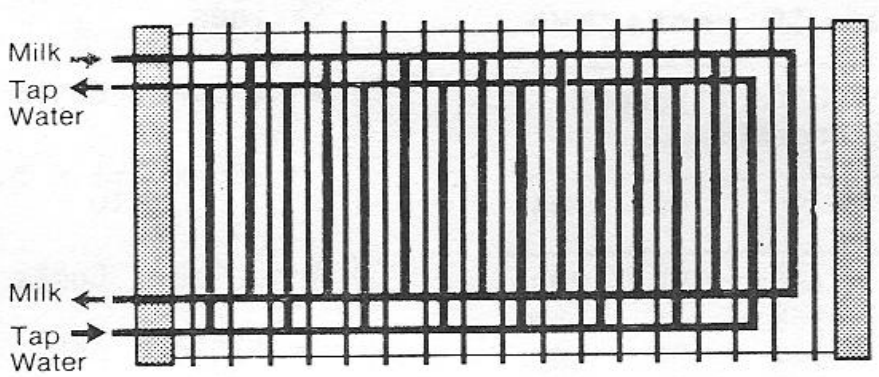
Pasteurized Milk Ordinance (PMO)

- Milk Regulatory “Bible”
- Milk cooled to $\leq 50^0$F $\leq$ 4 hr. after first milking starts in tank
- Milk cooled to $\leq 45^0$F 2 hr. post milking
- Blend temperatures $\leq 50^0$F on subsequent milkings

Well Water Precoolers

- Well Water Precooler
  - Potential to reduce cooling requirements by 60%
- Variable speed milk pump
  - Typical 15°F increase in milk cooling

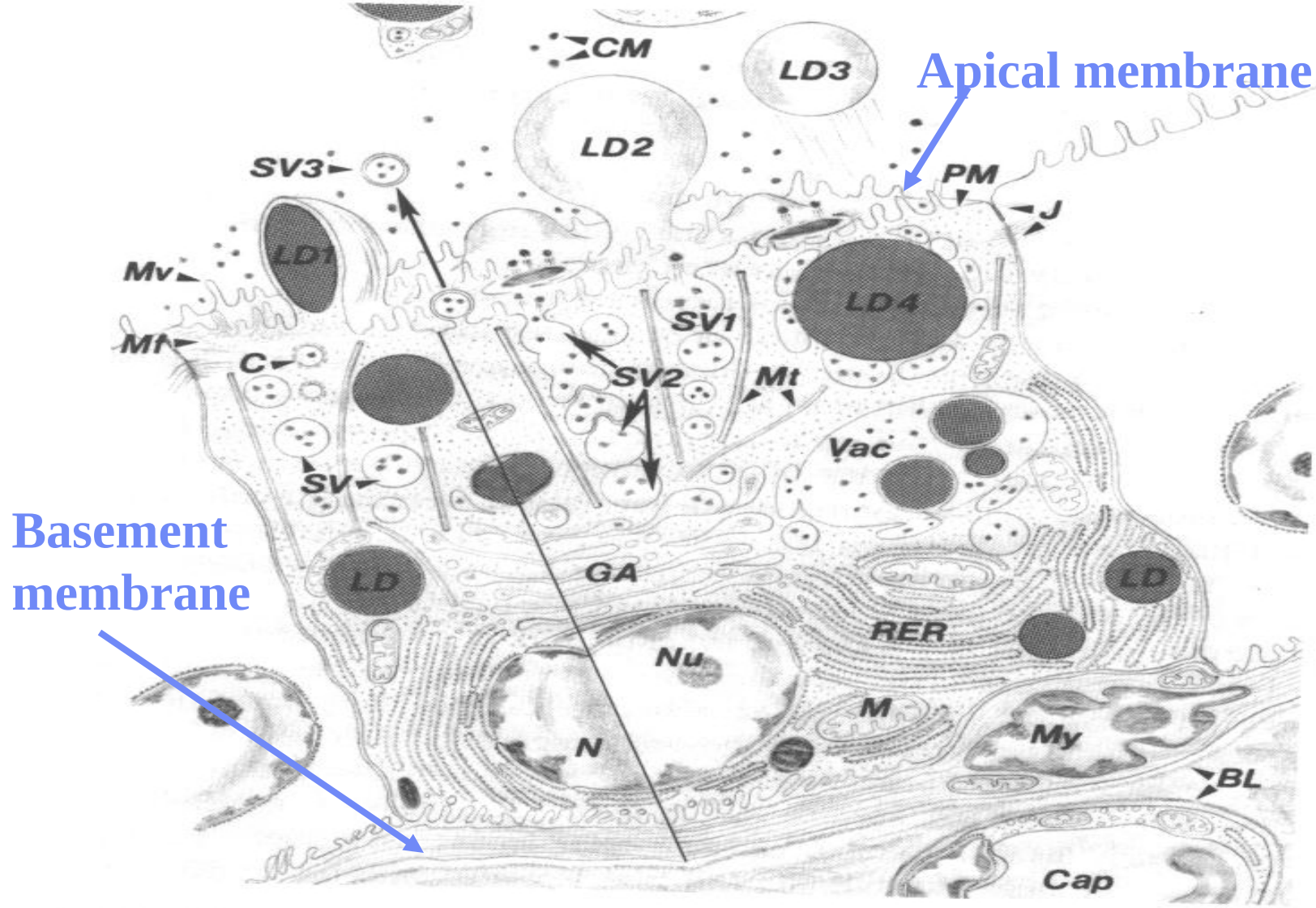




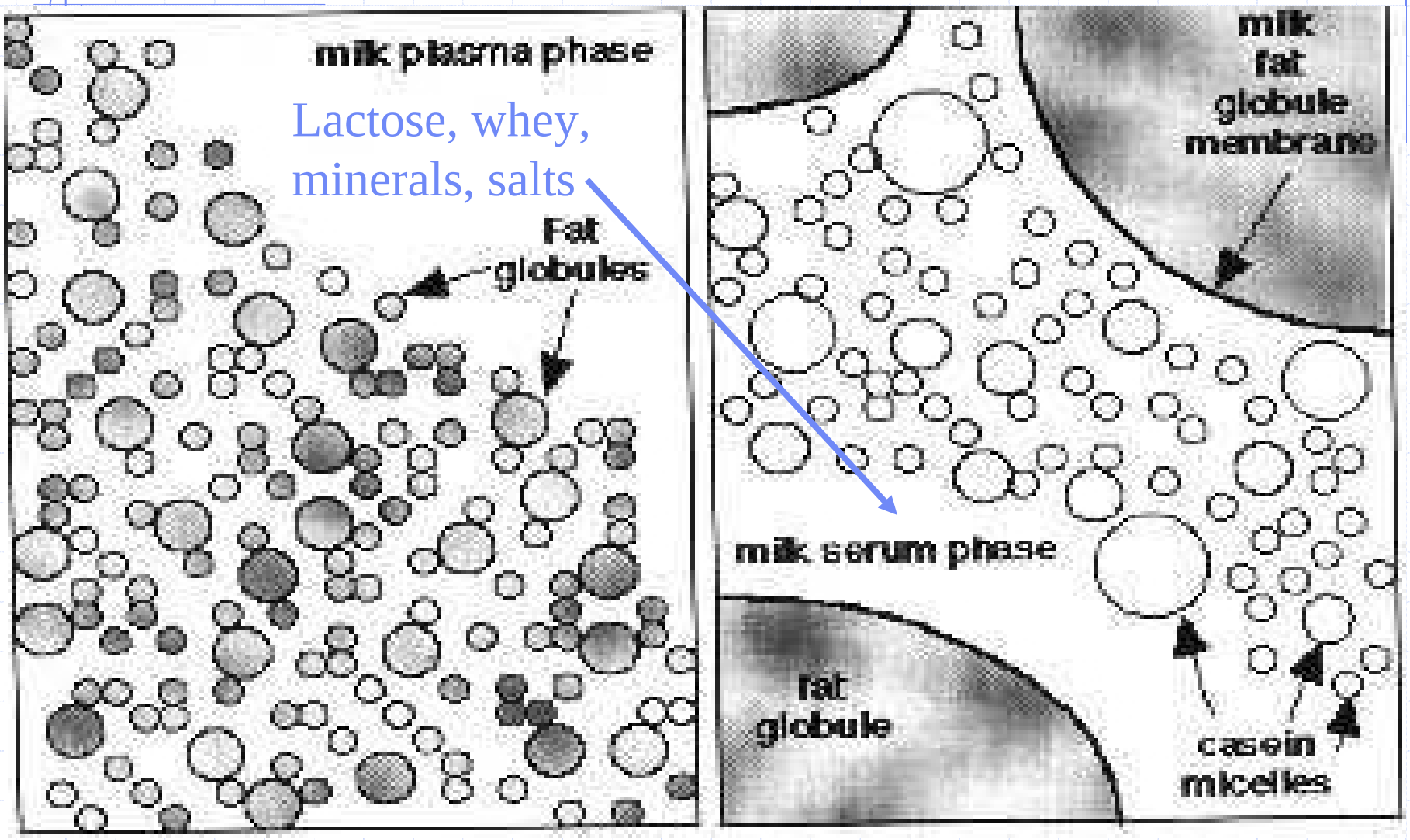
Well Water Precoolers By-Products

- Decreased milk temp.
  - Potential to:
  - Reduce bacteria
  - Enhance product quality
  - Enhance shelf life
  - Increase price!!!
- Decreased agitation
  - Enhanced flavor
  - Increased fat test?
  - Fat = $1.20 - $2.00/lb

MILK COMPOSITION



MILK COMPOSITION



Well Water Precoolers By-Products

- **Increased warm water**
  - Cows drinking is primary water use!
  - Cows drink a lot of water (20-50 gal)
  - Cows prefer warm water, especially during summer.
  - Milk = 87% water
  - Water = $$$$$$

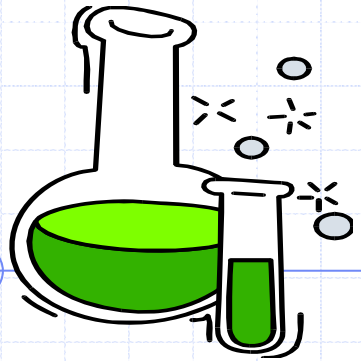
Variable Speed Vacuum Pump

- Typically reduces VP electrical usage by 60%.
  - Ranges from 30 to 80%.
  - Reduce oil use / emission
- High initial costs!
- Must have appropriate size!
- By Products???

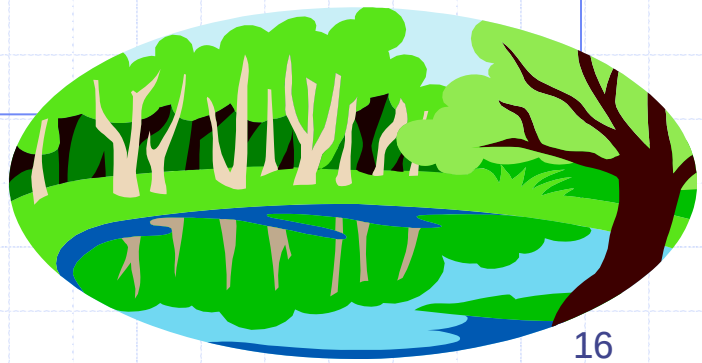
Water Heating – Cleaning Milking Systems

- Pasteurized Milk Ordinance
  - System “cleaned” after each use
  - System sanitized before each use
- Milk = multiple cleaning steps
  - Warm water rinse – remove 99% milk solids
  - Alkaline wash 160 – 120^{0}F (fat and protein)
  - Acid rinse 90 - 110^{0}F (minerals, neutralize Alk.)
  - Acid sanitize before milking!
- Uses warm / hot water: vacuum pumps/system

Water Heating – Cleaning Milking Systems



Sofi-Clean Wash Recovery System



Wash Recovery – What Is It?

- Simply stated, we use this system to recover the wash and sanitation solutions for re-use on the next wash cycle.
- Objective is for the farm to:
  - Save on water usage.
  - Save on energy usage (water heaters and vacuum pump.
  - Save on chemicals (re-use the bulk of the detergents.
  - Save on time (fewer steps in each wash and sanitation cycles).

The Basic System

- Two tanks for holding wash solutions between milkings
- One is used to recover the sanitizer.
- The other is used to recover the detergent solution.

Field Trial

- This concept has been successfully used in dairy plants for many years.
- Some unique characteristics on farms (under vacuum, lower temperatures, etc.).
- We installed this system on one farm near Pine Island, MN for about 5 months to monitor performance.

Basic dimensions:

- 3’ wide X 5’6” tall X 6’ deep (front to back)
- 30-gallon capacity tanks.
- Larger systems would be marginally larger to accommodate larger volume tanks.

The Results

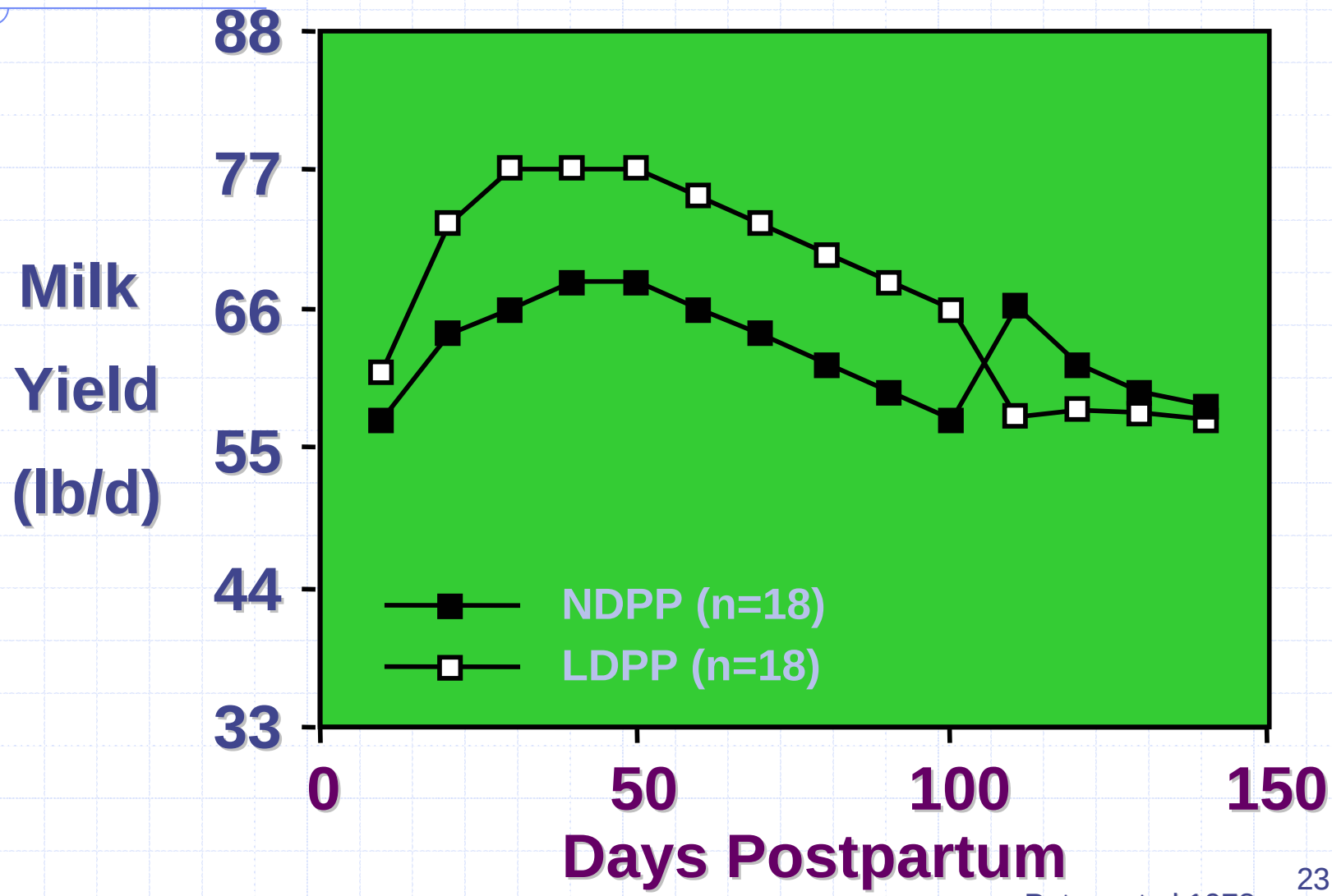
- Some modifications occurred during the test period but results were very good (milk quality).
- We monitored the following utilities to measure savings at the farm:
  - Water usage: 112 gallons/wash cycle in standard wash, vs. 30 gallons using Sofi-Clean.
  - Electrical usage: savings of 1059 kwh over the previous year (same period). (4% decrease)
  - Time savings: 75 minutes/wash cycle in standard wash, vs. 41 minutes when using Sofi-Clean.
  - Less chemicals: lower expenses (by-product)

Less water volume = less manure storage / costs

Lighting

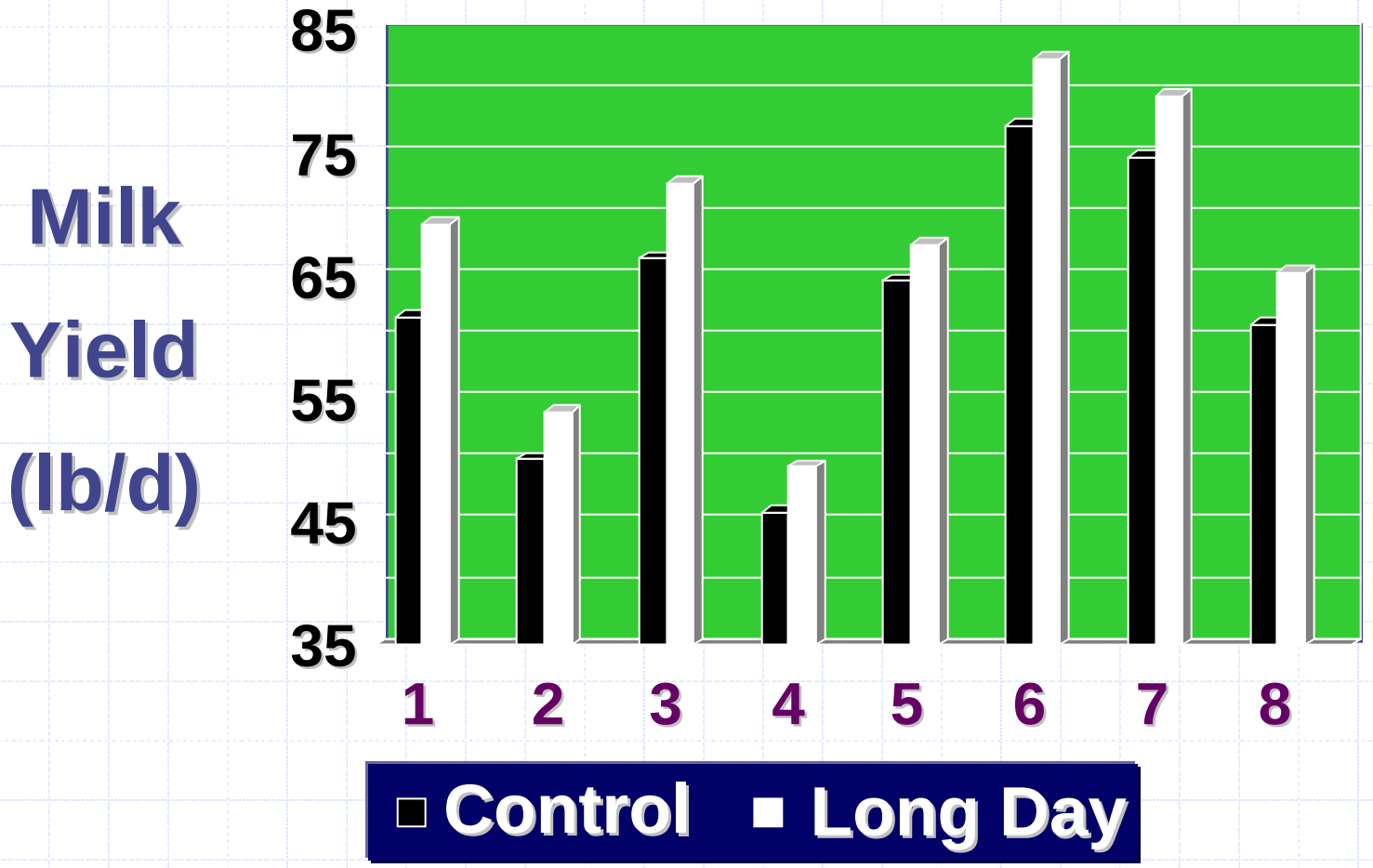
- High-efficiency lighting
  - Compact Fluorescent Lamps (CFL)
    - Cold starting to 0°F
    - Direct replacement for Incandescent bulbs
  - T-8 Fluorescent (1” diameter)
    - cold starting to 0°F
    - No Flicker
  - High Pressure Sodium – highest efficiency
  - Pulse Start Metal Halide
    - good color rendering
- Proper fixture types –
  - Moisture Resistant Rated for dairy barns

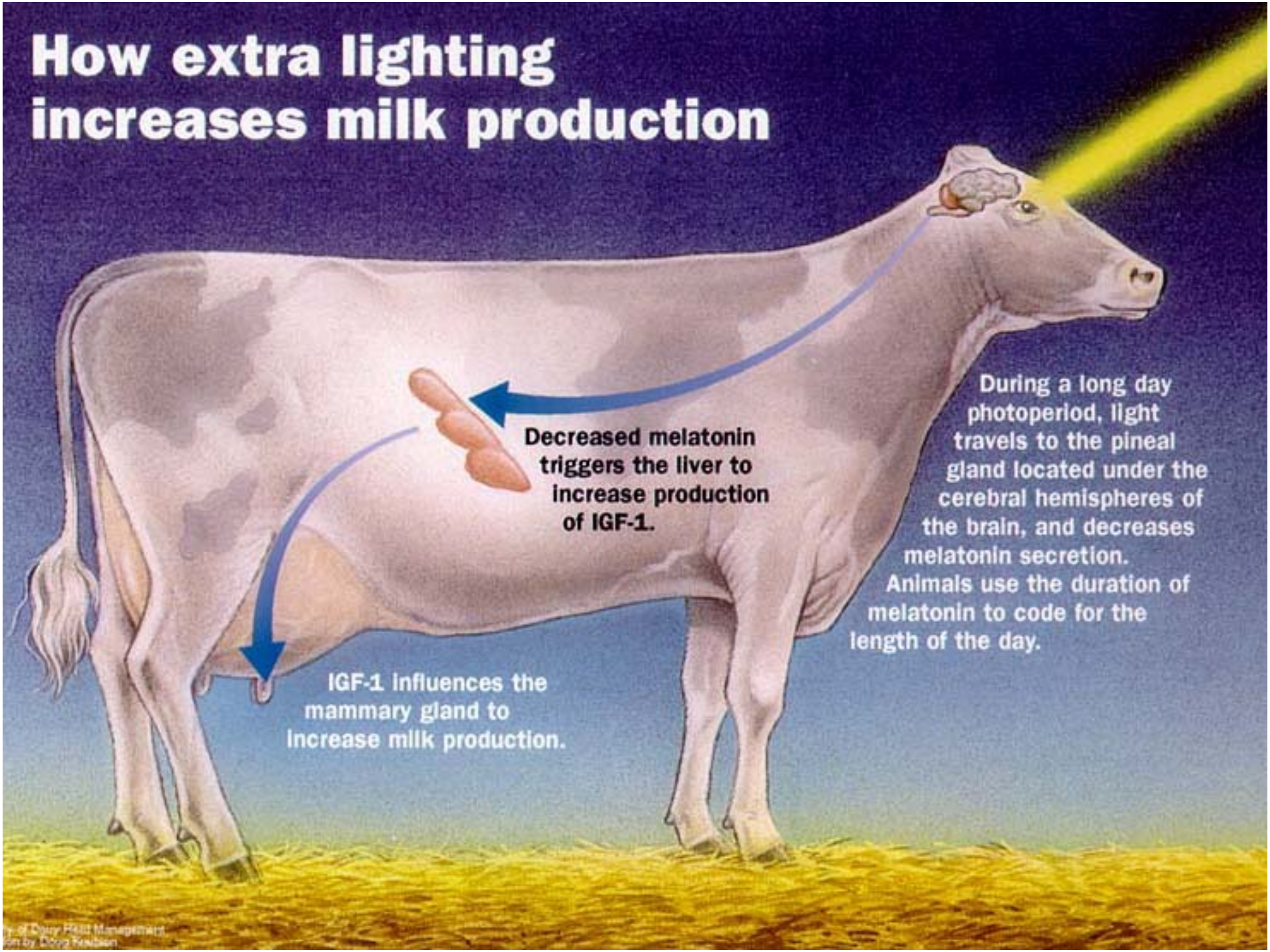
Long Days Increase Milk



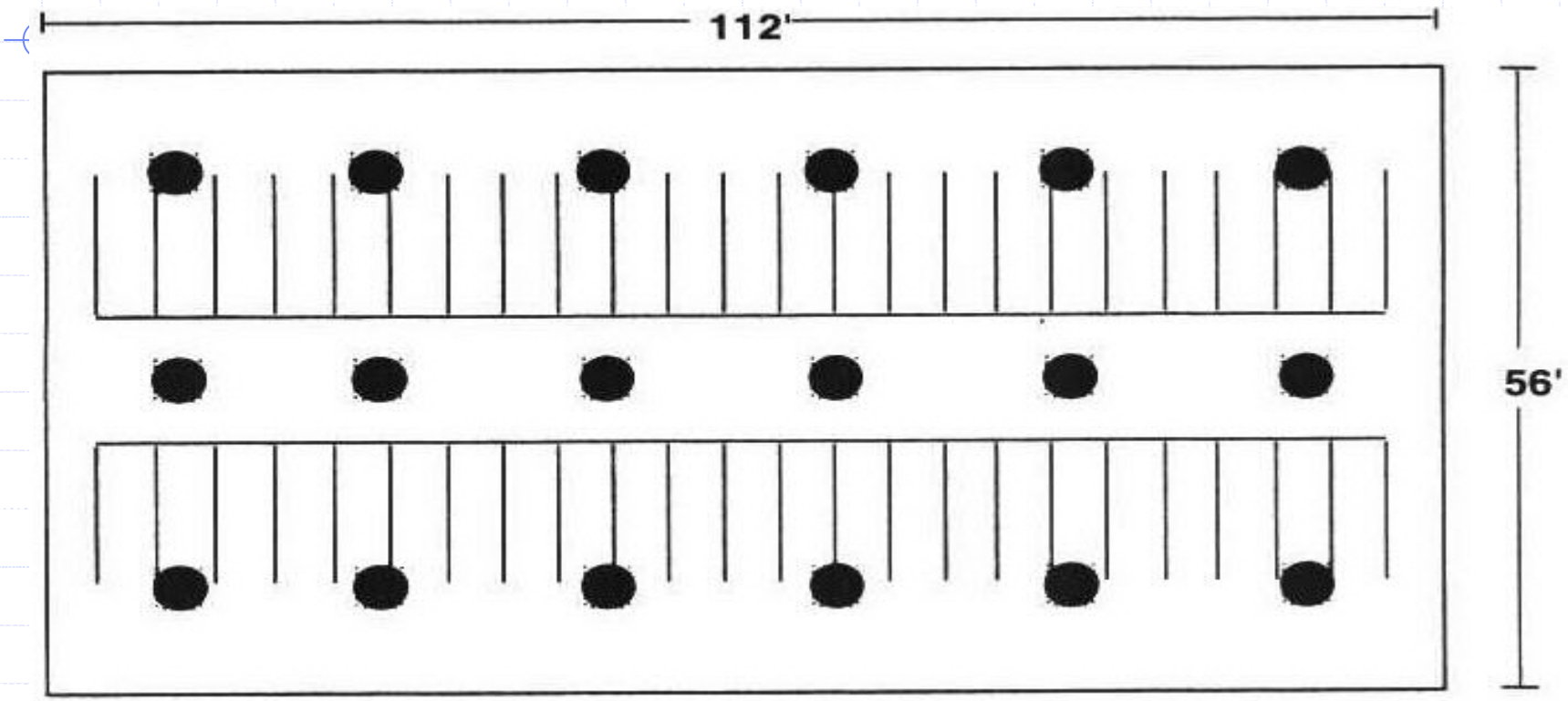
Peters et al 1978

Summary of Milk Yield 8 Studies




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 to....

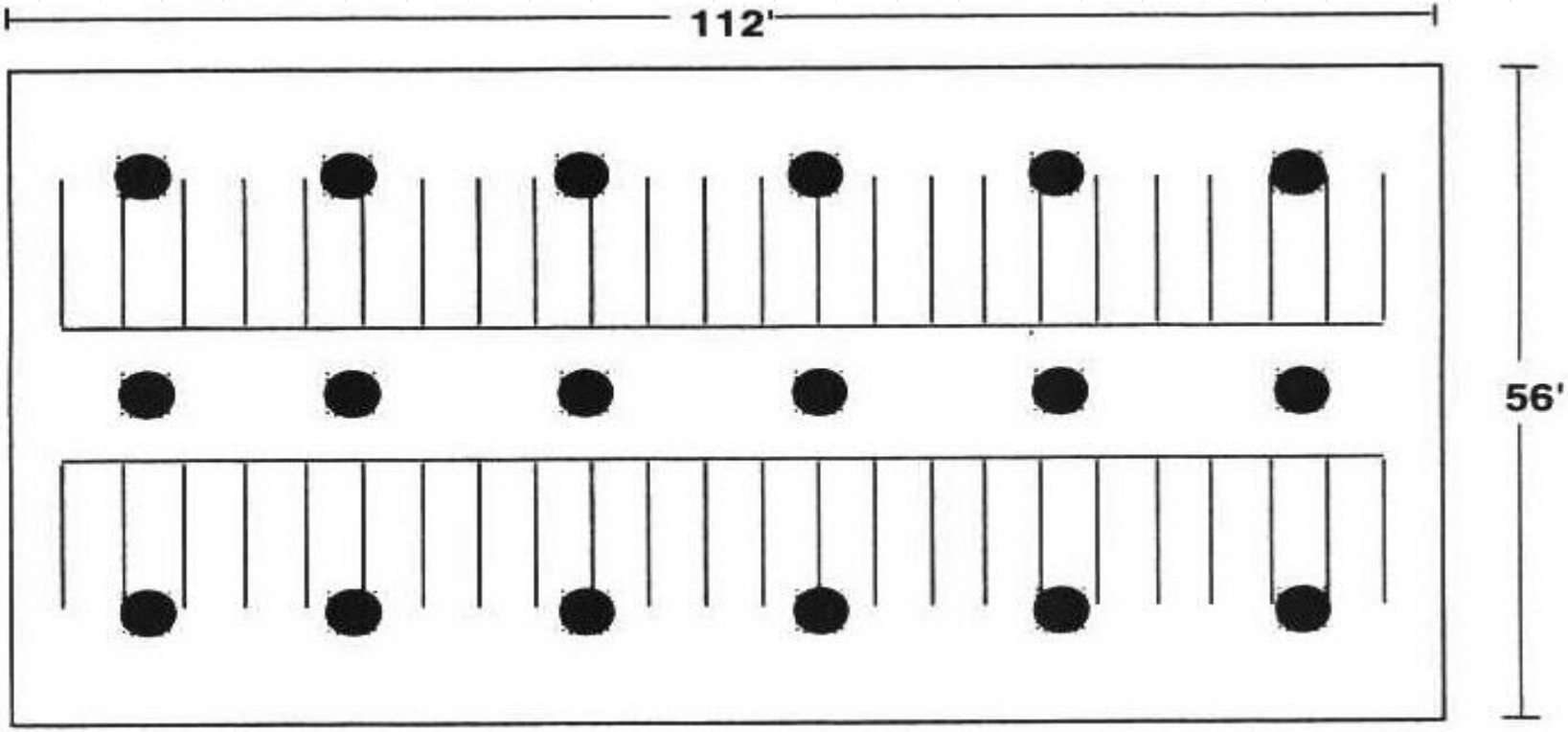


TOTAL LUMENS = (AREA) (FC) (K)

$$\text{FIXTURE NUMBER} = \frac{\text{TOTAL LUMENS}}{\text{LAMP LUMENS}}$$

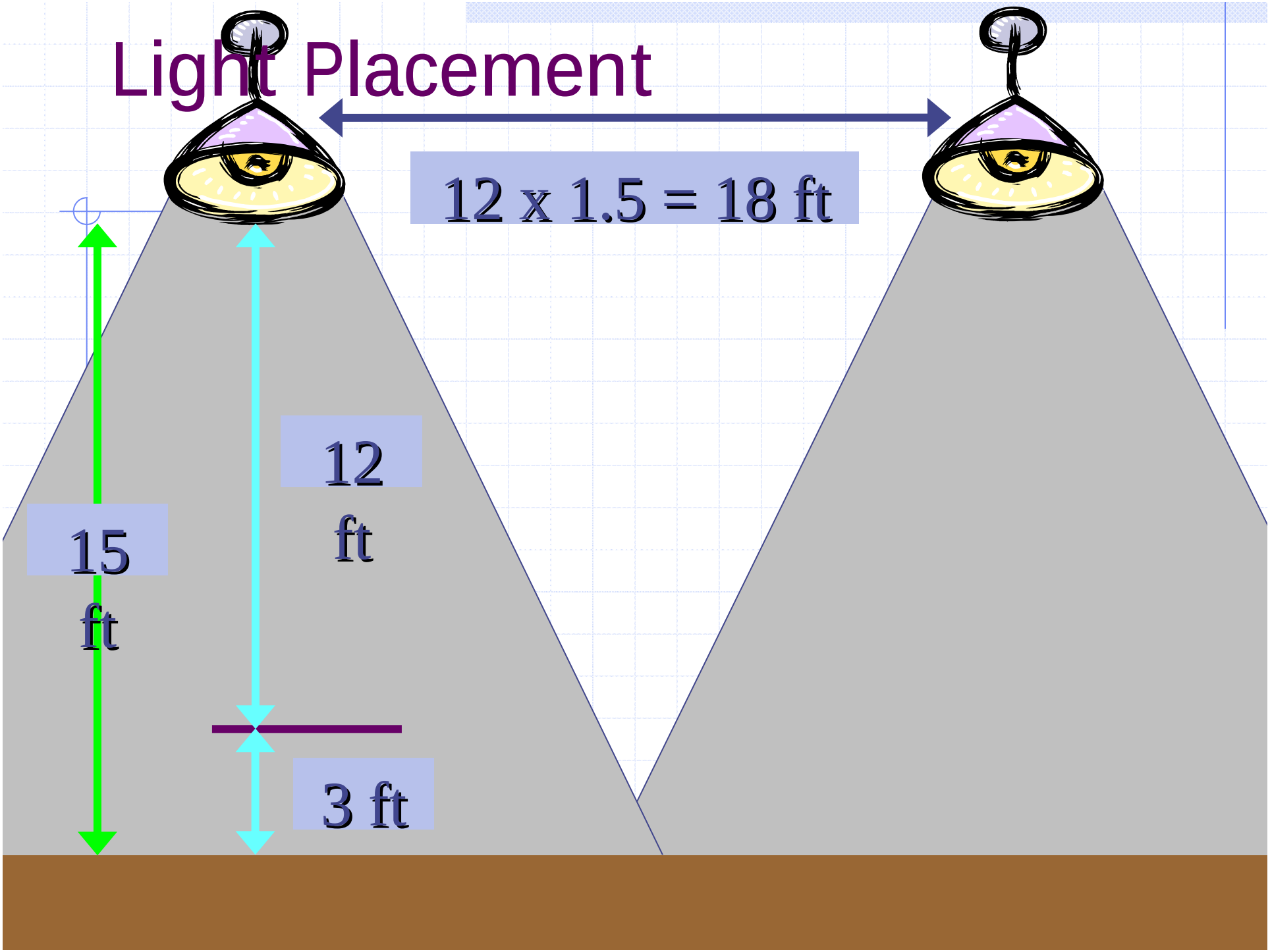
K = CONSTANT
2 - Tie stall barn
3 - curtain free stall

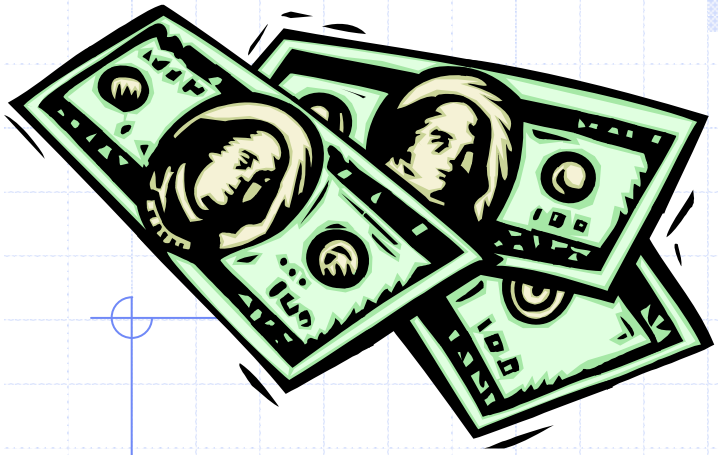
How to….



- Uniform spacing
- Proper height
- **Distance apart = 1.5 X height (ht.-3')**

Light Placement





Photoperiod Management: Is it Profitable?

Milk Price Sensitivity to Photoperiod Management

10.50	Milk Price	150	Herd Size
5	Milk Response	.06	$ /lb DM
		.13	Electricity $/cow/d
0.53	Milk Income	0.28	Total cost/cow/day

Net Profits for Photoperiod Response

	Daily	Monthly	Yearly
Herd	$38	$1,125	$11,400
Cow	$0.25	$7.50	$76

LIGHTING SUMMARY

- **PROPER LIGHTING CAN PROVIDE:**
  - animal / worker comfort and safety
  - increased animal productivity (milk)

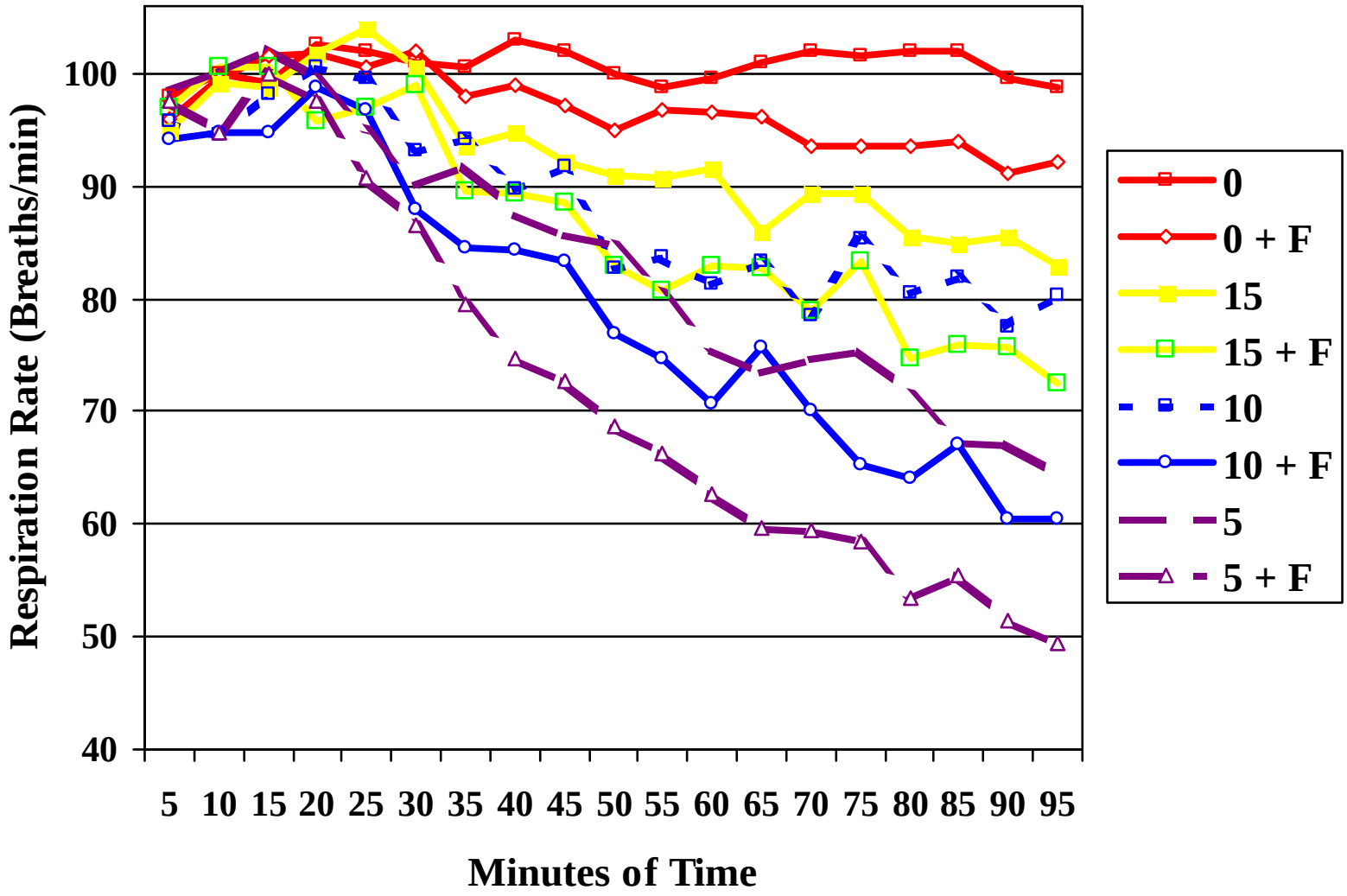
- **PHOTOPERIOD MANAGEMENT PAY$**
  - proper lights / lighting (10-20 footcandles)
  - proper placement (wherever eyes are!)
  - proper timing (16-18 hr light; 6-8 dark)
  - proper maintenance (cleaning/replacement)

*** Proper use may increase energy usage!?

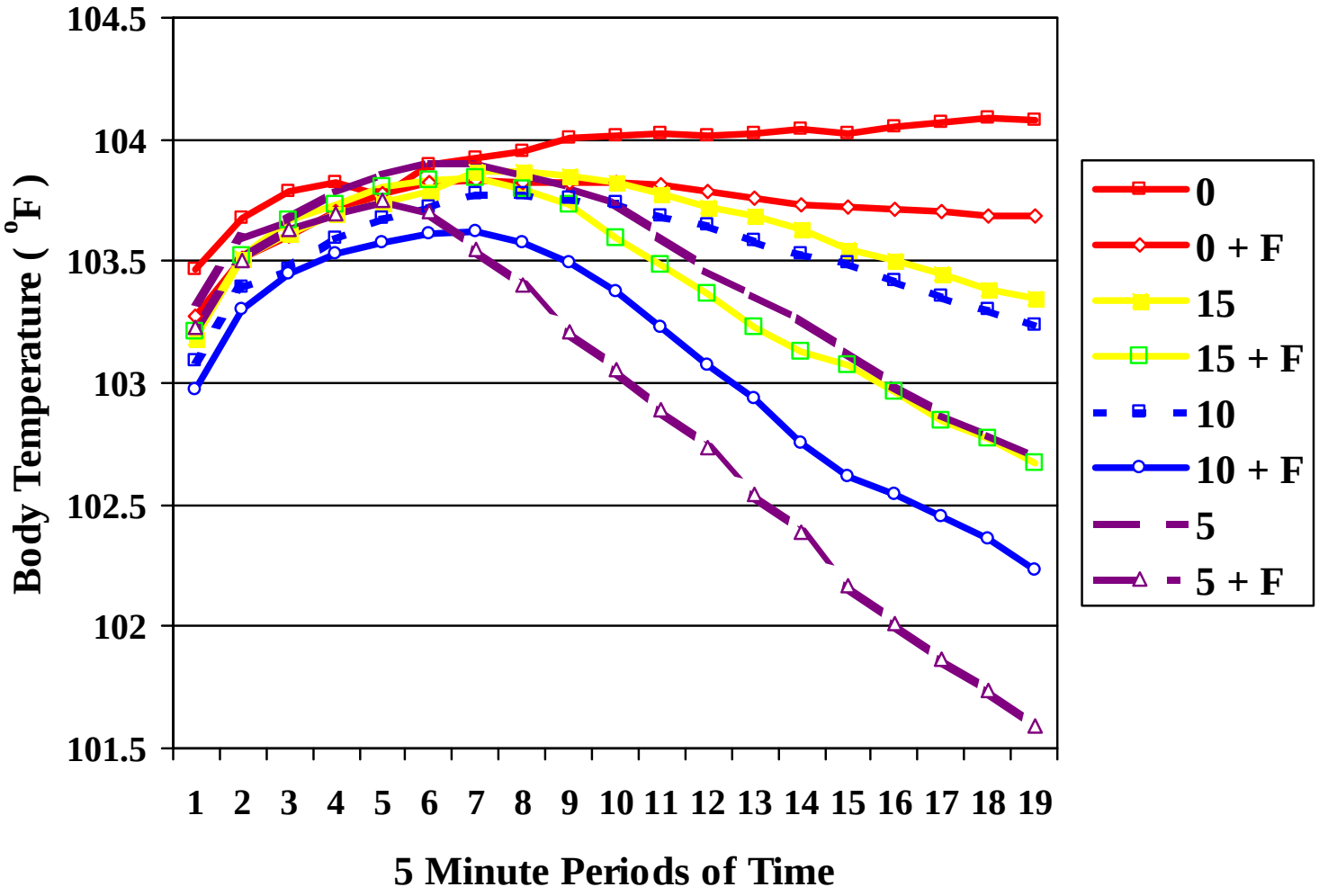
Ventilation

$$$ Summer is critical no matter what! $$$

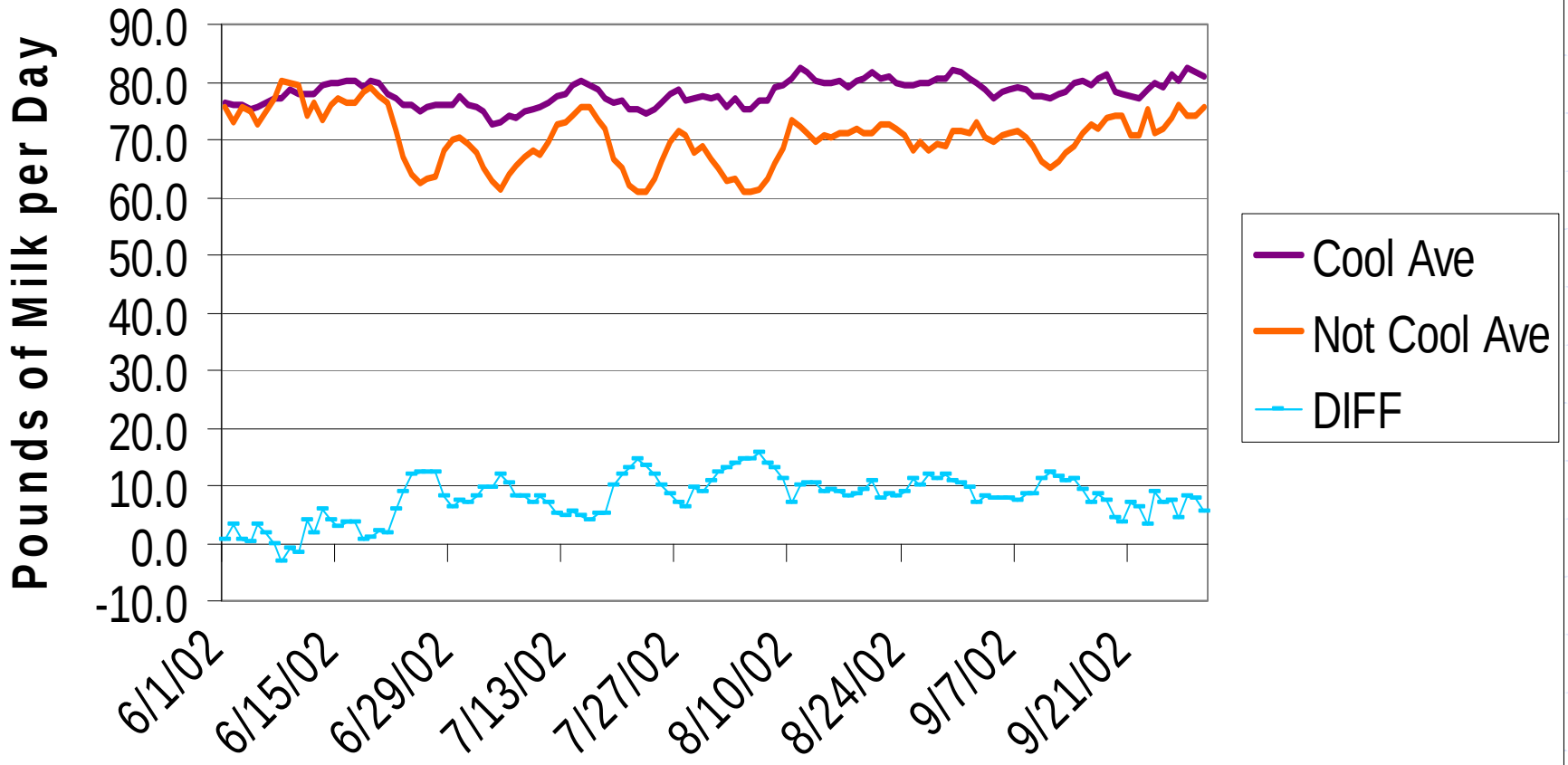
Effects of Cooling Treatments on Respiration Rate over 95 Minutes



Effects of Cooling Treatments on Body Temperature over 95 Minutes

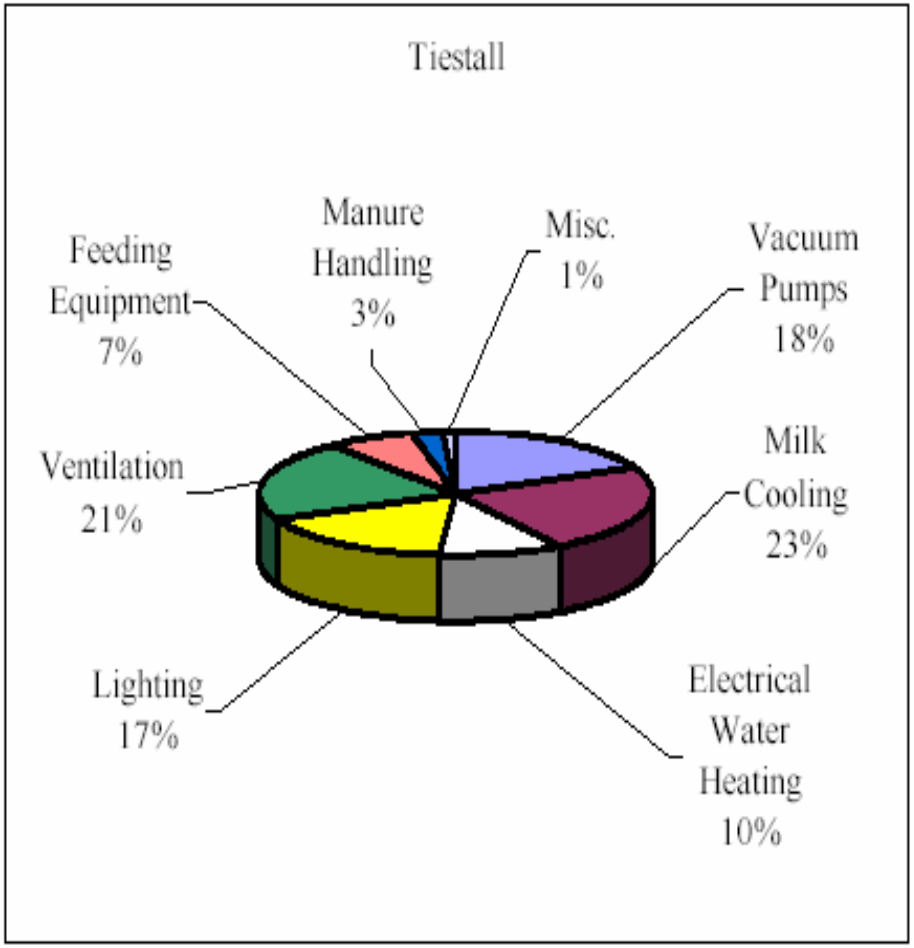


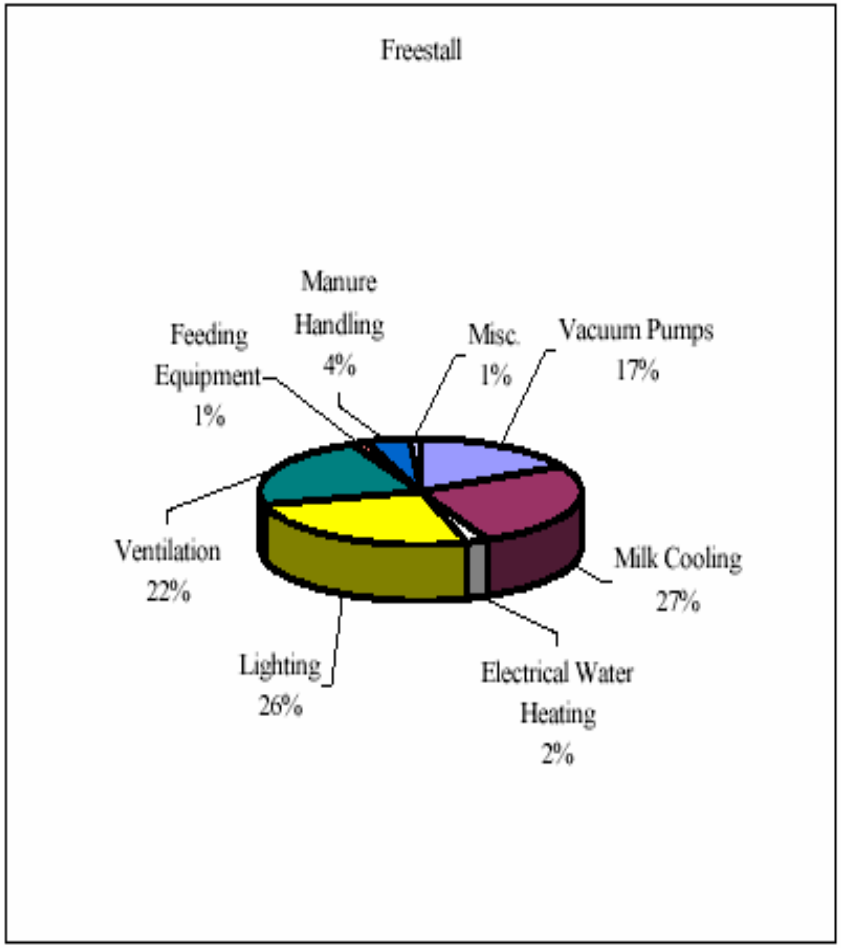
Daily Milk Production and Difference (cooled vs. no cooling)



Lighting and Ventilation

NYS Dairy Farm Survey





Source: Dairy Farm Energy Audit Summary, NYSERDA, July 2003

SUMMARY

- **DAIRY IS AN ENERGY INTENSE BUSINESS!**
- **PROPER ENERGY USE / EFFICIENCIES CONSERVING/ CAN BE IMPLEMENTED!**
- **ENERGY EFFICIENCY BY- PRODUCTS MAY BE CRITICAL FOR ADOPTION ($$)**
- **ENERGY EFFICIENCY: WIN:WIN FOR ALL!**

*** Producer *processor *industry *consumer**

Contact Information

Leo Timms

Associate Professor

Dairy Extension Specialist

Animal Science / College of Veterinary Medicine

Iowa State University - Ames

515-294-4522

ltimms@iastate.edu