# Heat Stress Pre- and Postpartum and its Effect on Calf Performance

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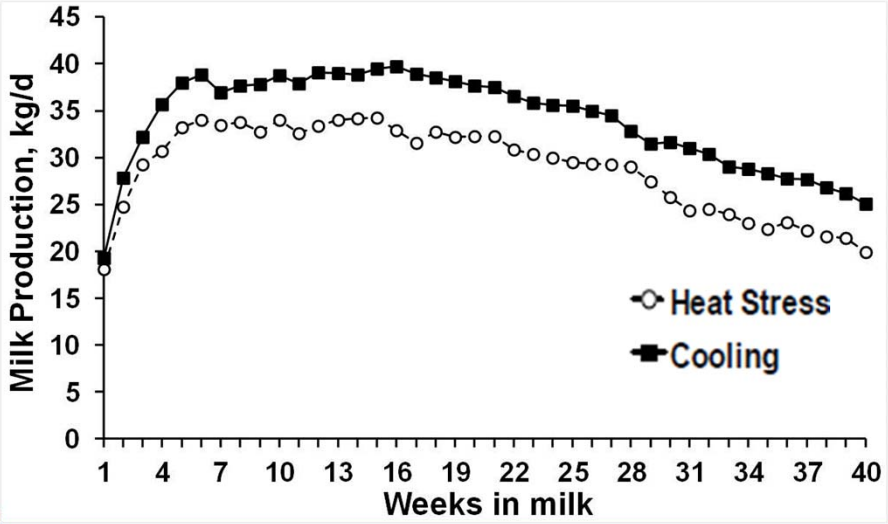
# Cooling is the key to prevent negative effects of heat stress on lactating dairy cows

# Cooling dry cows?

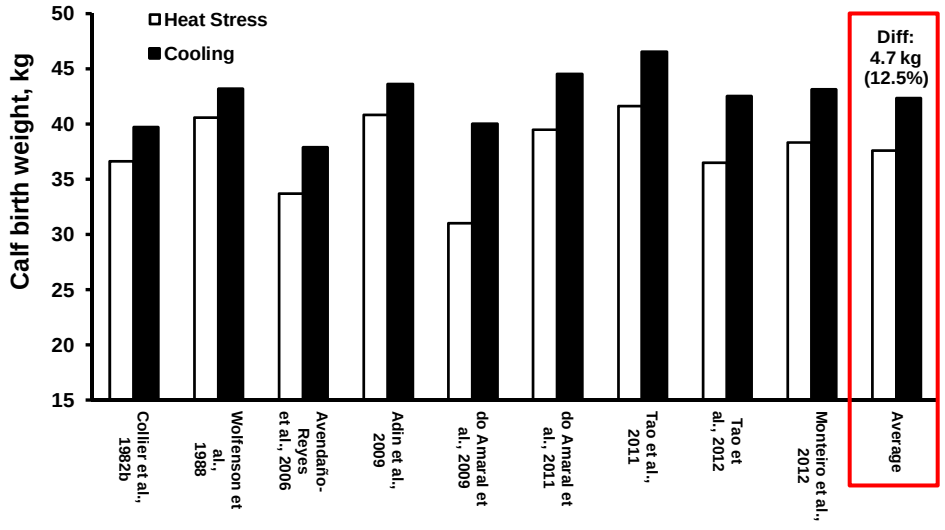
# Cooling during the entire dry period improves milk production




Tao et al., 2011

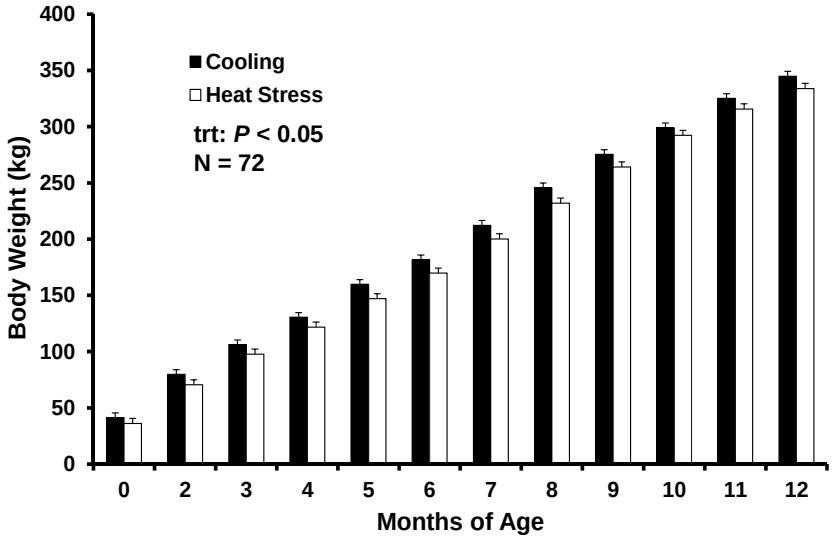
## Maternal heat stress on calf

## Late gestation heat stress decreases birth weight



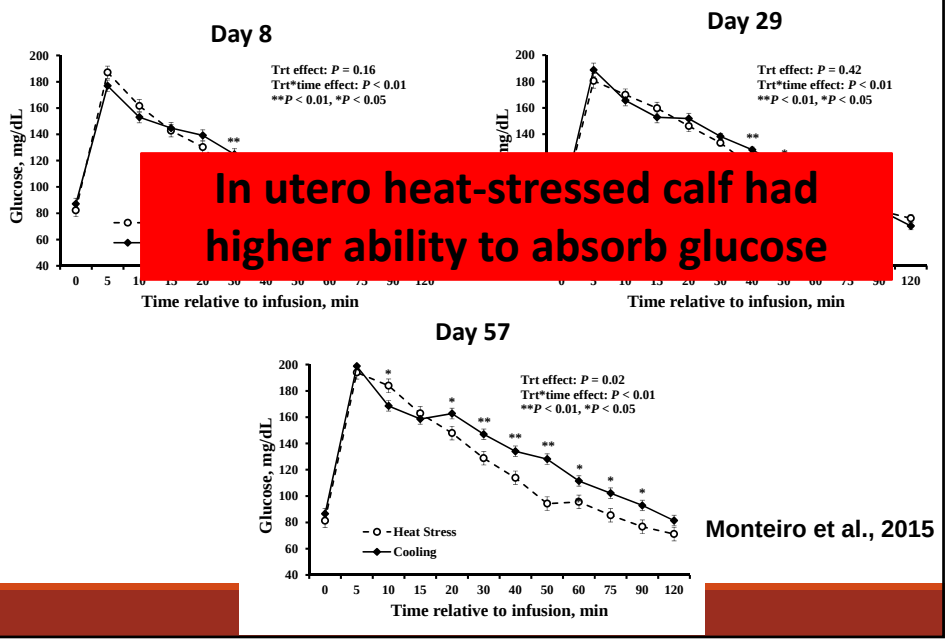

Adapted from Tao and Dahl, 2013

## Late gestation heat stress affects calf body weight




Monteiro et al., 2013

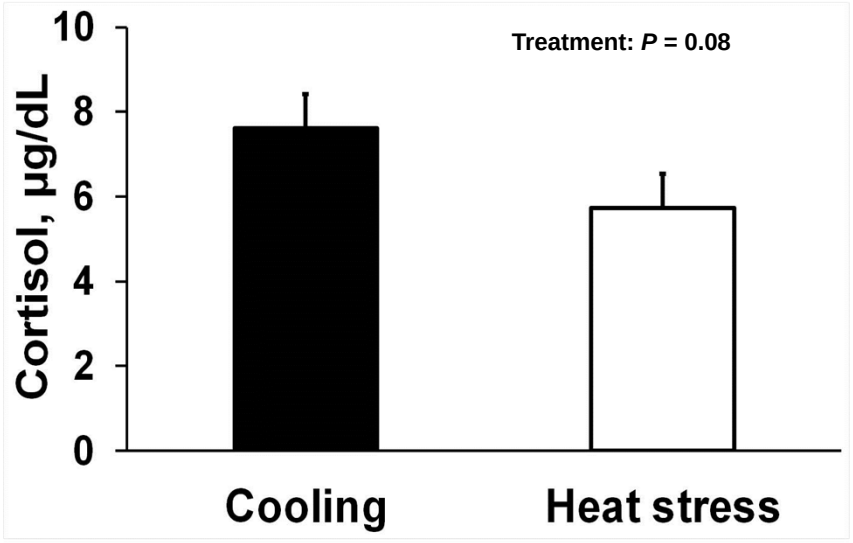
## Glucose clearance to glucose infusion




**In utero heat-stressed calf had higher ability to absorb glucose**

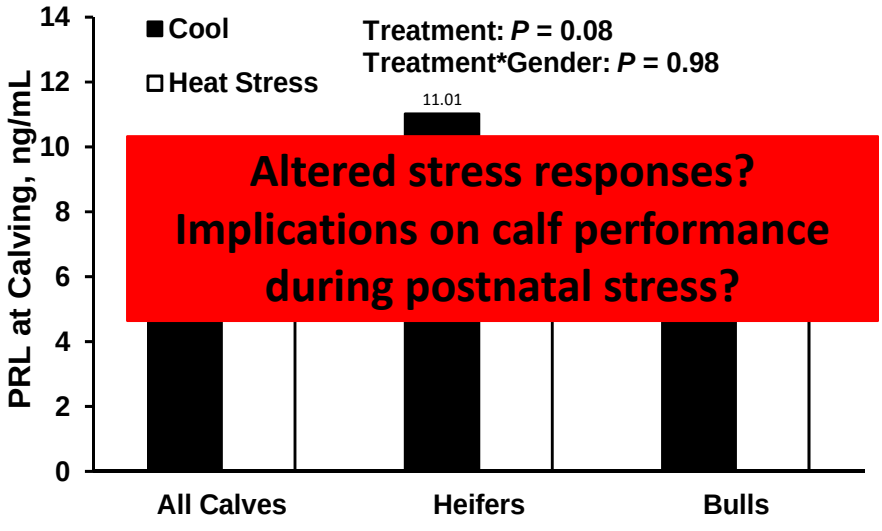
Monteiro et al., 2015

## Cortisol at Calving




Tao et al., 2012

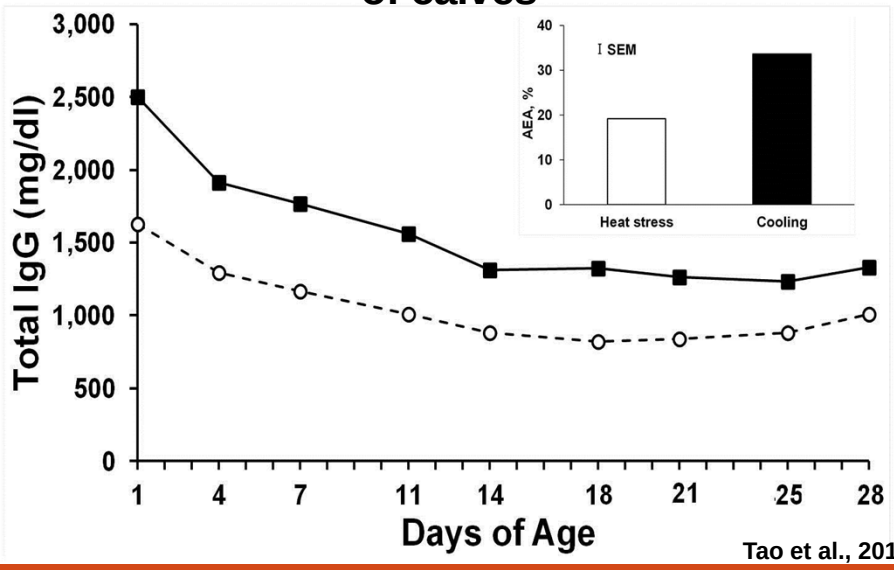
## Prolactin at Calving




**Altered stress responses? Implications on calf performance during postnatal stress?**

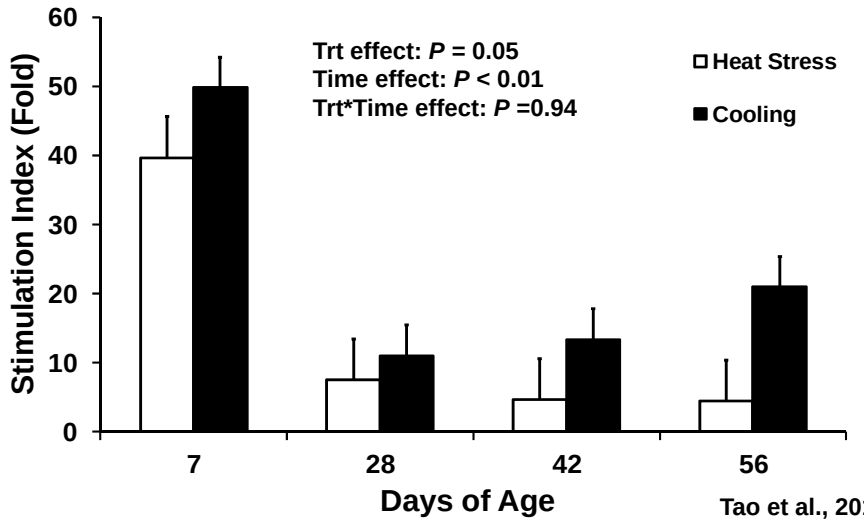
Guo et al., 2016

## Maternal heat stress decreases serum total IgG of calves




Tao et al., 2012

## Maternal heat stress affects lymphocyte function of calves



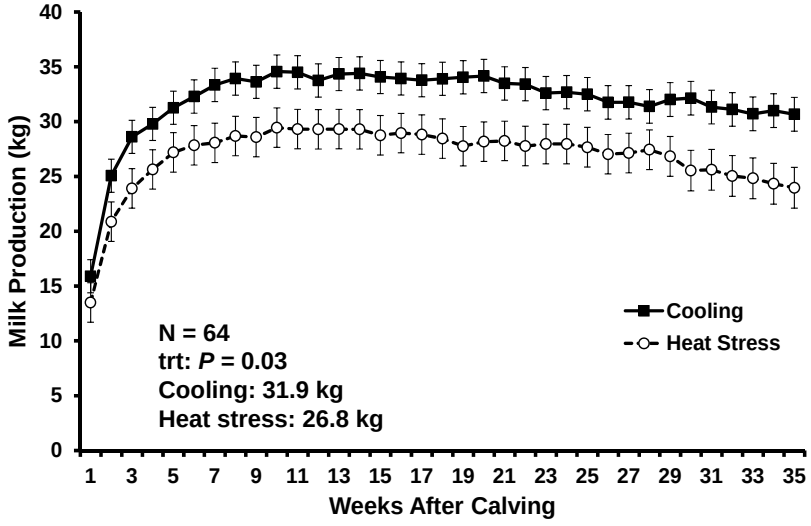

Tao et al., 2012

# Maternal heat stress decreases calf survival

| Parameter | Cooling AI | Cooling IVF | Cooling Total | Cooling % | Heat stress AI | Heat stress IVF | Heat stress Total | Heat stress % | *P* Trt |
|---|---|---|---|---|---|---|---|---|---|
| Bull calves, n | 30 | 1 | 31 | --- | 28 | 2 | 30 | --- | --- |
| Heifer calves, n | 29 | 12 | 41 | --- | 29 | 15 | 44 | --- | --- |
| DOA[4] | 0 | 0 | 0 | 0.0 | 2 | 1 | 3 | 4.1 | 0.25 |
| Males mortality by 4 mo of age | 1 | 0 | 1 | 3.2 | 3 | 0 | 3 | 10.0 | 0.35 |
| Heifers leaving herd before puberty | 1 | 4 | 5 | 12.2 | 3 | 7 | 10 | 22.7 | 0.26 |
| Due to sickness, malformation or growth retardation | 1 | 0 | 1 | 2.4 | 3 | 5 | 8 | 18.2 | 0.03 |
| Heifers leaving herd after puberty, before first lactation | 1 | 0 | 1 | 2.4 | 3 | 0 | 3 | 6.8 | 0.62 |
| Heifers completing first lactation | 27 | 8 | 35 | 85.4 | 22 | 7 | 29 | 65.9 | 0.05 |

***Monteiro and Dahl, unpublished***

# Maternal heat stress decreases offspring's milk production




**Monteiro, et al., 2013**

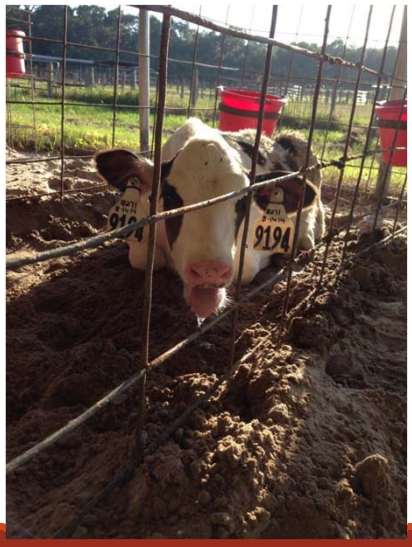
## Summary – Heat stress during the dry period on calf

- Impairs fetal growth and lowers birth weight
- Compromises immune function before weaning
- Decreases milk production in the first lactation

## Consideration and recommendation

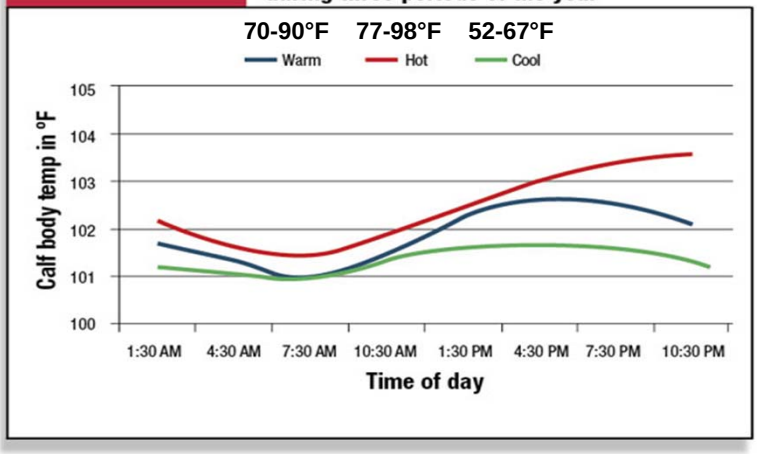
- Provide cooling during the entire dry period
- Provide maximal cooling as for lactating cows
- Cool springer heifers as well

## Neonatal calves also suffer from heat stress!



## Daily variation in calf body temperatures

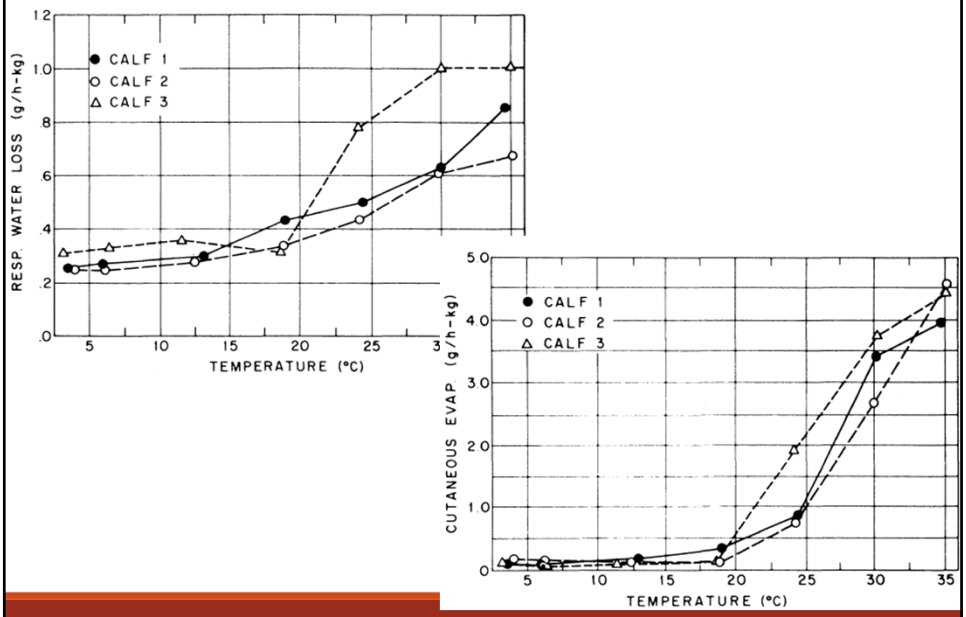
**Figure 1** Daily variation in calf body temperatures during three periods of the year




In all three time periods observed, the body temperature of the calves was lowest early in the morning and rose throughout the day.

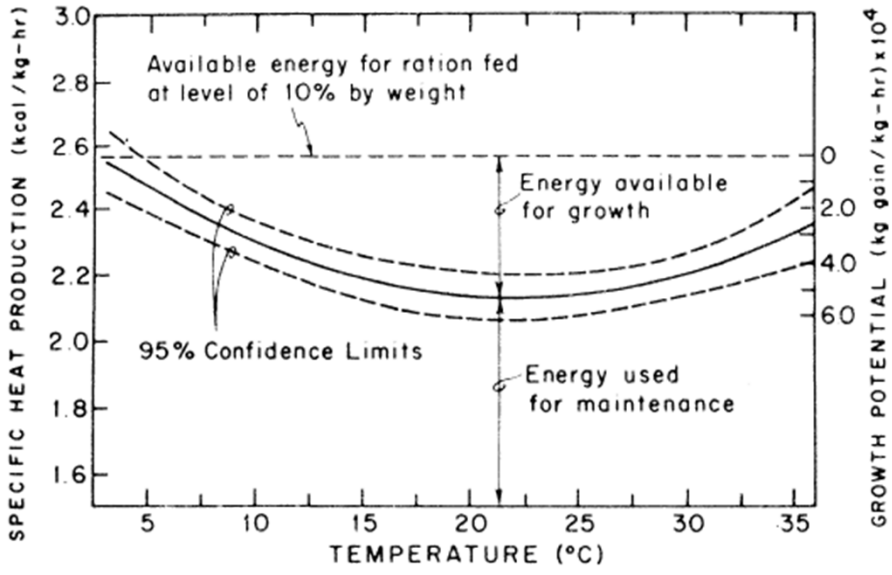
*Progressive Dairyman. Gale Bateman II and Mark Hill, 2012.*

## Evaporative Cooling is Initiated at 20 °C



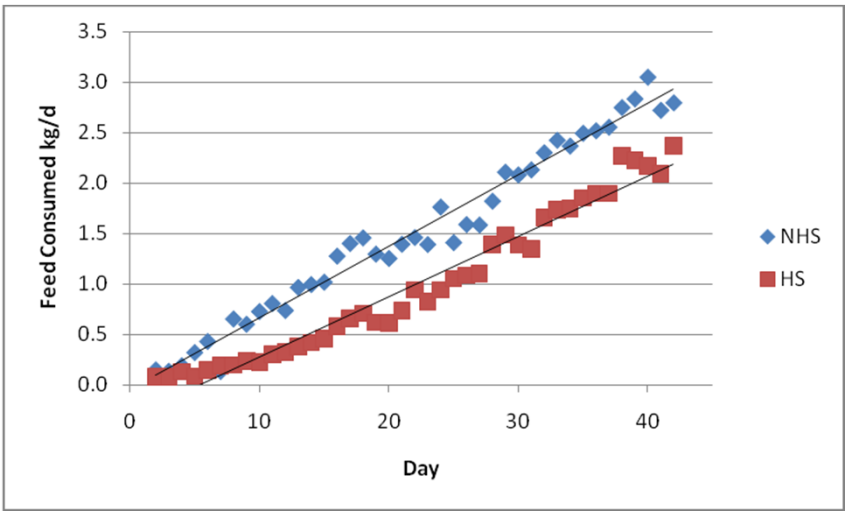

*Gebremedhin et al., 1981*

## Environment Affects Calf Growth



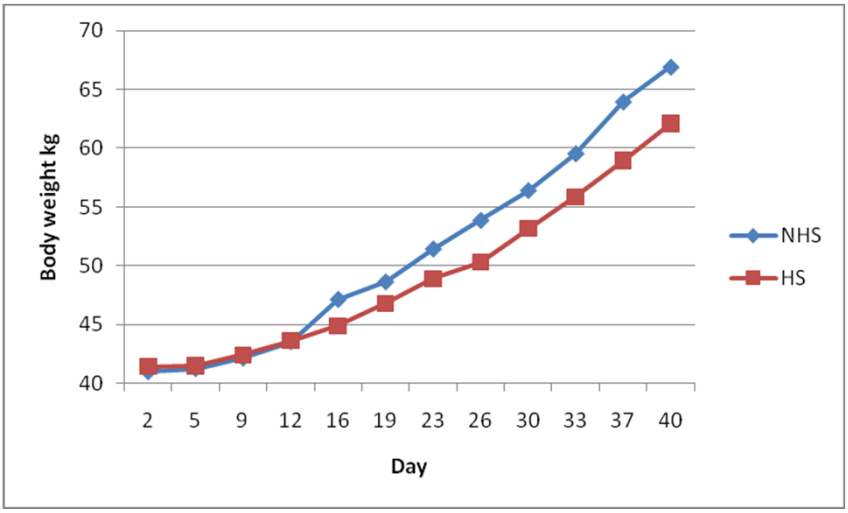

*Gebremedhin et al., 1981*

## Heat stress reduce starter intake



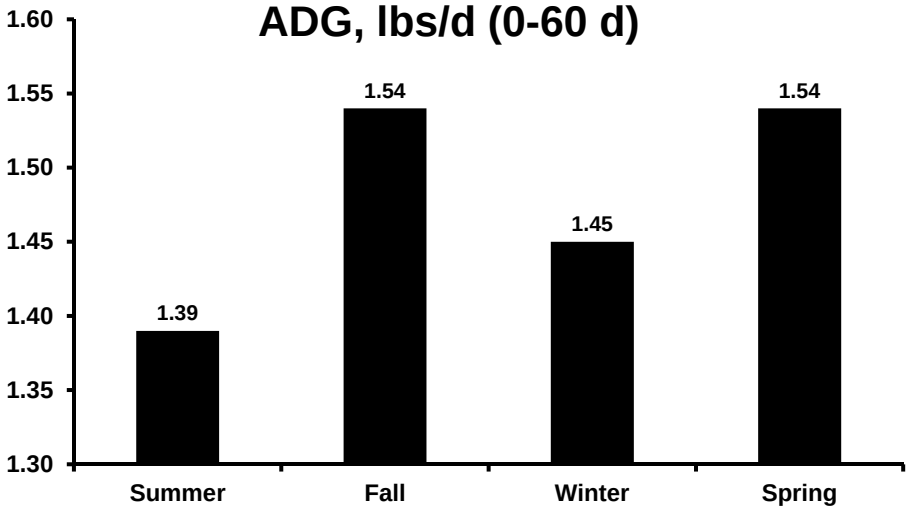

*Chaves, TM, Thesis, Texas A&M*

## Heat stress reduce growth




*Chaves, TM, Thesis, Texas A&M*

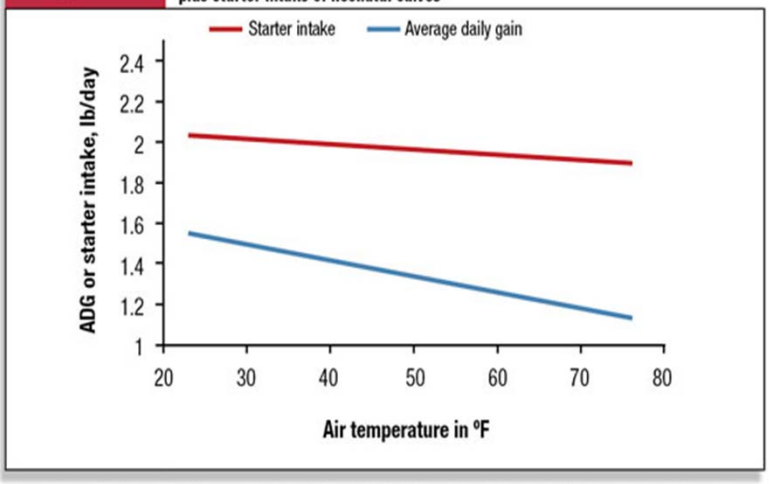
## Summer heat reduces ADG




*Adapted from Wiedmeier et al., 2006*

## Air temperature vs. ADG and grain intake

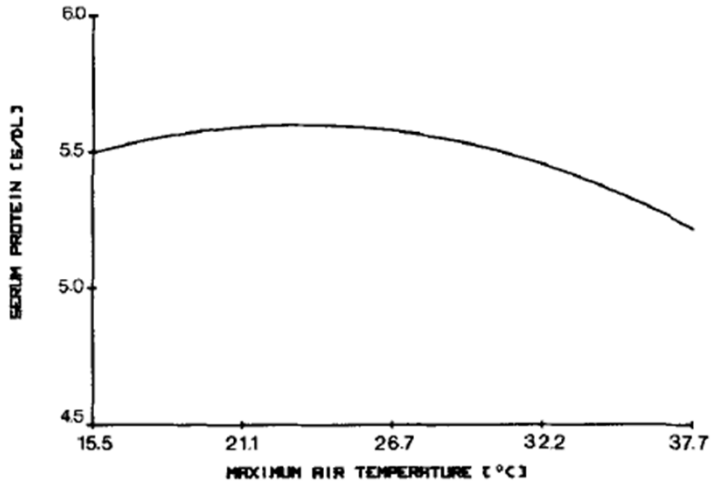
**Figure 2** Relationship between air temperature and average daily gain (ADG) plus starter intake of neonatal calves




There was a linear relationship that as air temperature increased, calf average daily gain decreased. Within these calves, for every 10 degrees increase in air temperature, calf average daily gain decreased by 5 percent.

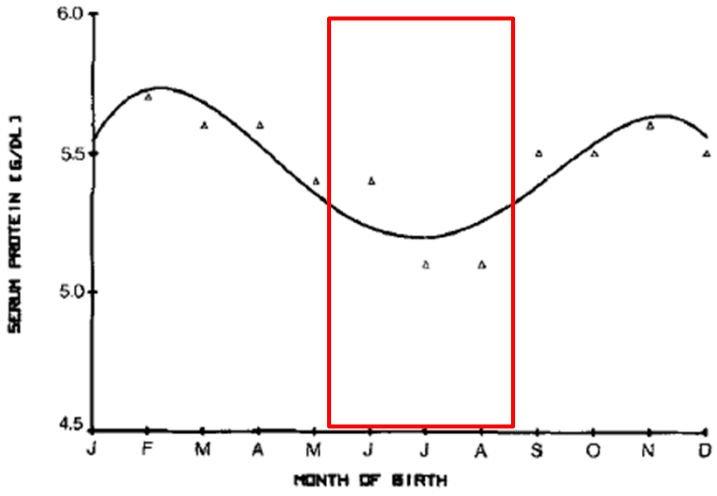
*Progressive Dairyman. Gale Bateman II and Mark Hill, 2012.*

## Elevated ambient temperature at birth is related to lower serum protein of neonate



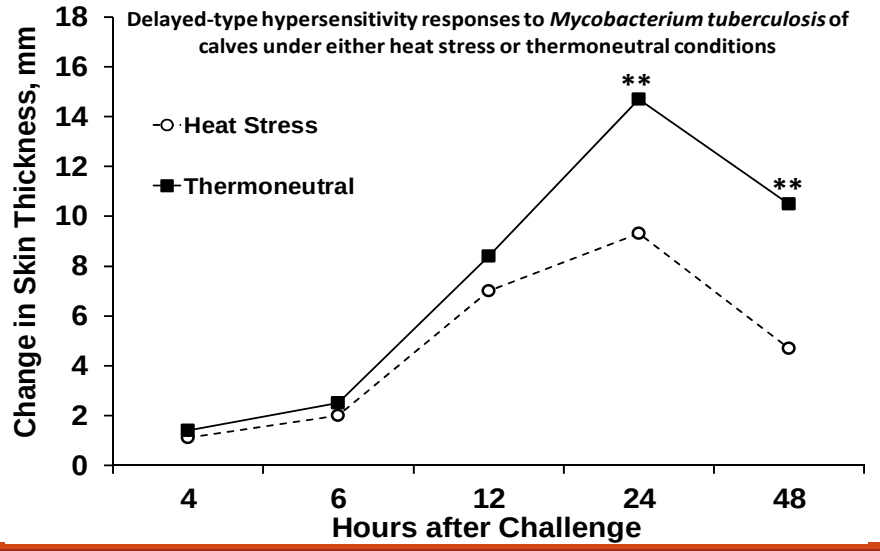

*Donovan et al., 1986*

## Seasonal variation of serum protein of new born calf in Florida



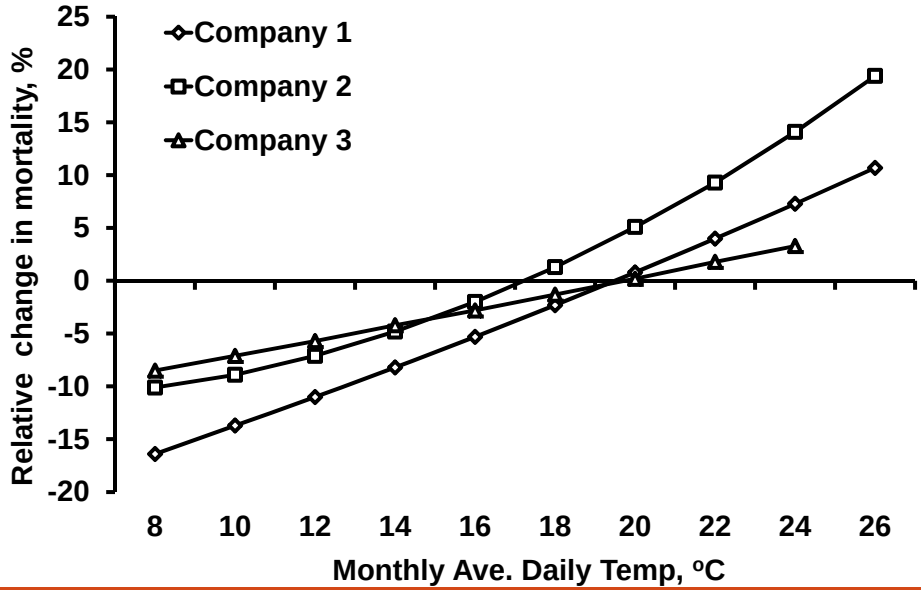

*Donovan et al., 1986*

## Heat Stress compromises cellular immunity




*Adapted from Kelley et al., 1982*

## Heat Stress increases mortality of calves



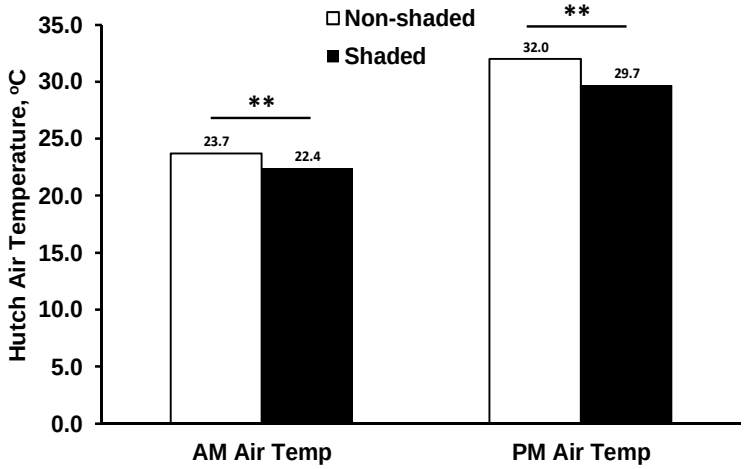

*Adapted from Stull et al., 2008*

## Management strategies

- Shade
- Insulation cover
- Improve ventilation
  - Natural wind by hutch elevation
  - Cooling by fan

## Providing shade to the calf

## Providing shade reduces hutch air temperature

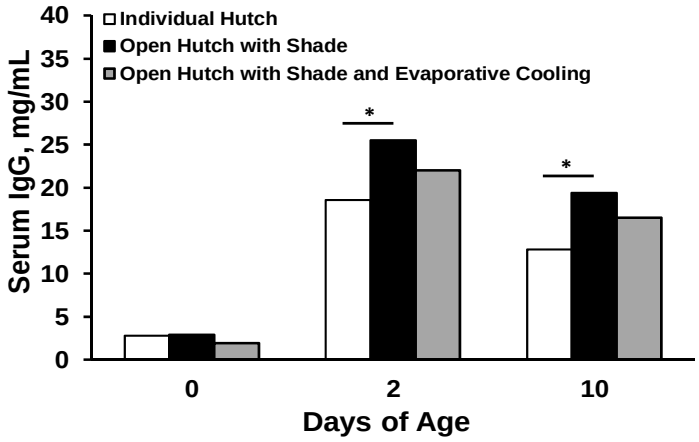



Plastic hutches were placed either in an open area directly exposed to sunlight or beneath a 80% solar radiation blockage shade cloth

*Adapted from Spain and Spiers, 1996*

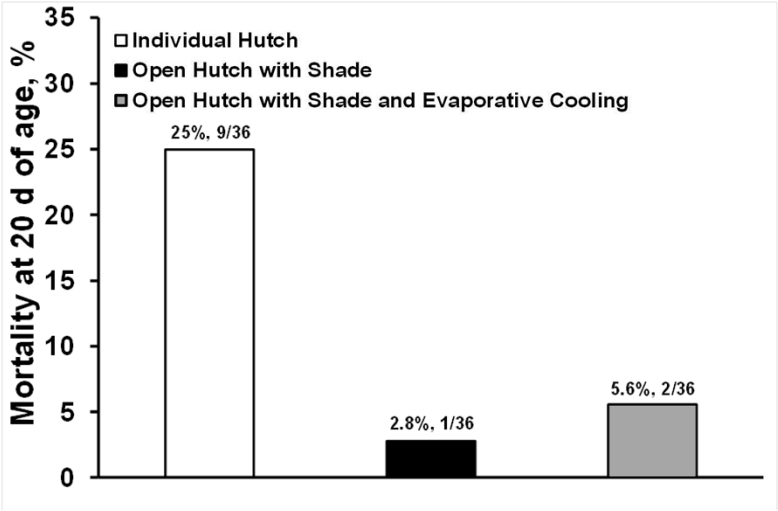
## Providing shade improves immune transfer

Greater IgG concentration in serum at 2 and 10 days old




*Adapted from Stott, et al., 1976*

## Providing shade decreases mortality




*Adapted from Stott, et al., 1976*

## Shade may promote bacterial growth without good management

TABLE 4. Fecal and total coliform bacteria counts per gram in bedding samples collected from shaded and control hutches during yr 2.

**Good bedding management is required**

| | | |
|---|---|---|
| Fecal[1] | $2.39 \times 10^7$ | $7.91 \times 10^6$ |
| Total[2] | $1.59 \times 10^8$ | $1.45 \times 10^7$ |

[1]Main effect of treatment ($P < 0.05$; SEM = $3.1 \times 10^6$).
[2]Main effect of treatment ($P < 0.01$; SEM = $0.2 \times 10^7$).

**Polyethylene hutches were placed either in an open area directly exposed to sunlight or beneath a 80% solar radiation blockage shade cloth**

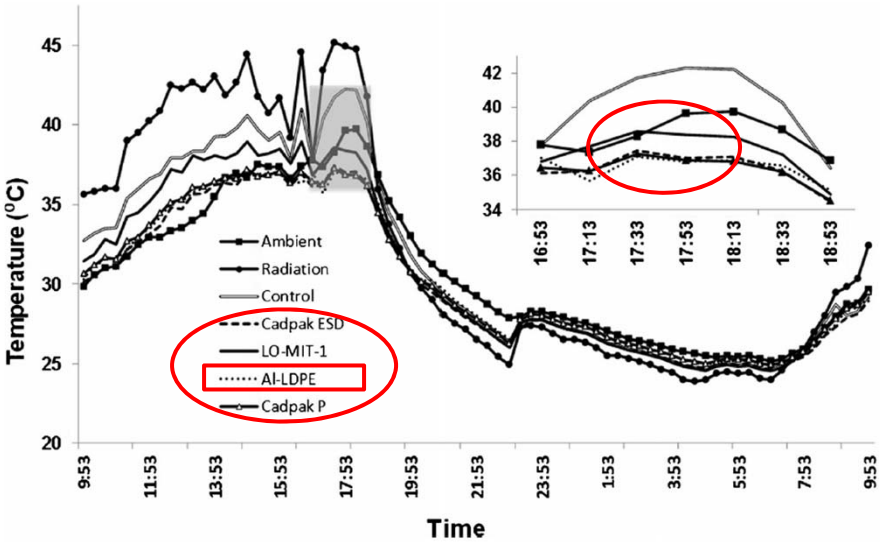
*Coleman, et al., 1996*

## Cover the hutch

*http://www.coolcalfcovers.com/home.html*

## Aluminized low-density polyethylene covers

- Largely reduce hutch air temperature




*Friend et al., 2014*

## Aluminized low-density polyethylene covers

- Reduce calf respiration rate

**Table 1. Respiration rate per minute for calves**

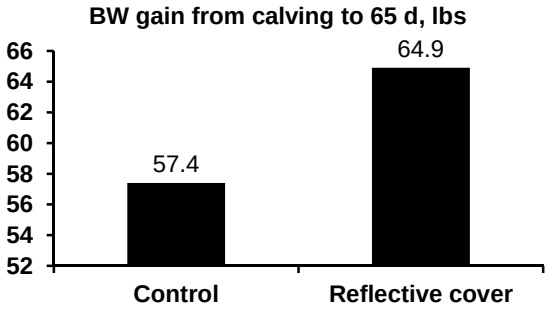
| Collection day (presence of clouds) | Control/ no cover (bpm) | Reflective/ with cover (bmp) | P-Value |
|---|---|---|---|
| 21 (clear) | 72.2 ± 1.09 | 61.0 ± 0.76 | <0.001 |
| 42 (clear) | 72.8 ± 0.9 | 62.4 ± 1.07 | <0.001 |
| 56 (cloudy) | 66.2 ± 1.28 | 60.6 ± 1.33 | 0.15 |

*bpm = breaths per minute

*Friend, T., Department of Animal Science, Texas A&M*

## Aluminized low-density polyethylene covers

- Improve performance




*Friend and Haberman, 2016*

**Table 3. Number of calves given treatment**

| Symptom | Time period | Control/ no cover (n=61) | Reflective/ with cover (n=49) | P-Value |
|---|---|---|---|---|
| Ear infection | In hutch | 13 | 5 | 0.11 |
| Pneumonia | In hutch | 8 | 7 | 0.90 |
| | 3-4 months postweaning | 23 | 8 | 0.01 |

## Aluminized low-density polyethylene covers

- Reduce calf respiration rate
- Improve performance
  - Reduce disease
  - Numerically increase gain
- Price: $8-10/cover plus freight
- Lifespan: 9 weeks
- May not store for next summer
- More information:

  http://www.coolcalfcovers.com/home.html

*Friend, T., Department of Animal Science, Texas A&M*

## Improve natural ventilation – Hutch elevation

***WSU Extension. Dale A. Moore, Jen Duprau and John R. Wenz, 2011.***

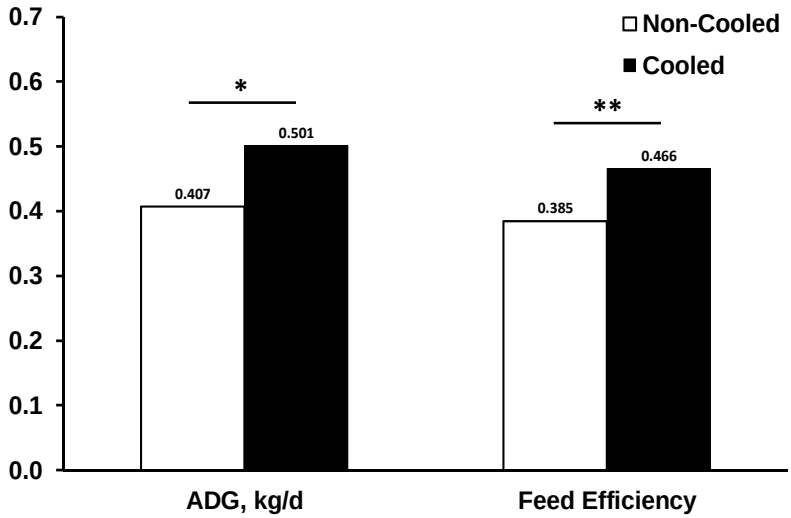
## Results when hutch is elevated

- Slightly reduce hutch internal air temperature
- Slightly decrease respiration rate in the afternoon
- Decrease carbon dioxide levels, indicating an improvement of ventilation inside the hutch and good air quality
- Lowered concentrations of airborne bacteria

*WSU Extension. Dale A. Moore, Jen Duprau and John R. Wenz, 2011.*

## Cooling by fan

## Cooling by fans improve calf growth




**Calves were housed open hutches in a nursery barn and were either cooled by fans from 8AM to 5 PM or not**

***Adapted from Hill, et al., 2011***

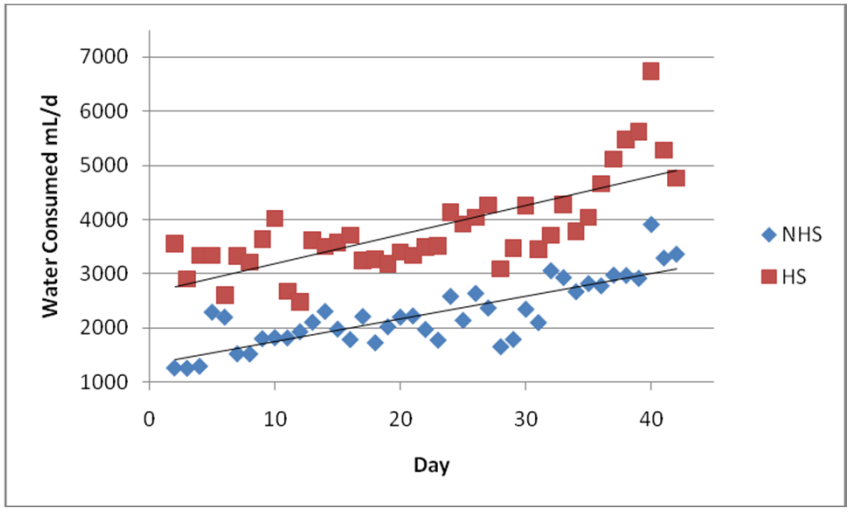
## Nutritional strategies

- Water
- Milk replacer
- Calf starter

## Water

- The most important nutritent
- Encourage the starter intake
- Free choice of fresh water – keep the bucket full

## Heat stress increases water intake

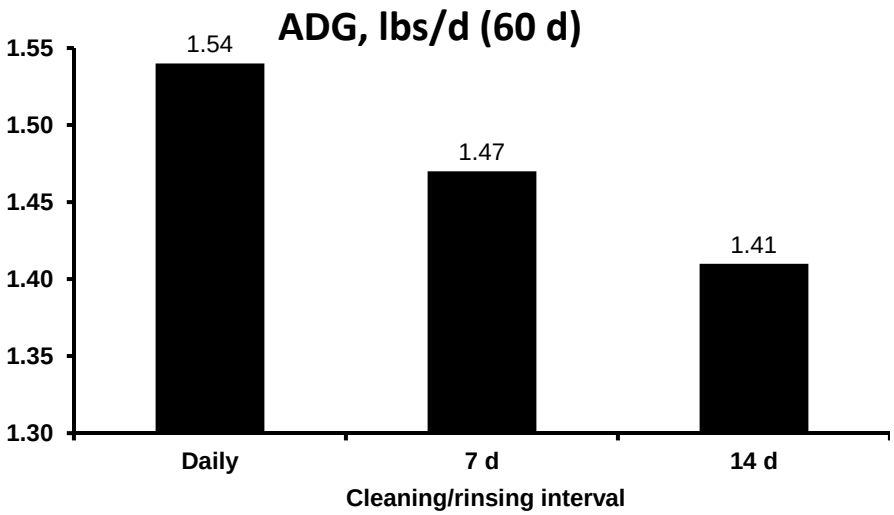



*Chaves, TM, Thesis, Texas A&M*

## Water

- The most important nutritent
- Encourage the starter intake
- Free choice of fresh water – keep the bucket full
- Clean often

## Frequent cleaning/rinsing water bucket improve gain



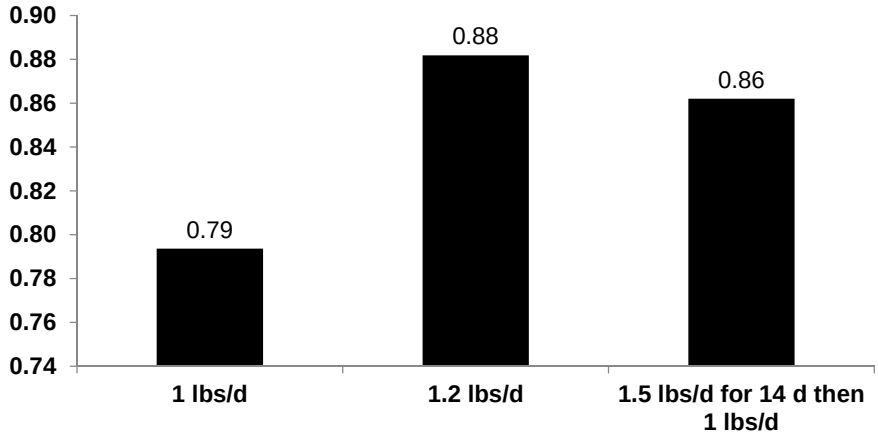

*Adapted from Wiedmeier et al., 2006*

## Milk replacer

- Should we feed more during summer?

## Increase the amount of milk replacer fed in summer improve ADG – Exp 1

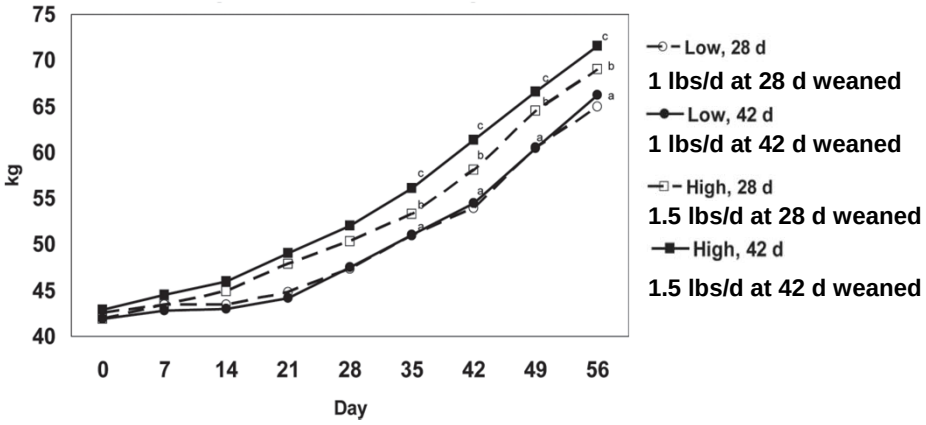
**ADG (28 d) -- (21:21 MR)**




**Ave air temp: 24 $^{O}$C (9-37), Ave relative humidity: 66% (23-98%), 28 d weaning, no difference in starter intake**

***Adapted from Hill et al., 2012***

## Increase the amount of milk replacer fed in summer improve ADG – Exp 2 (21:21 MR)




**Ave air temp: 24 $^{O}$C (13-34), Ave relative humidity: 72% (25-99%), 42 d weaned calves had lower starter intake than 28 d, but milk replacer rate did not affect starter intake**

***Adapted from Hill et al., 2012***

## Milk replacer

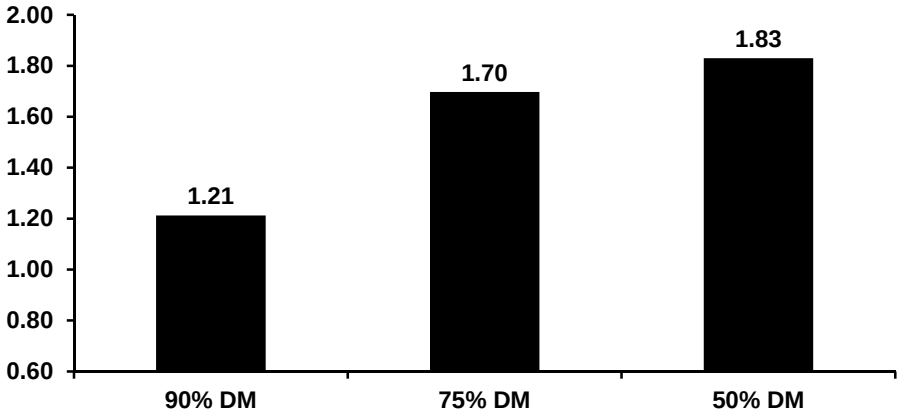
- Should we feed more during summer?
- Accelerated vs. traditional 20:20?
  - -- Under investigation

## Calf starter

- Heat-stressed calf has lower starter intake
- Keep starter fresh
- Increase moisture content

## High moisture content of starter improve starter intake in summer

**Starter intake , lbs/d, until weaning at 50 d**

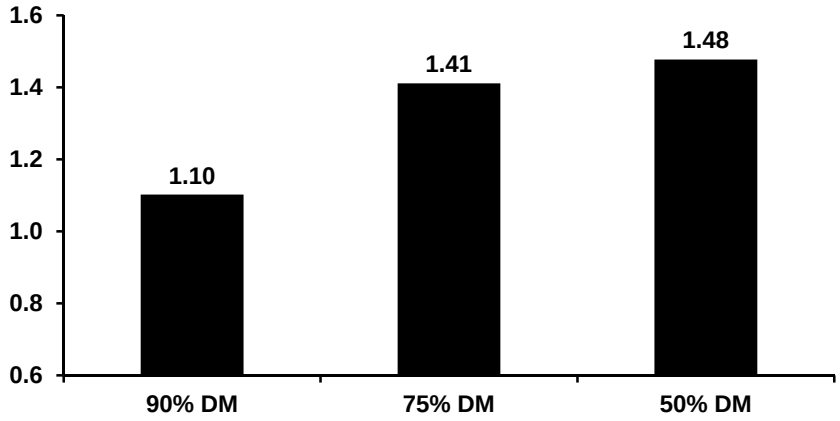



**Fed pasteurized milk. Weaned at 50 d; Fresh starter provided on a daily basis; No difference in feed efficiency**

***Adapted from Beiranvand et al., 2016***

## High moisture content of starter improve ADG in summer

**ADG , lbs/d, until weaning at 50 d**




**Fed pasteurized milk. Weaned at 50 d; Fresh starter provided on a daily basis; No difference in feed efficiency**

***Adapted from Beiranvand et al., 2016***

## Summary – Postnatal heat stress on calf

- Reduce starter intake and ADG, compromise immunity and increase disease
- Depend on specific situation, appropriate management approach need to be implemented.
- Keep water and starter fresh, consider feeding more liquid feed.

# Thank you!!!