Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

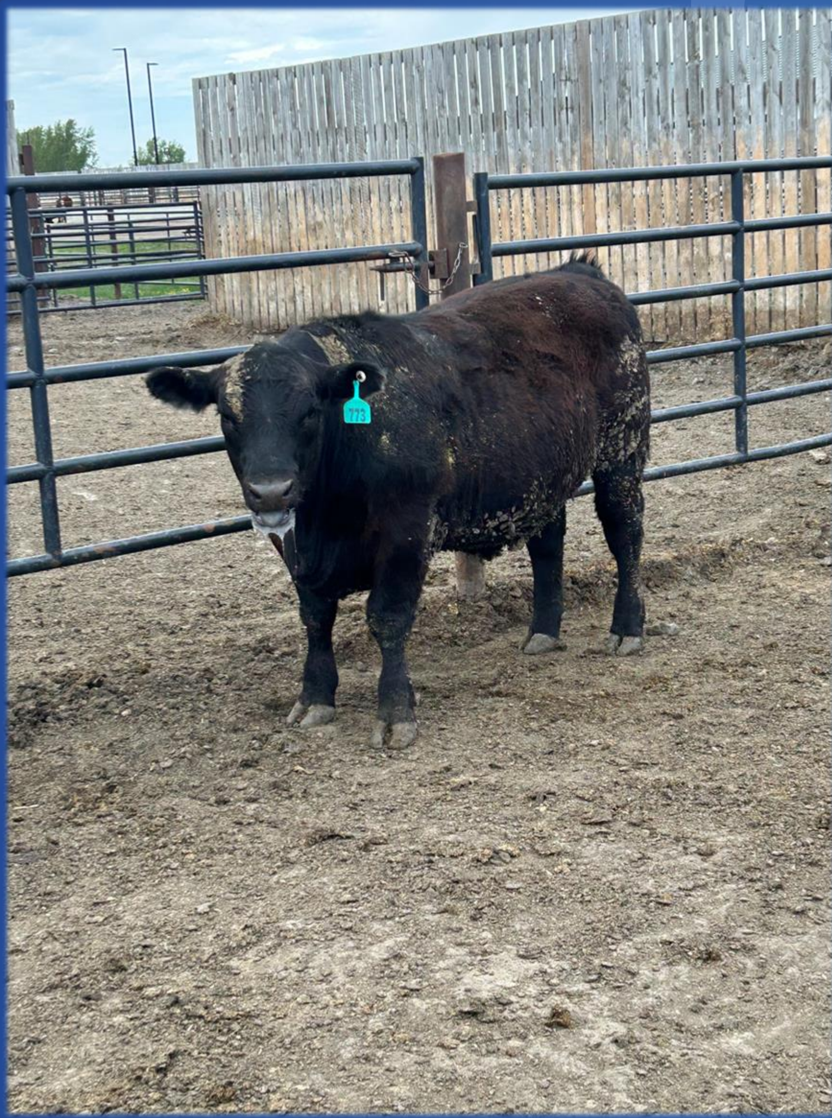


Image Courtesy of G. Riberio (U of S)

Understanding, Identifying, and Managing Heat Stress in Beef Cattle

Dr. Karen Schwartzkopf-Genswein

AAFC Lethbridge, AB

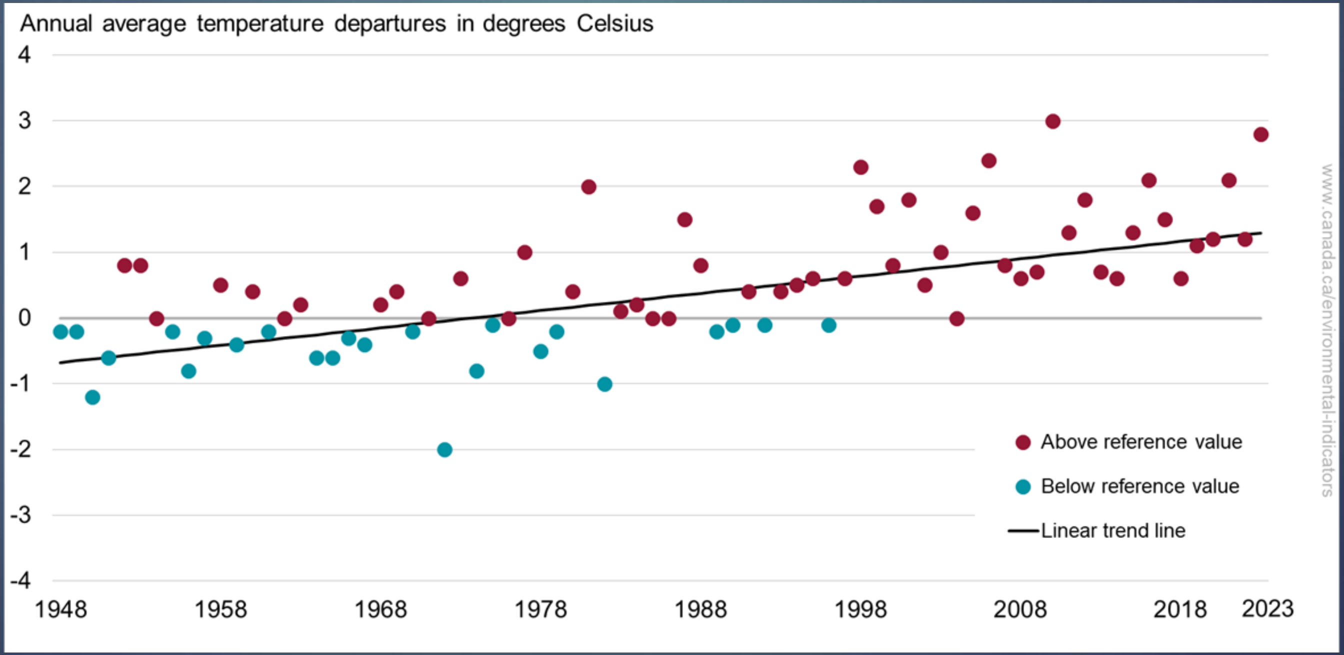
Feb 12, 2026

28th Western Canadian Feedlot Management School

Saskatoon, SK

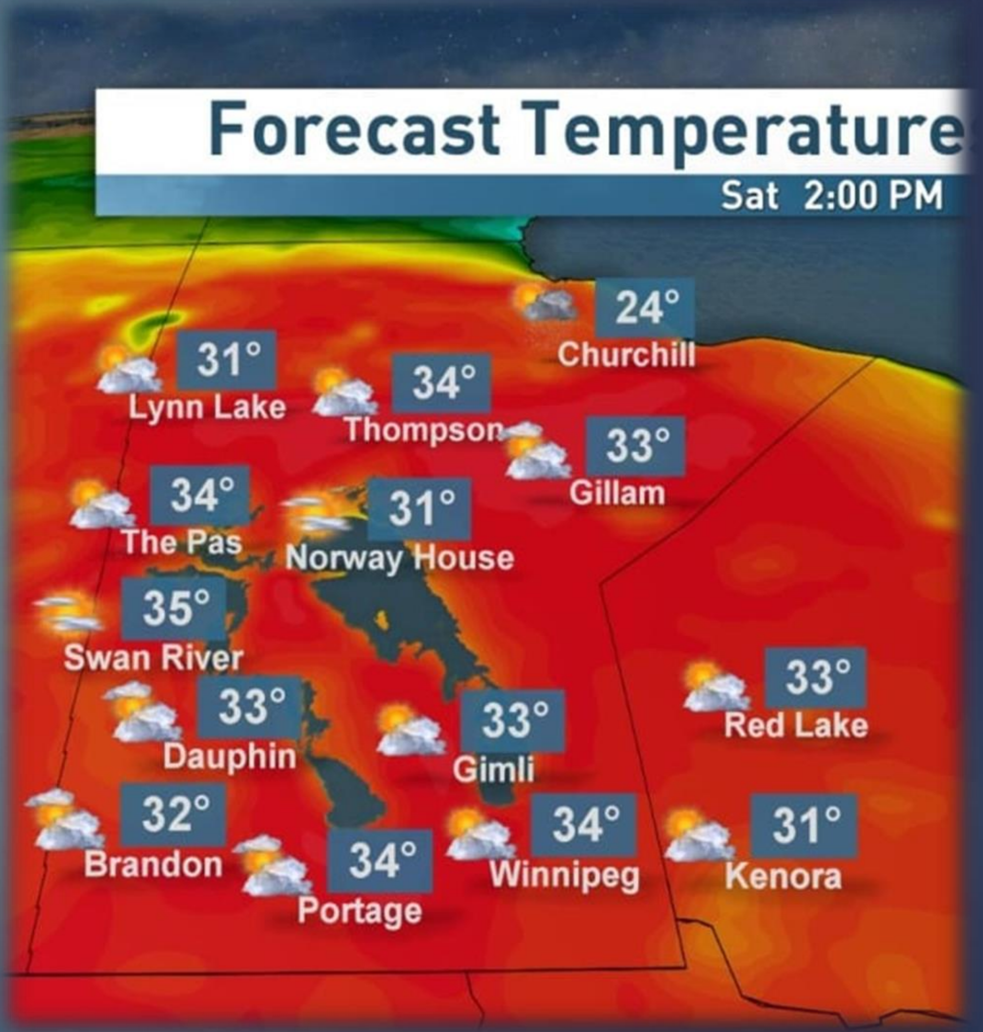
Heat Stress - Not an Issue in Canada?

- Heat stress (HS) - not typically on the radar of Canadian producers
- Impacts on production, animal welfare, economic return - significant
- Average annual increase from ref value 2.0°C warmer between 1948-2023 (Environment Canada (EC) 2025)
  - 2 x global rate (Intergovernmental Panel on Climate Change; IPCC, 2021)



Heat Stress - Not an Issue in Canada?

- Western North American heat wave - summer 2021 (June 25-July 7):
  - Alberta - Average air temp. exceeding 34°C
  - Southern AB – Temp. > 39°C for several consecutive days - little wind or night cooling
  - Saskatchewan recorded avg temp of 33°C
  - > 650,000 farm animal deaths in Canada (White et al. 2023)
- Days > 35°C predicted to increase in western Canada over next decade (IPCC, 2021)



Heat Stress- A Multifaceted Problem

- Greater environmental heat loads increase susceptibility of livestock to HS (Phillip et al. 2021)
- Cold tolerant cattle (Angus and Hereford) more susceptible to HS
- Interaction between environment, animals and management factors
- Example Scenario:
  - Rising environmental temperatures
  - Increased prevalence of black-hided, heavy fat cattle
  - Increased feedlot pen stocking density
  - Little or no shade

Environmental Conditions

- Combination of weather factors determine how livestock “feel” their environment
  - Temperature
  - Humidity
  - Wind Speed
  - Solar Radiation

- Awareness and monitoring of conditions help producers make appropriate management decisions

- Methods of measuring weather impacts
  - Temperature Humidity Index (THI)
  - Wind Chill Index (WCI)

Calculating and Using THI

- THI= 0.8 x Air Temp. ºC + [(% RH/100) x (Air Temp. – 14.4)] + 46.4

Example:

Air temperature = 30˚C

Relative Humidity = 70%

THI = 0.8 * 30 + (0.70) * (30 - 14.4) + 46.4
THI = 24 + 0.70 * 15.6 + 46.4
THI = 24 + 10.92 + 46.4

THI = 81.32

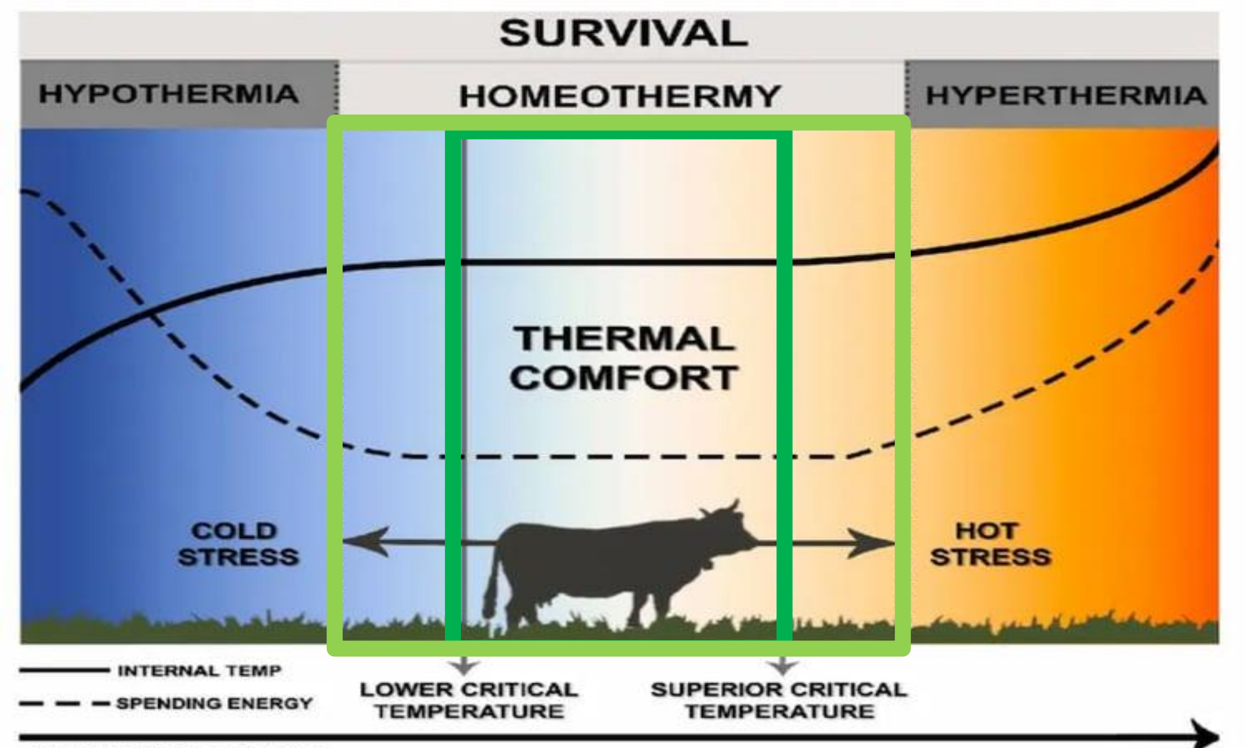
Humidity (%)

Temperature (°C)	20	30	40	50	60	70	80	90	100
22	66	66	67	68	69	69	70	71	72
24	68	69	70	70	71	72	73	74	75
26	70	71	72	73	74	75	77	78	79
28	72	73	74	76	77	78	80	81	82
30	74	75	77	78	80	81	83	84	86
32	76	77	79	81	83	84	86	88	90
34	78	80	82	84	85	87	89	91	93
36	80	82	84	86	88	90	93	95	97
38	82	84	86	89	91	93	96	98	100
40	84	86	89	91	94	96	99	101	104

- **THI < 72** - No heat stress
- **THI 72-76** - Mild heat stress
- **THI 76-80** - Moderate heat stress
- **THI > 80:** Severe heat stress

Understanding Thermal Stress

- Environmental conditions requiring minimal energy to maintain body temperature - Thermoneutral zone
- Conditions above or below the thermoneutral zone cause thermal stress



Adapted from De Oliveira Aparecido et al. 2021

- Heat stress occurs when animals cannot dissipate excess body heat
- Can increase maintenance energy requirements by 7-25% (NRC 2001)

Understanding Thermal Stress

- Normal body temp (BT) in cattle - 38.5 °C
  - Peaks 3-5 h after max daily temp (Dewell, 2018)
- BT – must be maintained within tight limits (1 °C) for normal physiological function (Robertshaw 1985)
- Challenge for cattle to maintain constant BT (Dewell, 2018)
  - Peak heat from ruminal fermentation 4-6 h post feeding (3-8% of total heat production)
    - Microbes breaking down feed
  - Heat dissipation can take up to 6 h - during cooler nighttime conditions
  - Incomplete heat dissipation – BT next day will be above thermoneutral zone (cumulative heat load)

Risk Factors for Heat Stress

- Not possible to precisely define temp. of thermal neutral zone for all cattle
- Upper and lower critical temp. depend on:

Environmental Factors

- Temperature
- Wind Speed
- Humidity
- Solar Radiation

Animal Factors

- Sex
- Hair color and thickness
- Hide thickness
- Breed
- Acclimation

Management Factors

- Shade
- Sprinklers
- Muddy pens
- Bedding
- Water
- Flow rate
- Temperature
- Accessibility

Thermal Regulation

- Convection – Air movement across skin
- Conduction – Water contact with skin
- Radiation – Heat loss from body to the atmosphere
- Evaporation – Respiration and sweating

Image Courtesy of G. Riberio (U of S)

Signs and Symptoms

- Animals alter behaviour and physiology to reduce metabolic heat to remain thermoneutral
- Confined cattle at greater risk of heat stress due to environmental constraints
- If passive transfer of heat from animals to environment cannot occur
  - Panting (main mechanism, evap. heat loss)
  - Sweating (limited in cattle)
  - Excessive salivation
  - Reduced feed intake
  - Lethargy or restlessness
  - Crowding near water or shade
  - Altered behaviour (> standing, bunching, agitation)
  - Peripheral vasodilatation

Effects on Cattle

- Depends on duration and intensity of heat stress
- Reduced weight gain and feed efficiency- diverts energy from growth to maintaining homeostasis (Lees et al. 2019)
- Reduced reproductive performance (Lees et al. 2019)
  - Negative affects on spermatogenesis and/or viability of spermatozoa
  - Impairs numerous functions associated with establishing and maintaining pregnancy
- Reduced milk production - 29 °C associated with milk yield reductions of 23% (Speirs et al. 2004)
- Increased disease susceptibility from metabolic alterations (Lacetera, 2019)
  - Immune suppression
  - Respiratory alkalosis
  - Ruminal acidosis
  - Oxidative stress
  - Increased incidence of AIP

Economic Impacts

- Canadian climatologists predict $40 billion annual loss from HS to Canadian beef industry
- No Canadian studies evaluating impacts
- Estimated annual loss in other countries
  - US dairy and beef industries - $1.3 billion (USD) (St-Pierre et al. 2003)
  - Australian feedlots 16.5 million (AUD) (Sackett et al. 2006)
- Economic impact underestimated – Estimates not based on current temp increases (Lees et al. 2019)

It can be Managed

- Cattle can acclimate to environmental changes
- Risk of heat stress increases when environmental change occurs rapidly
- Heat mitigation strategies can improve comfort and production
- Types of strategies
  - Handling
  - Water
  - Feed
  - Shade
  - Sprinklers
  - Bedding

  - Combining strategies are more effective than using a single strategy

Handling

- Handling cattle can elevate internal body temperature 0.56-2.24°C (Eirich et al. 2015)

- Handling
    - Processing
    - Pen movements
    - Sorting
    - Weighing
    - Re-implanting
    - Shipping –Un/Loading

- Recommend:
- Minimize handling to only necessary tasks when THI is severe (>80)
- Alter work hours for employees and the time-of-day cattle are handled
    - Early morning, before 10 am when temp and solar radiation is lower
- Avoid confining cattle in holding areas for long periods (>30 min)
- Restrict handling to one event/day

Water - Quantity

- Adequate water intake is necessary for overall health, optimal growth and performance (Wagner et al. 2022)

Approximate Daily Water Intake (L/Gallons)

Animal wt	4.4 °C	10 °C	14.4 °C	21.1 °C	26.6 °C	32.2 °C
600 lbs	20.1 (5.3)	22.0 (5.8)	25.0 (6.6)	29.5 (7.7)	33.7 (8.9)	48.1 (12.7)
900 lbs	23.0 (6.1)	25.7 (6.8)	29.9 (7.9)	34.8 (9.2)	40.1 (10.6)	56.8 (15)
	(Adapted -Nutrient Requirements of Beef Cattle, 7th edition)					

- Water requirements determined by:
  - BW, stage of production, diet (protein, salt, mineral), environment
- Feedlot cattle consume 87% more water during summer than winter (Arias et al. 2011)
- Approximate water intake - multiply DMI by 0.75 – estimates gallons/hd/d
  - If DMI = 24 lb/hd/d - water need is ~ 18 gallons/hd/d

Water – Access

- Linear tank space - 2-4 inches per 1,000 lbs for 5% of the pen
- Bunching around the water tanks – indicator of limit water tank space
- Split pens of larger cattle to provide additional water ta space
- Provide temporary water tanks - during peak demand
- Pens at end of supply lines most impacted by high dema
- Add tanks before extreme heat events – cattle need tim to learn to use them
- Stray voltage may further limit use of water

(Riberio et al. 2025)

Water –Flow Rate

- Water intake increases throughout the day- late afternoon demand could water supply systems

https://www.beefresearch.ca/blog/fast-action-at-the-watering-hole/

- Ensuring adequate water flow rate is critical

- Flow rate calculation example:

- To meet an 1,800-gallon demand for 100 head of cattle
  - Requires 75 gallons/h (1,800 ÷ 24 h)
  - Flow rate of 1.25 gallons/min (75 gallons/h ÷ 60 min/h)

- In summer months - daily water needs should be met in 6 h rather than 24 h
  - Based on above example -requires flow rate of 5 gallons/min

Water - Quality

- Water quality maintained by regularly cleaning water troughs and water lines
  - Prevents algae, mineral and bacterial buildup
- High TDS (sodium chloride, bicarbonate, sulfate, calcium, magnesium, silica, iron, nitrate, strontium, potassium, carbonate, phosphorus, boron, and fluoride) - reduce intake and cause toxicity
- Total dissolved solids should not exceed 3,000 ppm (NRC, 2016 8th ed.)
  Sulfate — 1,000 ppm
  Nitrite — 33 ppm
  Nitrate — 45 ppm

- Relatively few studies of water quality on water intake

Feeding and Feed

- Cattle compensate for the hotter conditions by consuming smaller meals, more frequently and during cooler parts of the day (Ray et al. 1971; Brown-Brandl et al. 2005)

- Feeding management strategies (Mader et al. 2006)
  - Time of feeding
  - Volume of feed
  - Frequency of feeding
  - Dietary energy level
  - Feed additives

- Deliver feed later in day – shifts metabolic heat load to evening when ambient temps lower

- Voluntary feed intake starts declining at ~ 25 °C to 27 °C (Beede et al. 1986)

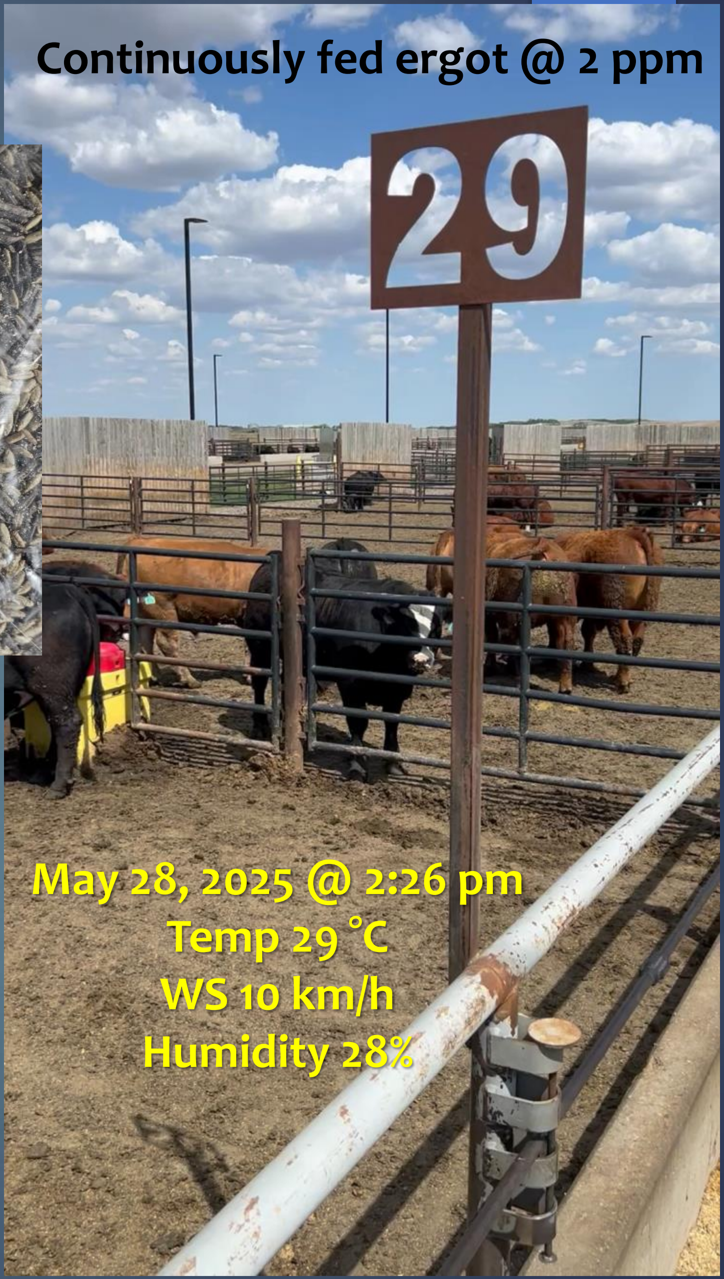
- Temperature when dry matter intake declines influenced by
  - Diet - ↑ roughage exhibit ↑ reductions in DMI
  - Breed (genotype)
  - Production and health status
  - Body condition
  - Days on feed (DOF)

Contaminated Feed

- Ergot

- Impacts of Feeding Ergot contaminated Feed (BCRC and AAFC)

  - G. Riberio (U of S) PI
  - K. Stanford (U of L)
  - K. Schwartzkopf-Genswein (AAFC)
  - T. McAllister AAFC (AAFC)



Shade

- Reduce heat accumulation from solar radiation on cattle and pen floor – up to 30% (Bond et al. 1967)

- Numerous studies on impacts of shade
  - Reduced physiological responses -panting score, respiration, temperature
  - Increased performance - BW, ADG, DMI, FE
  - Positive effects on behaviour - lying, standing, feeding/drinking, ruminating (Edwards-Callaway et al. 2020)

- Reduced water usage (Debord et al. 2024)

- Crowding at water trough reduced in shaded versus non-shaded pens

- Shade over water tanks - cooler water temperature

https://www.agproud.com/articles/52908-whats-shade-got-to-do-

Shade

https://emeat.io/news/shade-trees-keeping-cattle-cool-in-nebraska-feedyard

- Shade design and construction impact effectiveness
  - Shades > 21.5 ft^2 (sheet of plywood) did not improve cattle production (Sullivan et al. 2011)
  - Shade height - high enough not to impede equipment, air flow or heat dissipation
    - Recommend 7-14 ft (2.1-4.3m) high (Arias et al. 2011)
  - Benefits reduced if bunching occurs (Kerr et al. 2015)
  - Shades need to withstand peak wind speeds and snow accumulations
  - Lack of info on best orientation and location within a pen
  - Return on investment - variable depending on # of high THI days and shade cost
  - Shade had greatest positive effect in regions with > 700 h above 29.4°C (Brandl-Brown 2018)
    - -7.5 d/mo over a 4 mo summer period

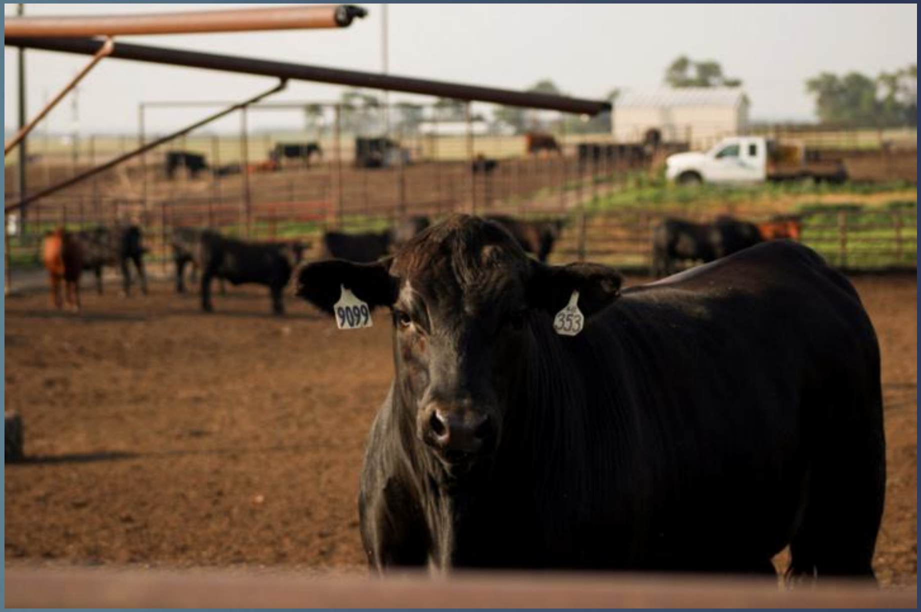
Sprinkler

- Sprinklers relieve heat stress by increasing evaporative heat loss of animals and environment (Mader 2003)
- Most effective when large droplets dispensed -wets skin and pen floors
- Mists or too fine a spray - $\uparrow$ humidity but don't wet cattle or pen needed for evaporation

https://www.dtnpf.com/agriculture/web/ag/livestock/article/2016/04/18/cool-cattle-one-drop-time

Sprinkler

- Timing of sprinkler use important for best results
  - Most effective cooling when used early morning hours peak environmental heat (Davis et al 2003)
- Avoid use in late afternoon
  - ↑ humidity at the pen floor
  - ↓water pressure during maximum water demand
- Not necessary to sprinkle entire pen



https://beef.unl.edu/beefwatch/2024/time-start-planning-heat-feedlot/

- Goal - return cattle to thermoneutrality without creating mud

Bedding

- Bedding use associated with cold weather
- Act as barrier to pen floor, ↓ thermal absorption
- Bedded areas within a pen 13.9°C (25°F) lower than a bare dirt pen floor (Rezac et al. 2012)
- Straw, grass hay, or any baled crop residue
- Best to bed pens 1 - 2 d before heat event – reduce cattle movement and disruption on the hottest days

https://www.mla.com.au/news-and-events/industry-news/woodchip-bedding-benefits-revealed/

Bedding

Environmental conditions during study

Item	Air temperature, °F	Relative humidity, %	Wind speed, MPH	Solar radiation
Mean value	97.9 (36.6)	31	3.6	780

Surface temperature of different materials in a cattle feeding pen

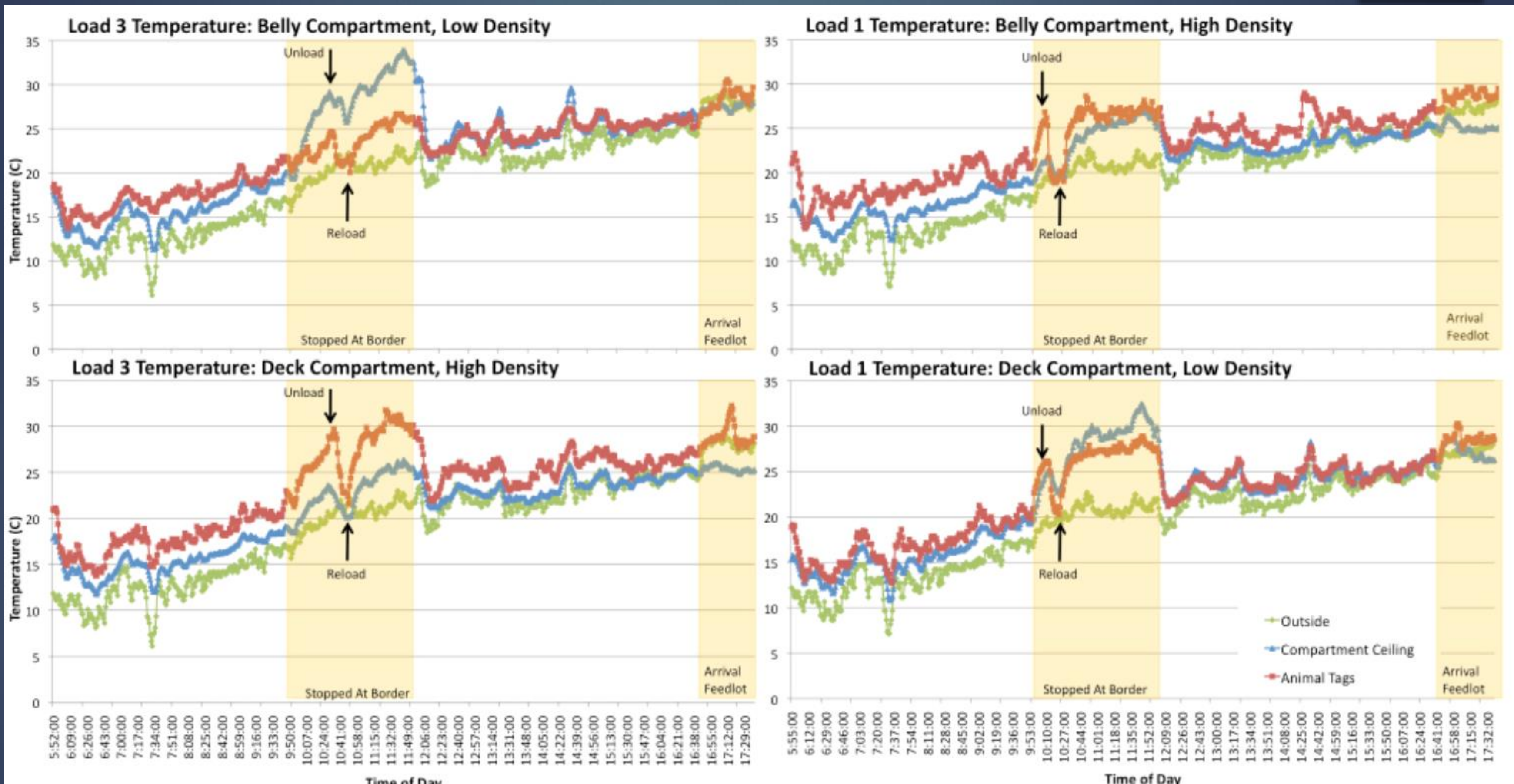
	Pen surface treatment					
Item	Bare surface	6 in. wheat straw	6 in. manure	12 in. manure	*P*-value	SEM
Surface temperature, °F	136.6[a] (58.1)	111.6[c] (44.2)	136.7[a] (58.2)	117.8[b] (47.7)	<0.0001	2.04

[abc] Means with different superscripts differ significantly ($P < 0.05$).

Rezac et al. 2012

Transport

Thermal profile of commercial cattle loads



- Temperatures ranged between -42 and 46 °C over 18 mo period during transport (Gonzalez et al., 2012a)
- Within a single trip from Alberta to California -30 to 30 °C (Schwartkopf-Genswein and Grandin, 2019)

Take Home

- Heat stress is a serious issue for beef cattle welfare and productivity
- Improved understanding of heat stress and underlying mechanisms are needed under Canadian conditions
- Focus on identifying and utilizing mitigation strategies efficient and effective at reducing heat load
- Work towards developing an integrated approach – environment, animal and management
- Prevention and early intervention are key

Thank you

Dr. Karen Schwartzkopf-Genswein

Beef Cattle Physiology and Welfare

Lethbridge Research and Development Centre

5403 –1st Ave S, P.O. Box 3000

Lethbridge, AB, Canada

T1J 4B1

Email: Karen.Genswein@AGR.GC.CA