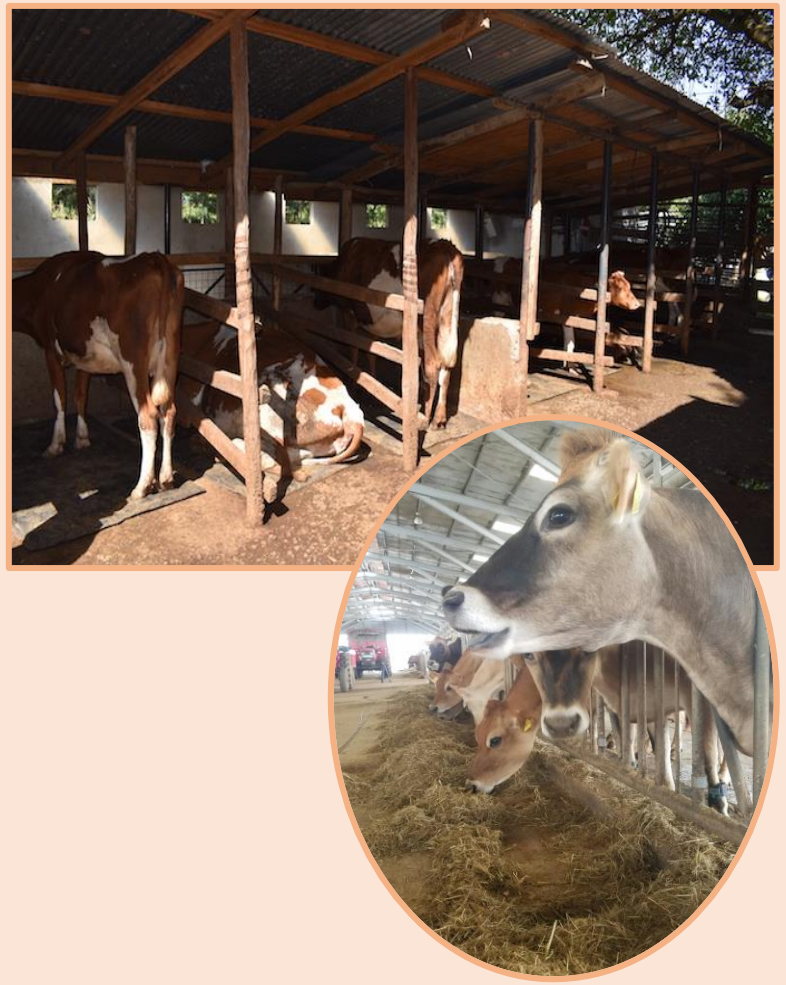
Theme 3: Animal Nutrition and Feeding

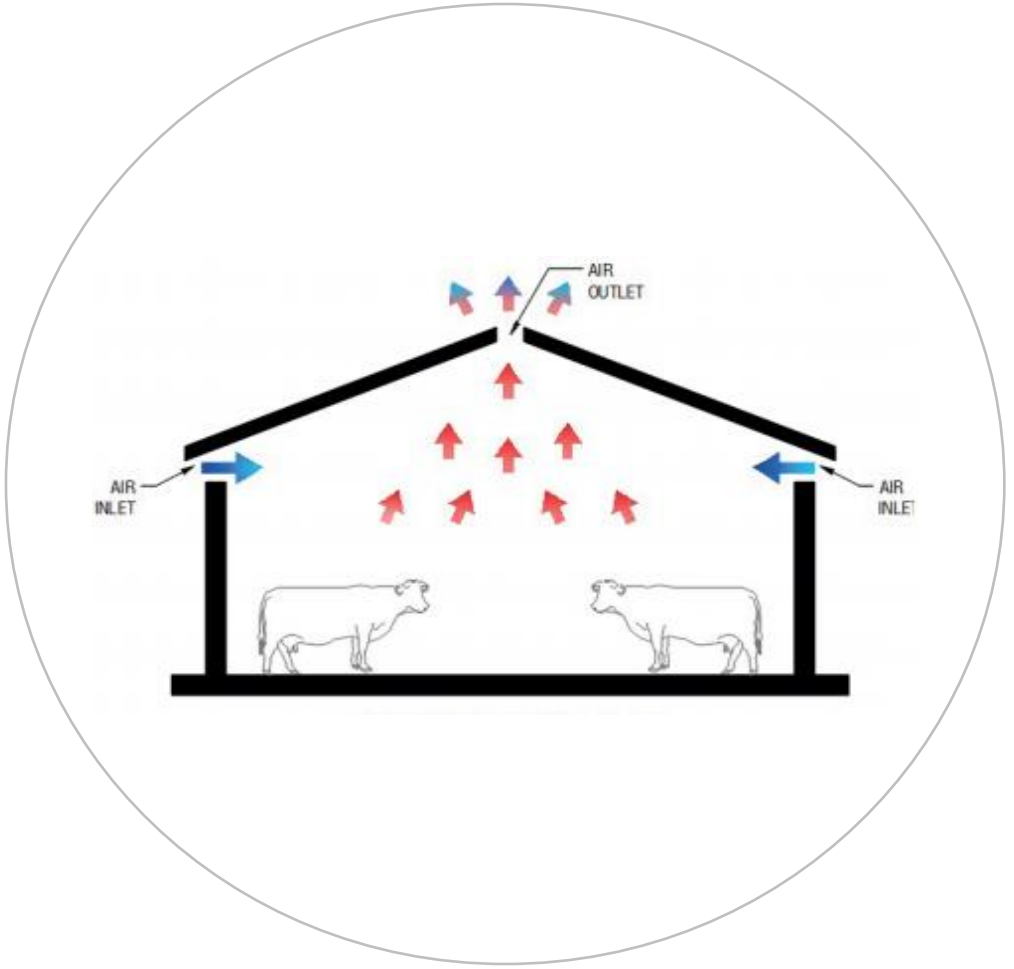
HEAT STRESS IN DAIRY CATTLE NUTRITION (Level 3)

Topic	Training & information Content
3.1	Estimating feeding value of fodder & feed on dairy farms
3.2	Sampling feeds & forages/analysis interpretation
3.3	Estimating Dry Matter intake for various breeds/age categories of dairy cattle in the tropics
3.4	Reviewing feed intake, rumen fill, Body Condition Scoring (BCS)
3.5	Life weight estimation of cows
3.6	Rumen fermentation
3.7	Mineral & vitamin requirement, guidelines
3.8	Manure scoring and evaluation
3.9	Guidelines for ration calculations for various breeds, heifers, lactation stage (Rumen8)
3.10	Use of Rumen8 software for ration calculation
3.11	Optimization of ration with Rumen8
3.12	Feeding management guidelines
3.13	Feeding management of dry cows/close-up
3.14	Feeding systems
3.15	Metabolic disorders
3.16	Scoring locomotion and hoof condition
3.17	Mycotoxin in dairy cattle nutrition
3.18	Heat stress in dairy cattle nutrition
3.19	Monitoring feeding management, using KPIs (based on Rumen8)



1. You will learn about (learning objectives):

- ❑ Heat stress in dairy cows.
- ❑ How heat stress affects nutrition in dairy cows.
- ❑ Causes of heat stress and how to prevent them.

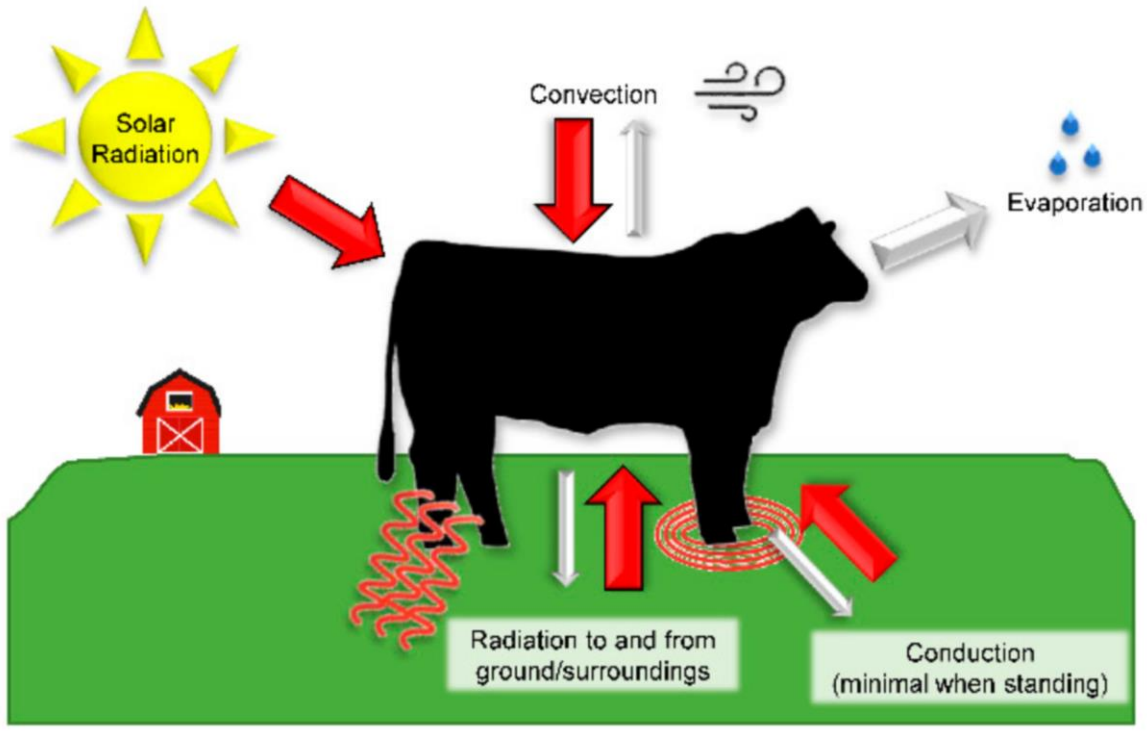


2. Introduction

- Intensive selection for high milk yield has made dairy cows less resilient to changes in climatic conditions in the tropics.
- Heat stress in some periods of the year for example, has led to reduced feed intake.
- Heat stress is further aggravated by rations high in fiber content (low digestibility), producing more heat.
- Heat stress negatively impacts performance parameters in dairy cattle and therefore possesses significant financial burden.

2.1 Introduction Cont'd…

- Heat stress occurs when cows generate and absorb more heat than they can easily get rid off.
- Cows are most efficient at a range of 4°C to 20°C.
- Failure of the cow to lose radiant heat (heat from sun and surrounding) leads heat stress.
- When ambient temperature exceeds 22°C, dairy cattle may already experience heat stress.



Heat stress

Source: https://www.mdpi.com/animals/animals-11-03539/article_deploy/html/images/animals-11-03539-g001.png

3. Factors that influence heat stress

i. Environmental and management factors
   - The weather and climatic conditions.
   - Cow barn design; ventilation and space.
   - Transportation of the cows.

ii. Cows factors
   - Milk production and stage of lactation.
   - Health.

iii. Feed.
   - Fibrous feeds with low digestibility produce more heat while being digested.

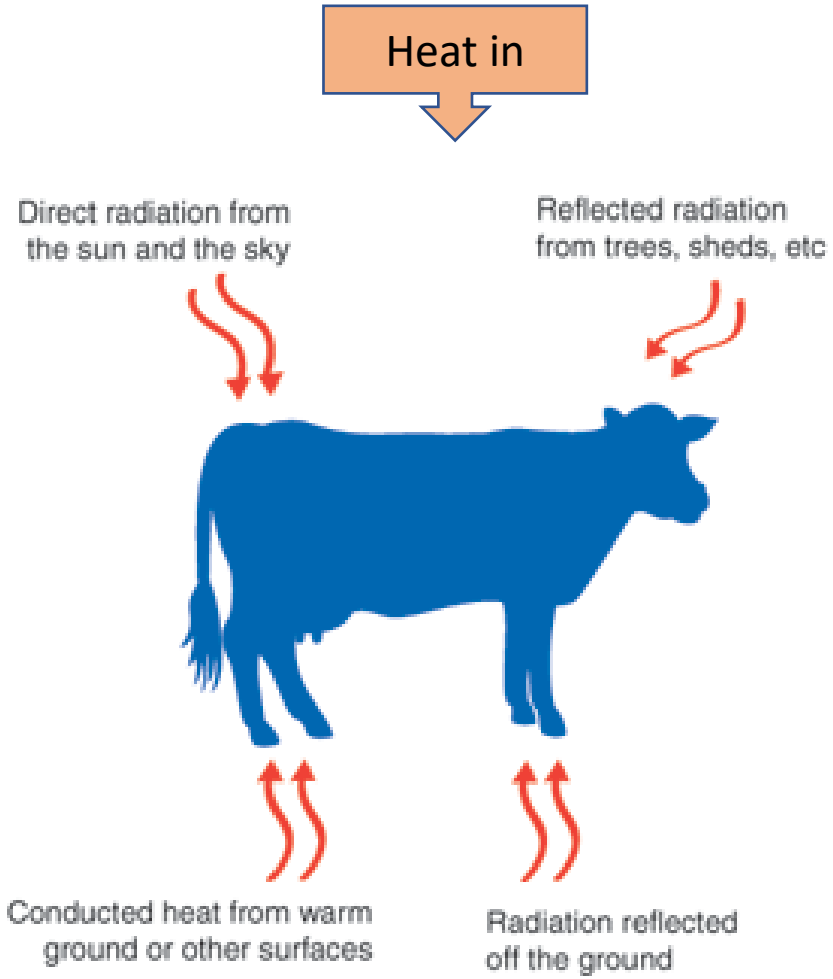
Milk production and stage of lactation

Fibrous feeds have low digestibility therefore more heat compared to less fibrous feed.

4. Environmental factors

- Cows absorb solar heat when out in the sun through radiation.
- Cows under a roof can also absorb heat from the environment especially in cow barn with minimum ventilation.
- They also get heat from the ground or other surfaces.
- Temperature and humidity levels determine when a cow may start feeling heat stressed.

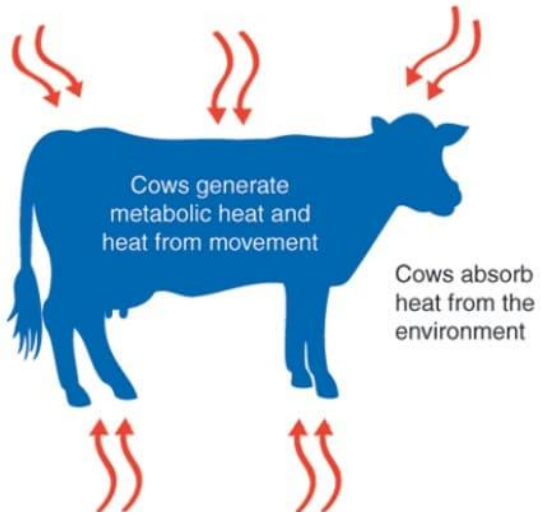
Cows get heat when out in the sun



How cows get heat from the sun and surrounding.

4.1 Environmental factors: Transporting cows

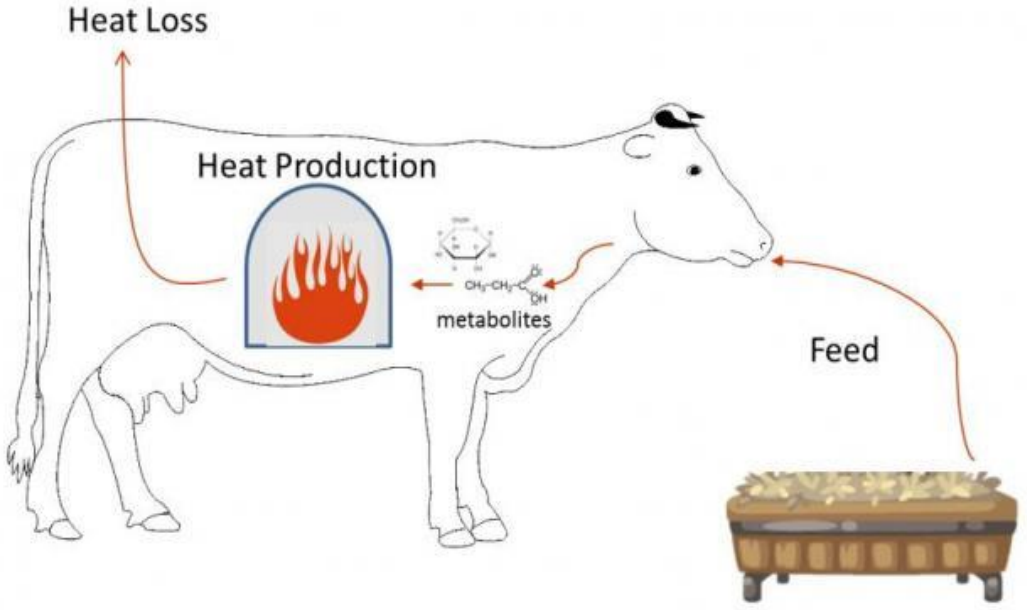
- A common time for experience adverse effects of high temperatures is during transport.
- Transport can create or worsen existing heat loads.
- Truck design can influence the environmental impact on animals.
- Handling of cows increases cows body temperature.



Track design can influence temperature gain by cows.

5. Cow factors: Heat produced from within the cow

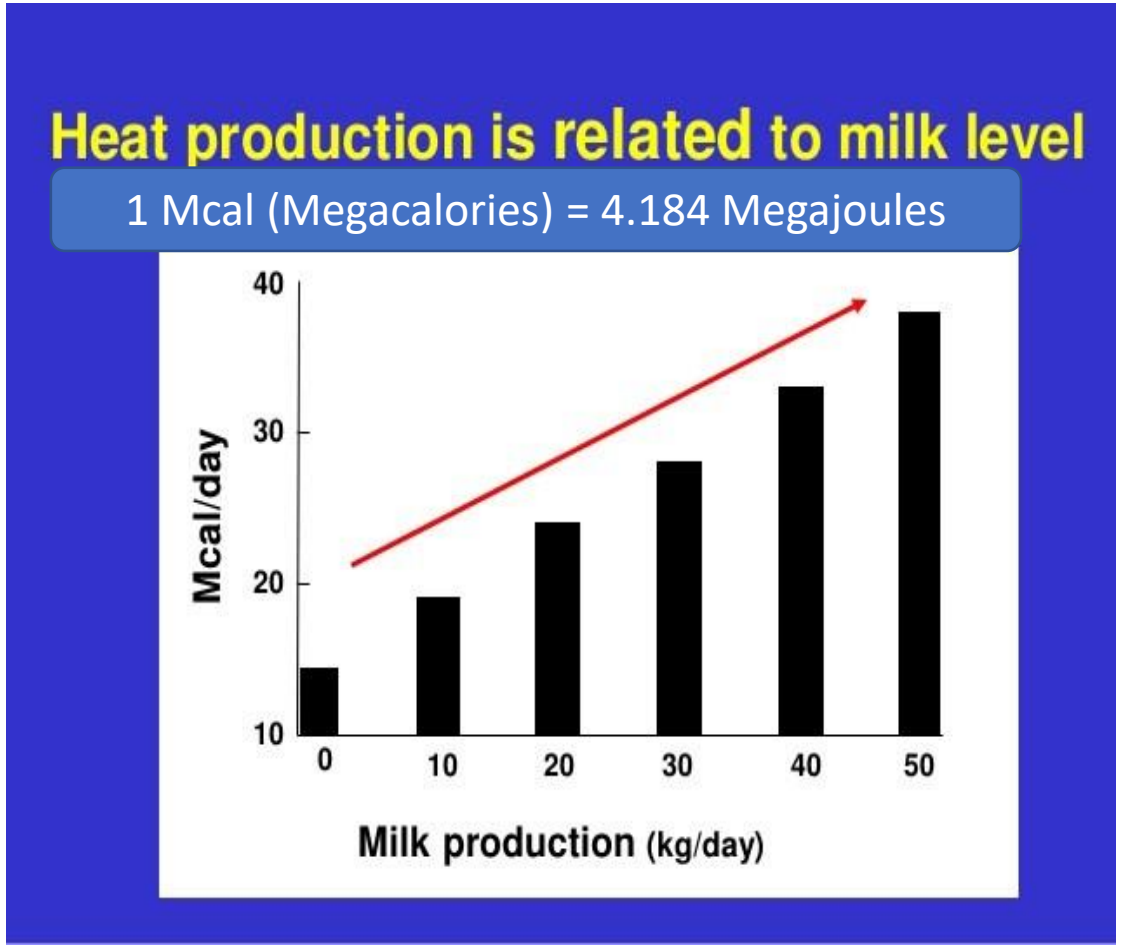
- The cow burns fuel in the form of metabolites (e.g. VFA) produced from feedstuff.
- She then uses some of the energy from the feed for milk production, muscle growth, etc.
- Some of the heat released from burning metabolites is lost to the environment.
- When heat stress occurs, it means the cow cannot lose all the heat of metabolism to the environment and therefore body temperature rises (i.e. hyperthermia).



Heat produced internally by metabolic processes	+	Heat gained from the external environment	-	Heat that is lost to the external environment

5.1 Cow factors: Stage of lactation

- Lactating cows especially during peak milk production can experience heat stress.
- In high-producing cows, the heat production is higher and the effect of a high environment temperature is more pronounced. This is because of the higher metabolic rate and heat production of the more productive cows.
- Dry cows can experience heat stress because of high fiber content in the ration with low digestibility.



6. Early signs of heat stress

i. Restless, spend increased time standing.
ii. Slight, excessive drooling or foaming.
iii. Elevated breathing with or without pushing from the flanks.
iv. Panting/open mouth breathing with tongue protruding.
v. Breathing is labored, and respiration rate may increase.
vi. Head dropped down.
vii. Individual animals may isolate themselves from the herd.
viii. Crowding around water sources.
ix. Increased water intake.

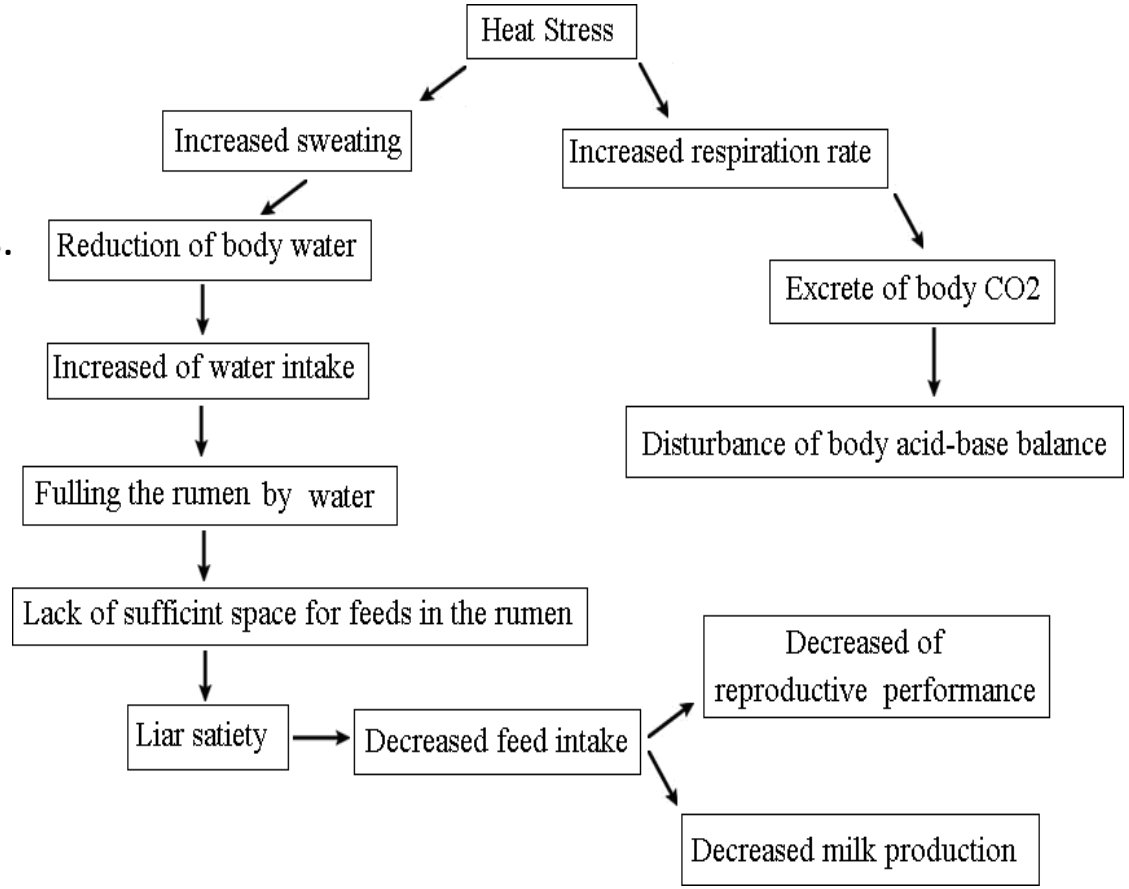
Drooling/foaming

Increased water intake

7. Effects of heat stress in dairy cows

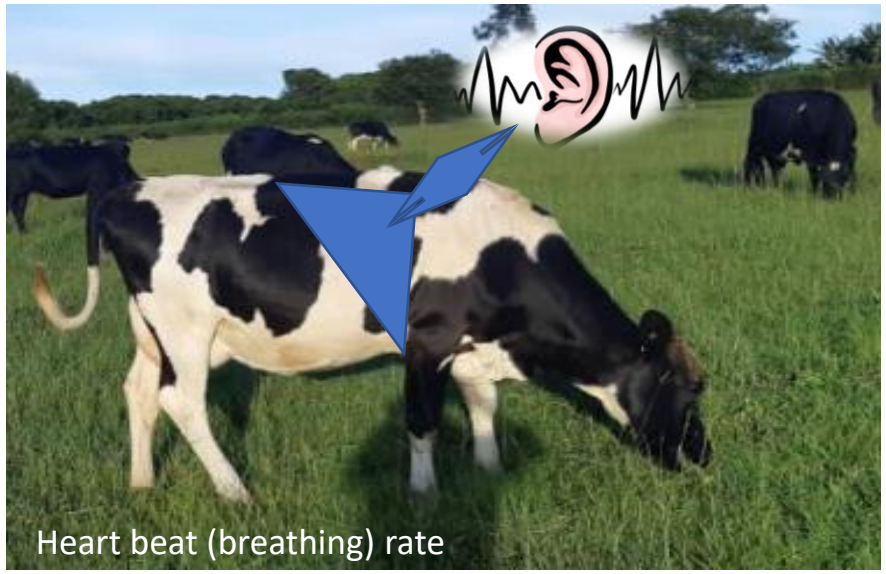
- Decreased milk production and milk quality.
- Change in body hormone levels.
- Poor reproductive performance.
- Lower calves birth weight.
- Increase the maintenance energy requirements.
- Metabolic disorders.

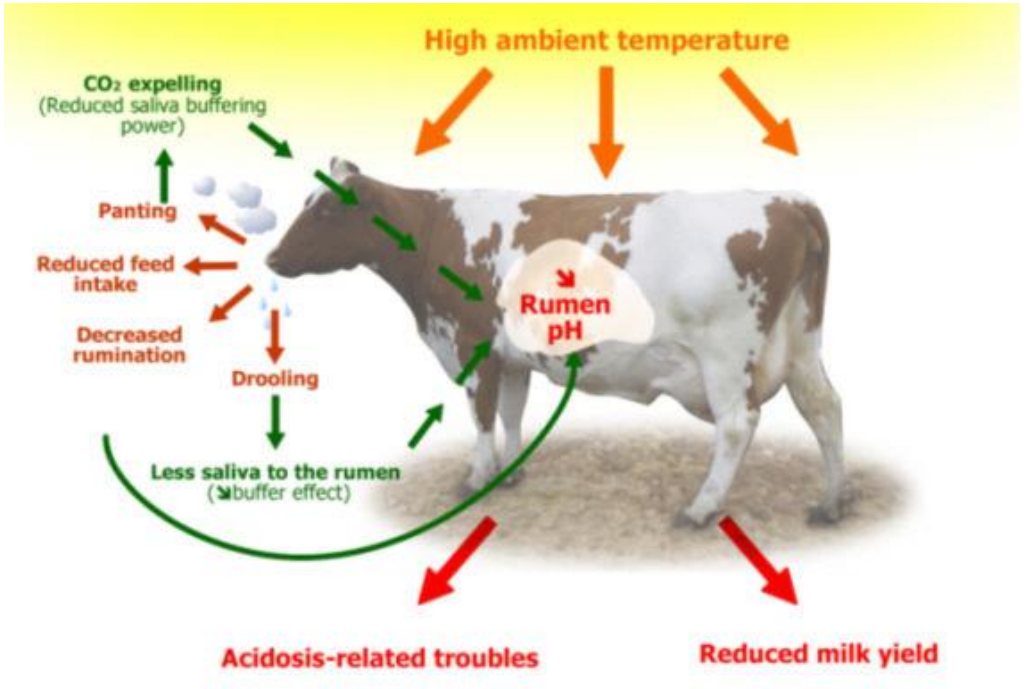
Decreased milk production



7.1 Effects of heat stress in dairy cows Cont'd…

- Increased heart beat rate and sweating.
- Decreased blood flow to internal organs.
- Changes in digestion of food, such as reduced or absent rumination (chewing of cud) and slower feed passage rate through digestive tract.
- Decreased dry matter and feed intake.
- Possible deaths.

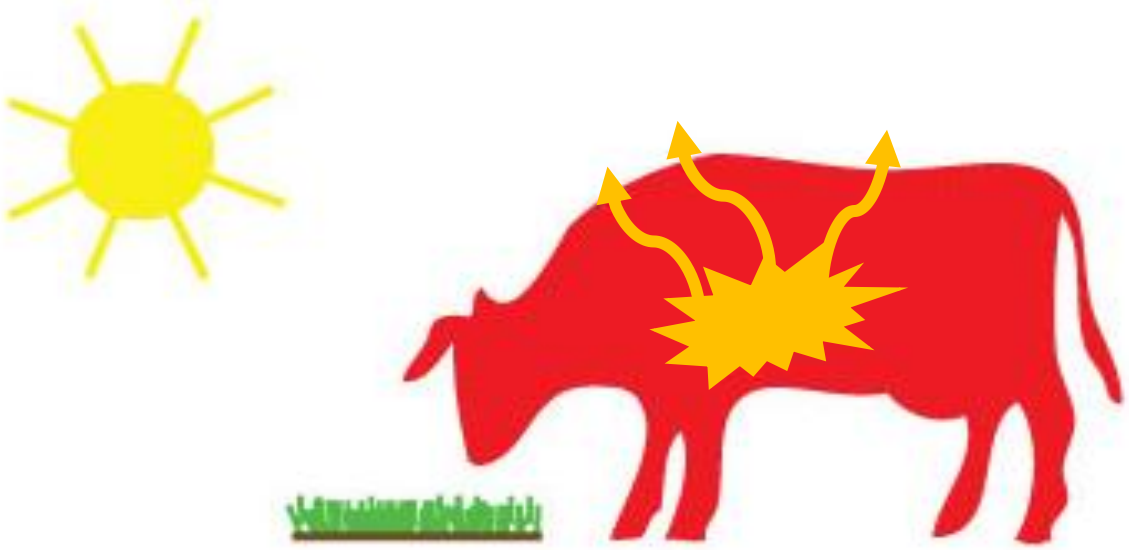

Heart beat (breathing) rate



8. Heat stress affecting dry matter intake (DMI)

- During cooler days or part of the day, cows feed intake is not affected by heat stress. The cows feed as expected.
- Cows then break down the fiber to generate energy and this process also produces heat, normally raising the cow's body temperature.
- Heat stress affect feed intake when the cow cannot lose the excess heat easily and naturally.

Heat generated after a cow feeds



Cows geta a lot of their energy by breaking down the fibre in the plants they eat. Breaking down fibre generates heat, so a cow's body temperature will naturally rise slightly after eating. Normally, this is okay, but a rise in body temperature can be dangerous if the cow is already in a hot climate.

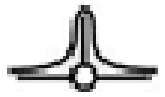
8.1 Heat stress affecting dry matter intake (DMI) Cont'd…

- The cow then looses appetite during heat stress hence feed intake is reduced.
- Eating behavior is negatively affected; cattle prefer to eat during cooler times of the morning and late evening.
- The cow tends to control the amount of metabolic heat production through reduction of feed intake.

Cows reduce feed intake in control of heat stress

9. Effects of reduced/depressed DMI

- This lowers rumen pH (more acidic) causing rumen acidosis.
- Lowers chewing of cud and gut motility.
- Reduces milk fat.
- Drop in milk production.
- Water and electrolyte loss.
- Body condition of the cow drops.

Body Condition Score	Vertebrae at the middle of the back	Rear view (cross-section) of the hook bones	Side view of the line between the hook and pinbones	Cavity between tailhead and pinbone	
				Rear view	Angled view
1 Severe underconditioning					

10. DMI management during heat stress

- Feed total mixed ratio (TMR) or forage, more frequently during cooler periods of the day.
- Feed a TMR to avoid selective eating and to maximize DMI.
- Provide a cool area for forage feeding.
- Manage the silage bunkers to avoid heating and molding of the silage face surface.
- Use quality forage to maintain required fiber level.

Manage silage bunkers.

10.1 DMI management during heat stress Cont'd…

- Raise nutrient density of the ration. Forage generates more heat than concentrates (e.g. grains) during digestion.
- Increase minerals to make up for losses in sweat.
- Maintain forage and water quality and availability.
- Add fat to the ration to boost energy intake (only economically viable for high producing dairy cows).
- Possibly have funs and or sprinklers over feeding areas when cows are kept indoors.

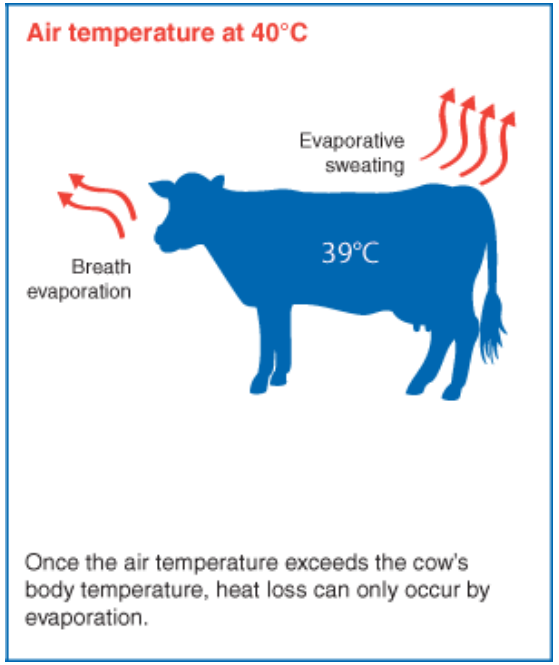
Increase minerals.

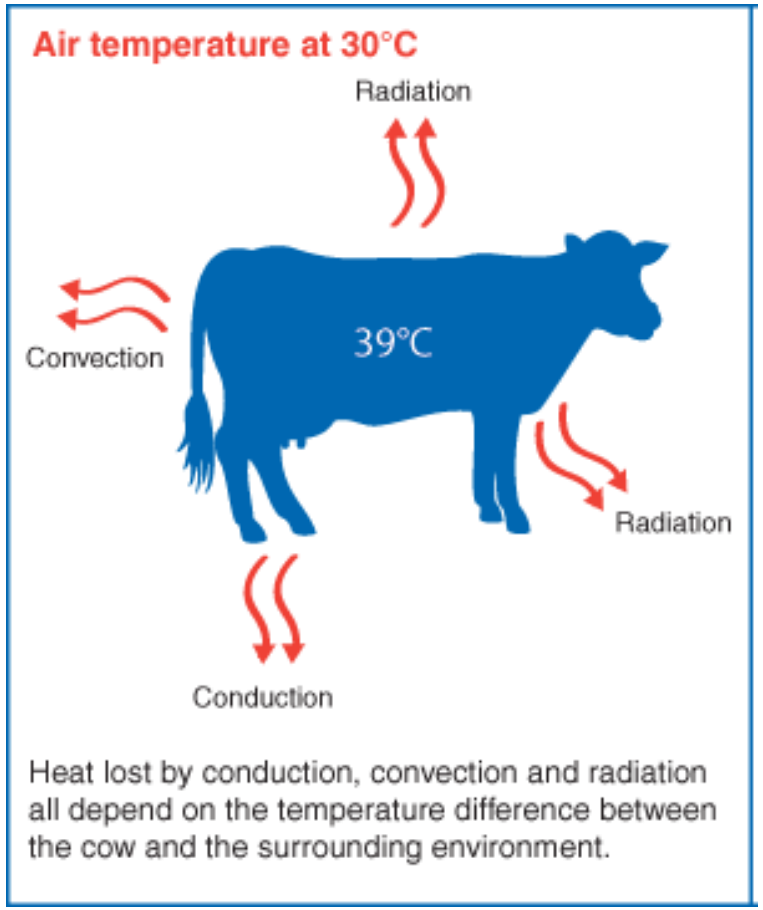
Quality water.

11. How cows lose heat

- Cows can lose body heat through conduction, convection, radiation and evaporative cooling.
- Conduction is based upon the principal that heat flows from warm to cold; physical contact with surrounding objects.
- When a cow wades into a pool, she is cooled by conduction.
- Convection occurs when the layer of air next to the skin is replaced with cooler air.

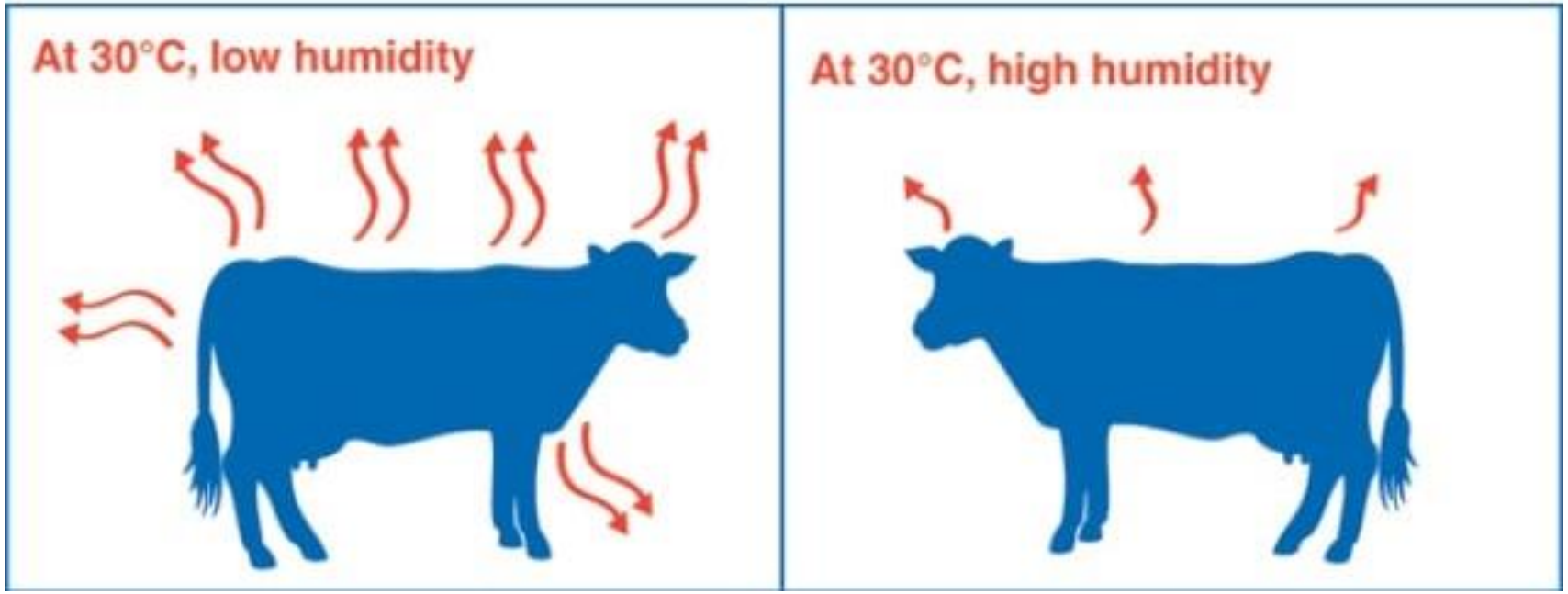
Cows wade into a pool of water to lose heat.





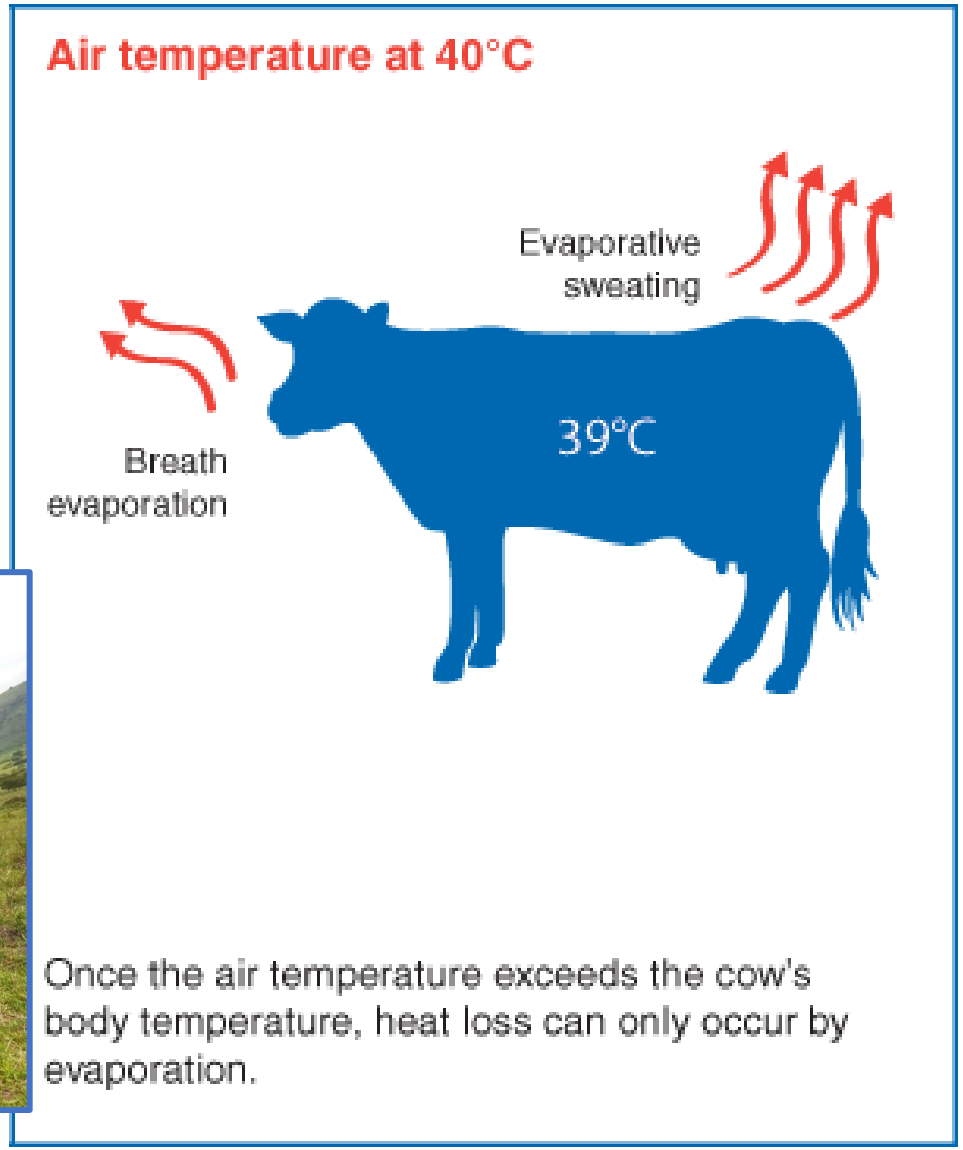
11.1 Humidity

- Environmental humidity (air moisture) affects heat stress.
- Air moisture can influence the rate of evaporative heat loss from dairy cows through both skin and the respiratory tract.
- Humidity can affect heat loss from a dairy cow under high temperature conditions.
- Therefore, the performance of a dairy cow falls markedly in hot and humid conditions.



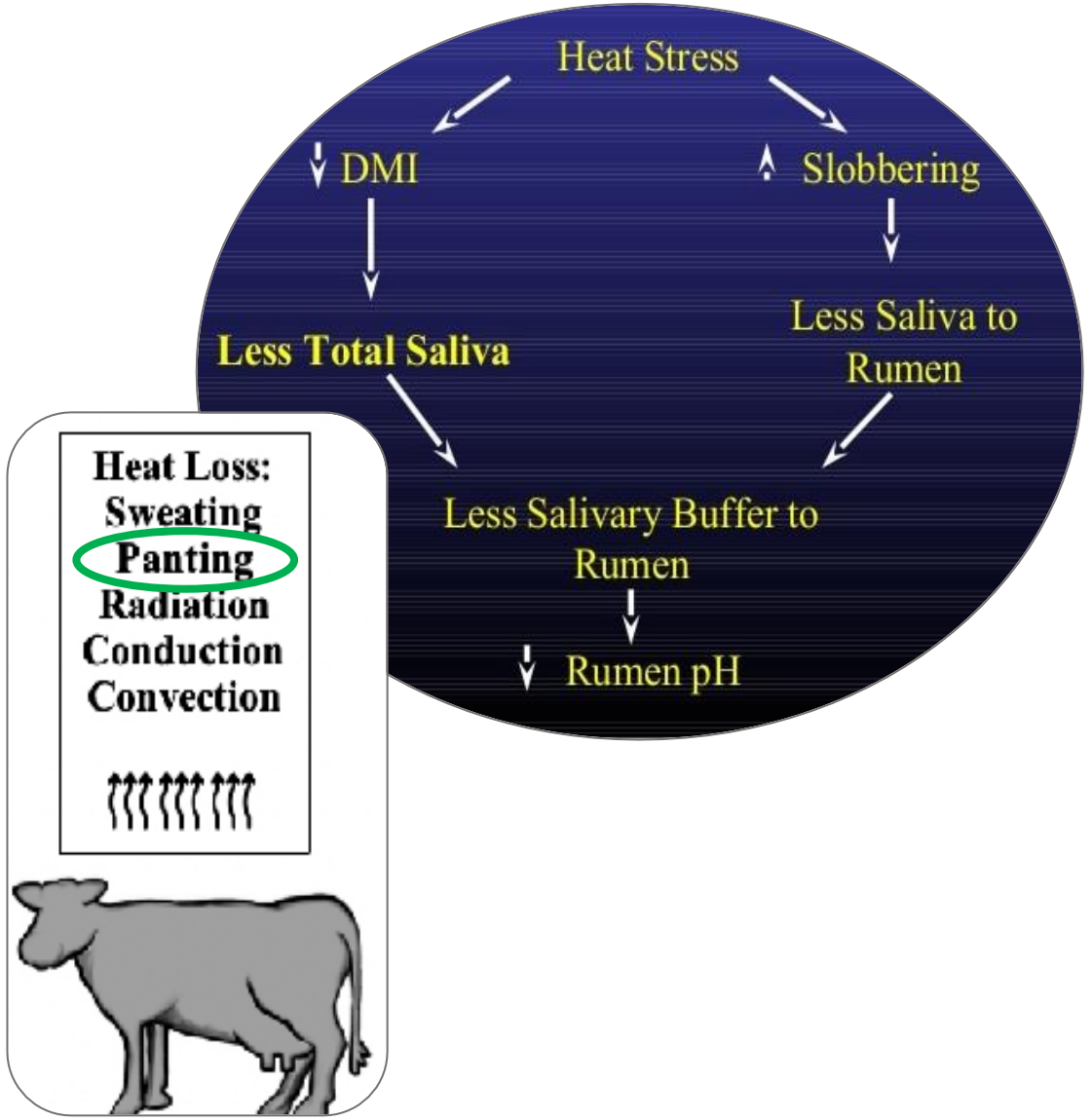
11.2 Evaporation for heat loss

- Evaporative cooling occurs when sweat or moisture is evaporated from the skin or respiratory tract. This explains why dairy cattle sweat and have increased respiration rates during heat stress.
- High humidity limits the ability of the cow to take advantage of evaporative cooling.
- Thermal environments have several aspects, including air temperature, humidity, air movement, and radiation rate.



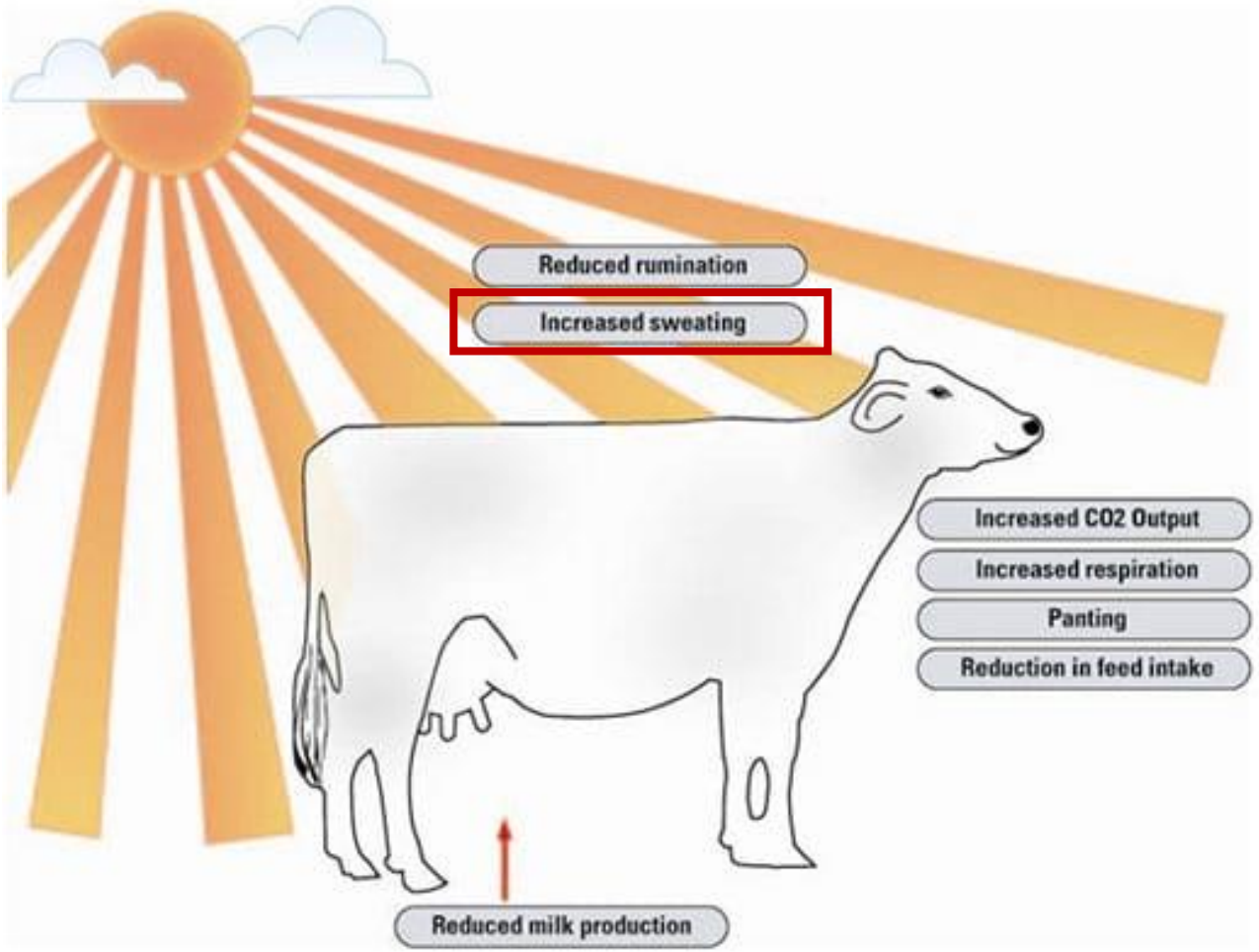
11.3 Panting

- During panting high volumes of carbon dioxide are excreted and this results to a disturbance in acid-base balance in the rumen.
- Heat stress leads to high loss of saliva (from drooling and open-mouthed breathing) in hot weather.
- This decreases the amount of natural buffers to the rumen contributing to acidosis.



11.4 Increased sweating

- During heat stress the hypothalamus activates sweating for cooling.
- Water, sodium, potassium and chlorine are important constituents of sweat and is lost when the animal is sweating.
- Addition of sodium bicarbonate or simply salt to the ration may be useful to prevent rumen acidosis in such a situation.



Source: https://images.engormix.com/e_articles/1019_01.jpg

11.5 Increasing water intake

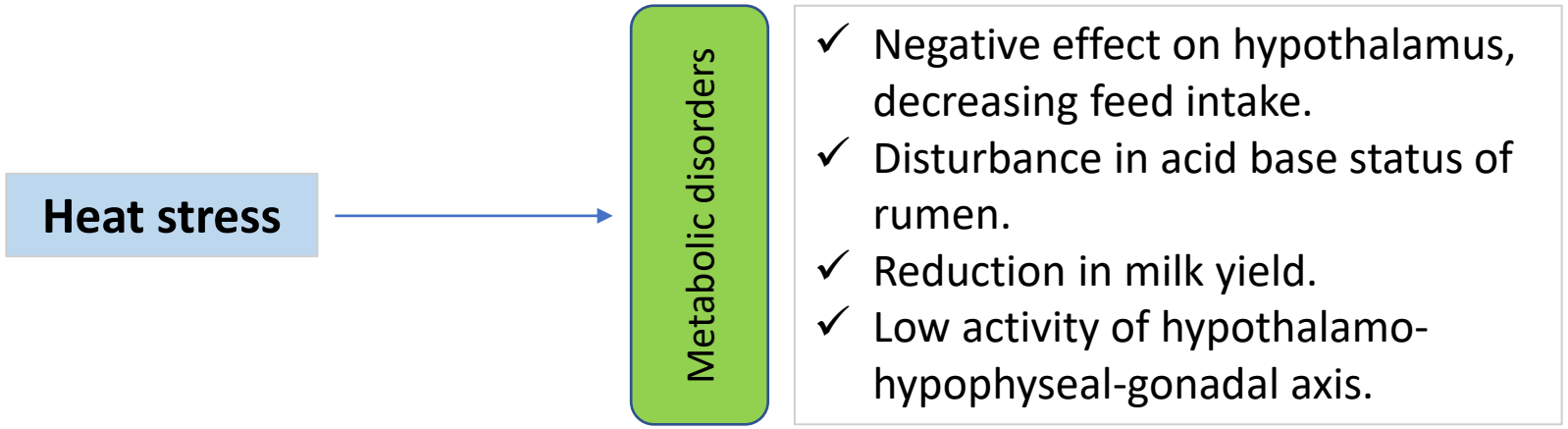
- Cows drink water during heat stress to cool themselves.
- Sweating leads to loss of body water and this aids in increasing water intake.
- High-yielding dairy cows may drink more than 100 liters/day; this can increase during heat stress.
- Water quality and cleanliness of the water troughs should be checked daily.
- The water temperature matters a lot for cooling the cow.

11.6 Increasing water intake Cont'd…

- Increasing water intake during heat stress however causes filling of the digestive tract.
- Cow tend to eat less during heat stress and drink more water.
- This lead to reduced feed intake due to the cow feeling full.
- Finally leads to nutritional deficiency due reduced feed intake per day.

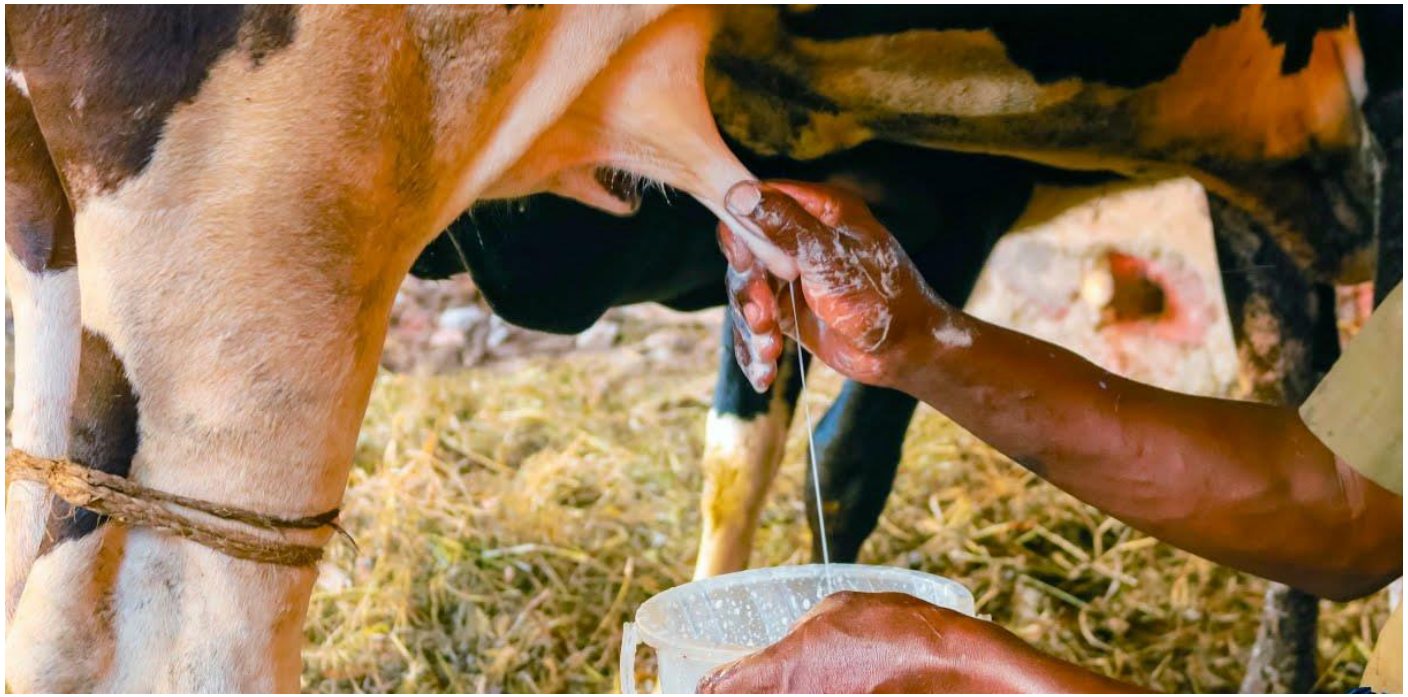
11.7 Decreasing blood flow

- Decreasing blood flow in the internal organs leads to lower activity of digestive tracts organs, especially the rumen and intestines. The frequency of volatile fatty acid production in the rumen is thus decreased.
- This lowers activity of digestive organs that lead to slower movement of feed particles in the gut.
- This is responsible for the rumen filling and finally, cows appetite will be reduced.



11.8 Change in milk production and composition

- This is majorly affected by change in feed intake caused by heat stress.
- Milk production decline is the most negative economic effect of heat stress (reduces farm profitability).
- Heat stress alters composition of milk through reduction of milk fat and protein content.

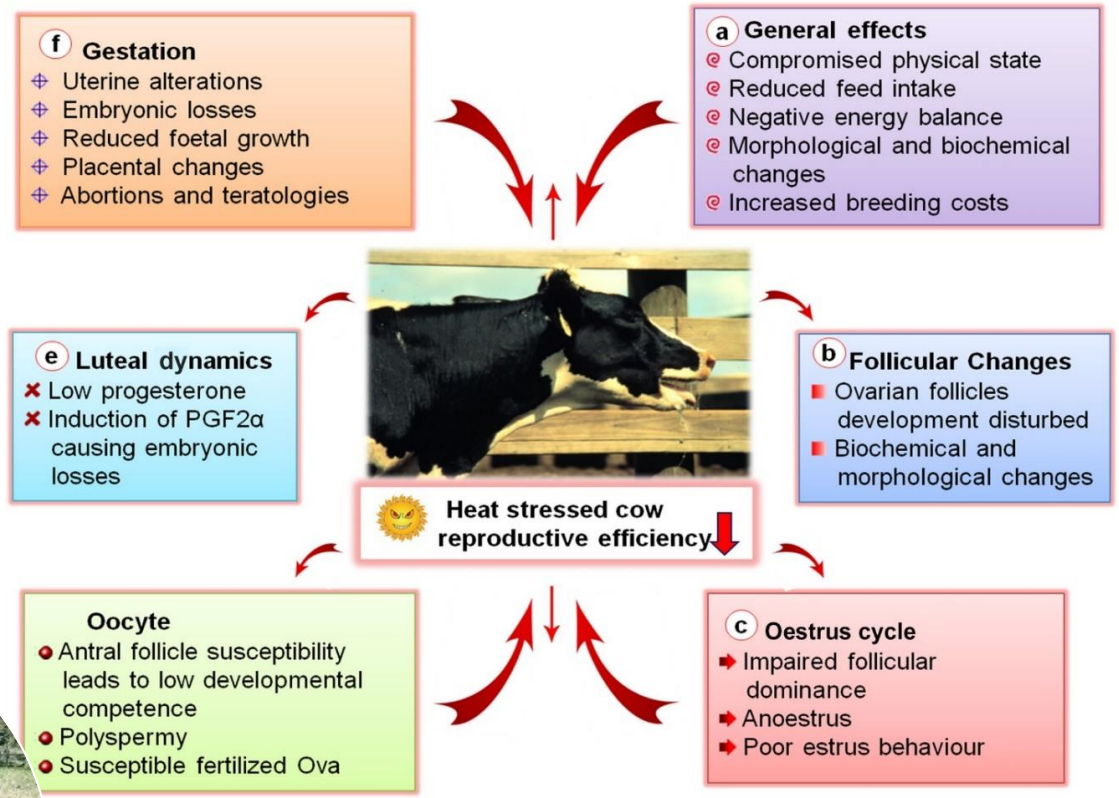


11.9 Change in reproductive performance/fertility

- Heat stress can affect cows reproductive performance/fertility.
- Heifers reared under heat stress conditions usually have significant delay in maturing and have a delay in first ovulation.
- Decline in fertility in hot environments is closely related to an increase in body temperature.

11.10 Reduced weight and body performance

- Heat stressed pregnant cows consume lower feed especially in late pregnancy, lowering nutrient for the cow.
- This results in lower nutrient availability for fetal growth, hence lower calves birth weight.
- Heat stress leads to reduced body condition of the cows. The weights of both heifers and cows drop during this stress load.



12. Preventing heat stress

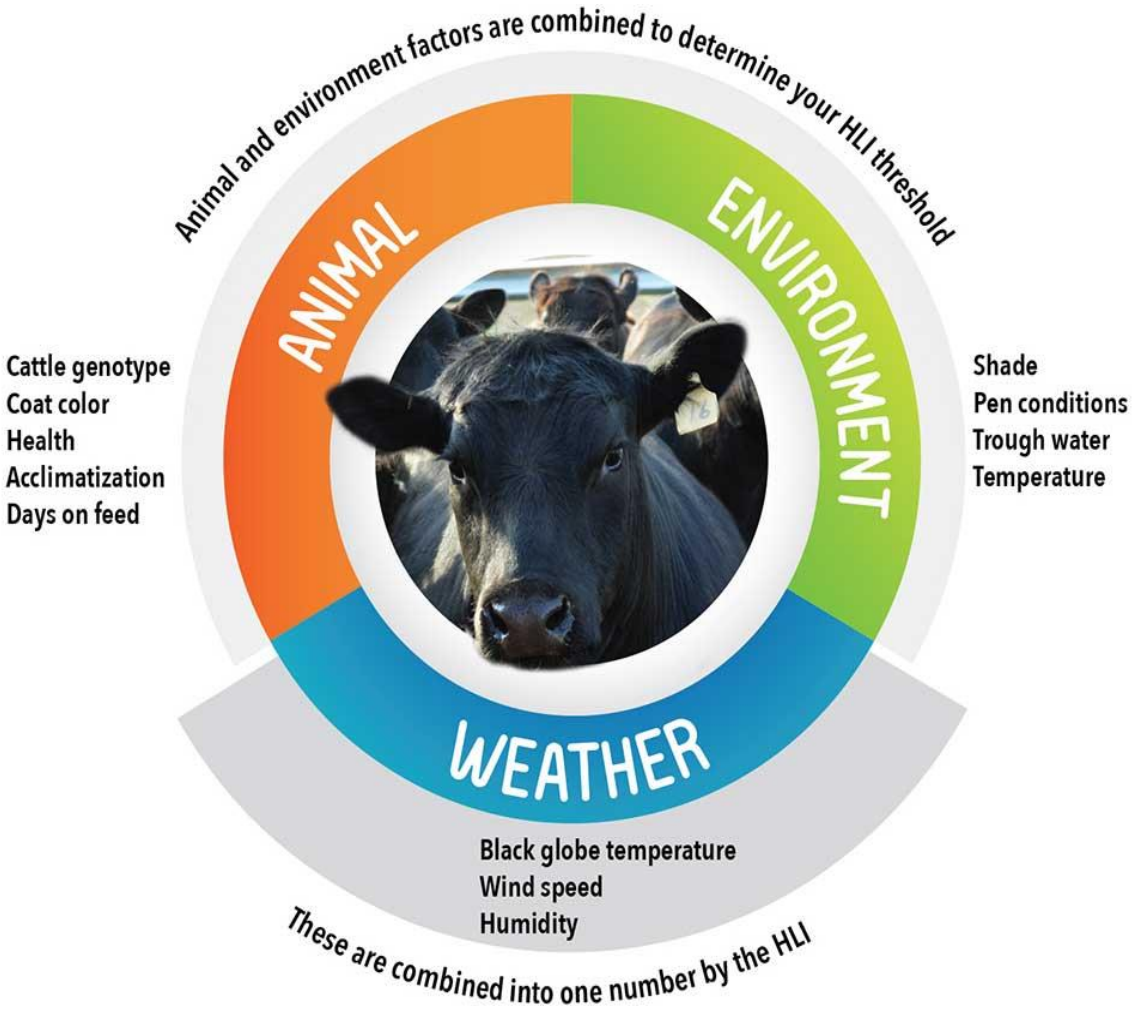
- Provide shades for the outdoor cows for cows grazing.
- Increase the efficiency of feed energy utilization, and reducing the heat increment of animals by feeding strategies.
- Lower the environmental temperature by modifying for cows that are housed indoors (cow barn), provide adequate ventilation.
- Under severe condition of heat stress, increase heat loss from animals by sprinkling them with water, using fans.

Natural shade under tress

Structure shade in the fields

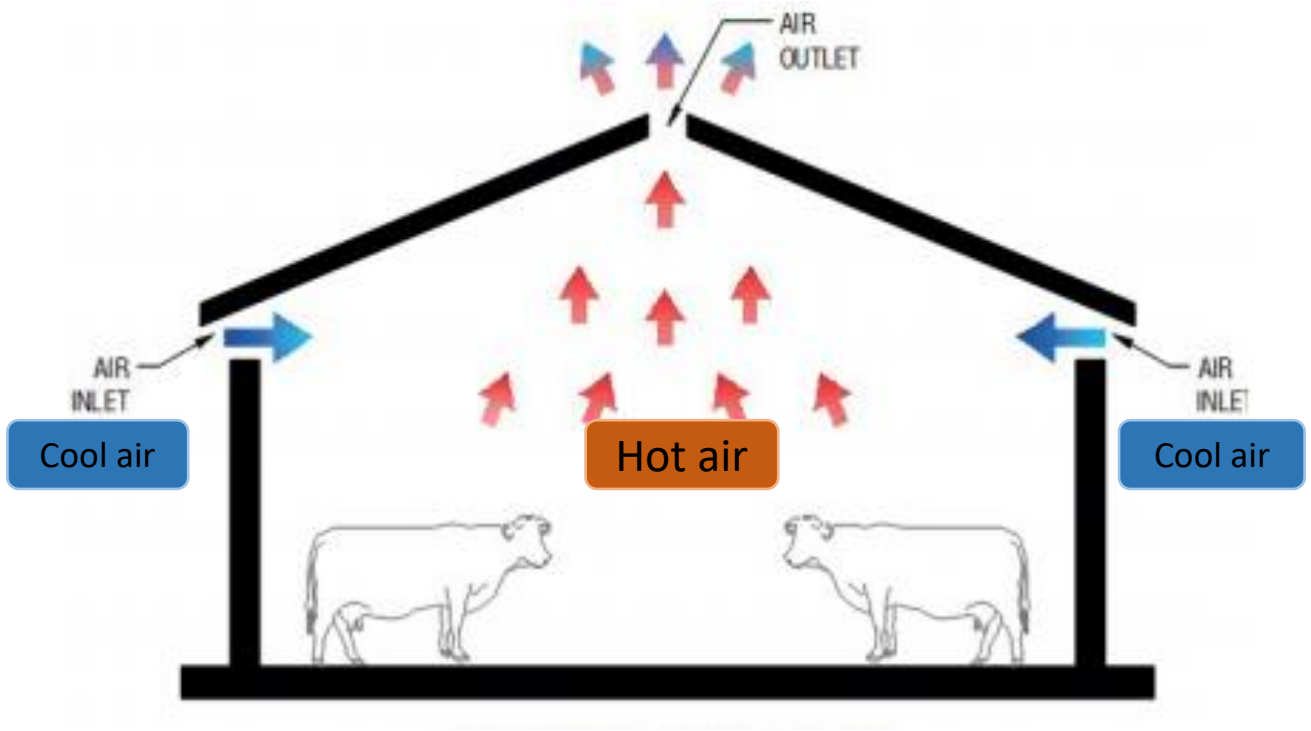
12.1 Methods of preventing heat stress Cont'd…

- Reducing and preventing heat stress in dairy cattle requires a multi-disciplinary approach.
- Breeding of dairy cows (cross breeds) for improved heat tolerance is a long term process.
- However, this is not a practical way in most dairy farms in a short period of time.



12.2 Cow barn as a prevention measure

- Reduce incoming of air high in temperatures.
- Proper ventilation is key and a cow barn expert should be consulted.
- Space is important for avoiding overcrowding in the barns.



13. Take home messages/Summary

i. Heat stress acclimation process causes several physiological, endocrinal and biochemical changes in the dairy cattle.
ii. Heat stress greatly affect feed intake in cows, leading to reduced performance.
iii. Breeding of dairy cows for improved heat tolerance is a long term process.
iv. Recommended cow comfort and barn structure can contribute to solving heat stress.

- END -