

*Theme 8: Animal housing*

# PREVENTION OF HEAT STRESS IN COW BARN (Level 3)

Topic	Training & information Content
8.1	Farm structures & housing cows/calves/young stock
8.2	Construct small zero grazing unit (SNV handbook)
8.3	Prevention of heat stress in cow barns
8.4	Cow house ground floor plan design (SNV book)
8.5	Best management practice feed fences.....
8.6	Housing & cow comfort (animal welfare)
8.7	Housing & reduction greenhouse emissions
8.8	Use of sensors (activity meter) in dairy herds



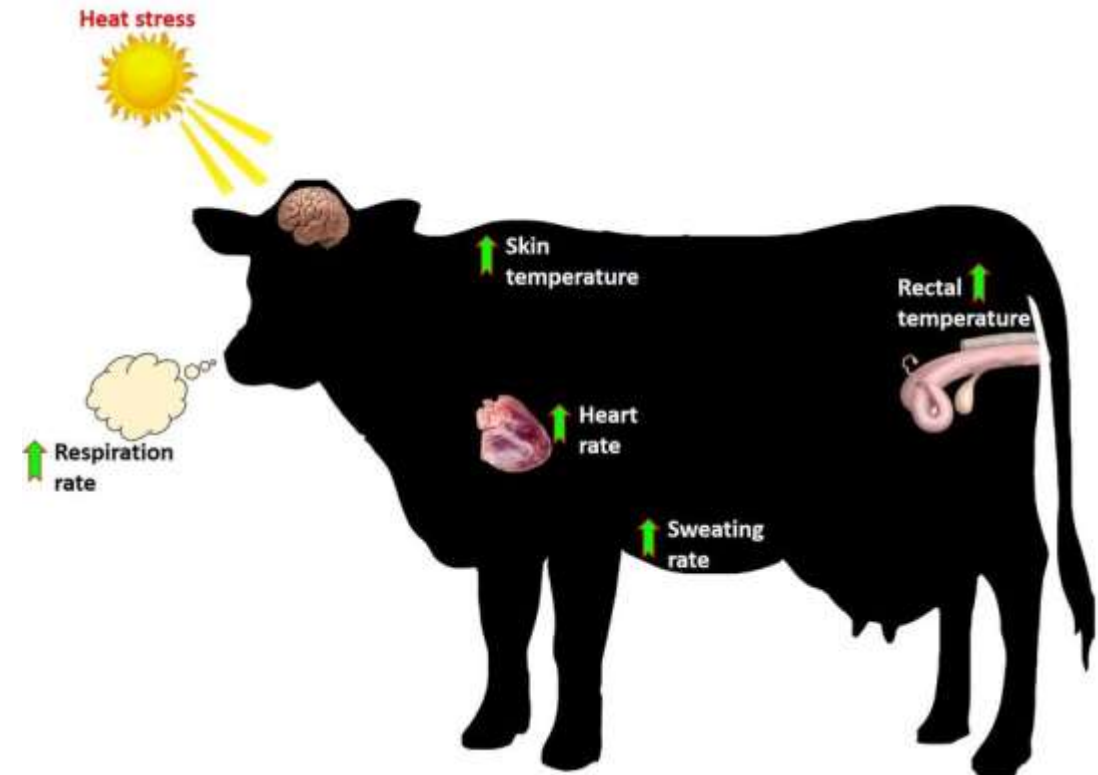
## 1. You will learn about (learning objectives):

- ❑ Housing recommendation for different climatic zones in Uganda.
- ❑ Know factors to consider so as to reduce heat stress in a cow barn.



## 2. Introduction

- The climate can have a considerable effect on animal production and it influences dairy farming systems, for example: heat.
- Animals (cows) exchange heat with their immediate surrounding (environment) so as to regulate their body temperature.
- The animals ability to regulate her internal body temperature is a result of her internal body activities, this can be slowed or fastened by climatic conditions.
- Cow housing with considerations of various methods of environmental modification like ventilation helps manage, reduce and avoid heat stress.



### 3. Causes of heat stress for cows in the cow barn

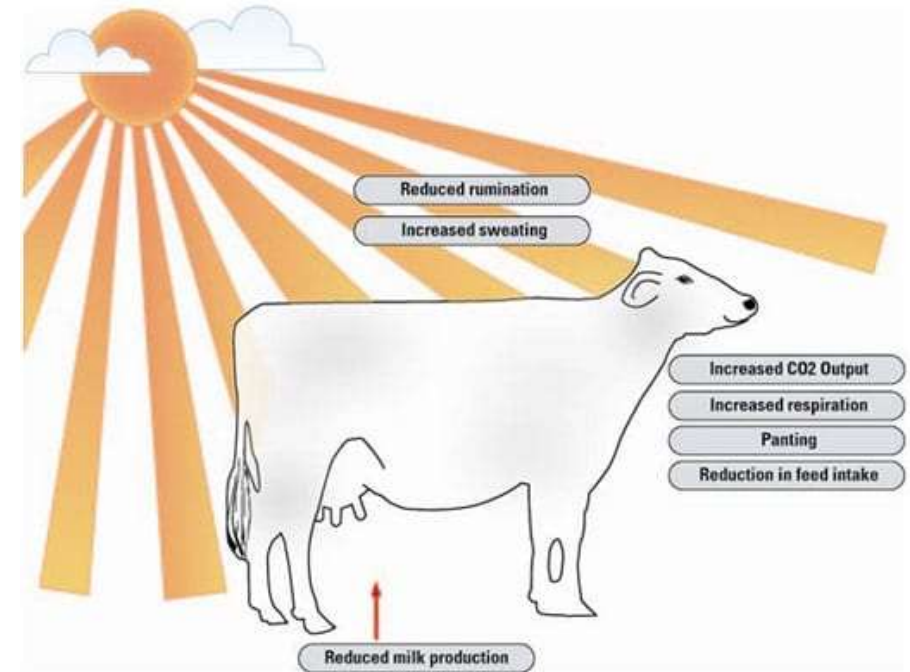
- Prolonged high temperatures are a major cause of heat stress for cows.
- Within the cow barn but also outdoors other factors that contribute to heat stress are:
  - Limited access to shade (pastures).
  - Overcrowding which results in limited air circulation.
  - Poor ventilation which results in limited circulation to fresh and cool air.
  - Limited access to clean drinking water.



**See module on: Heat stress in dairy cattle nutrition**

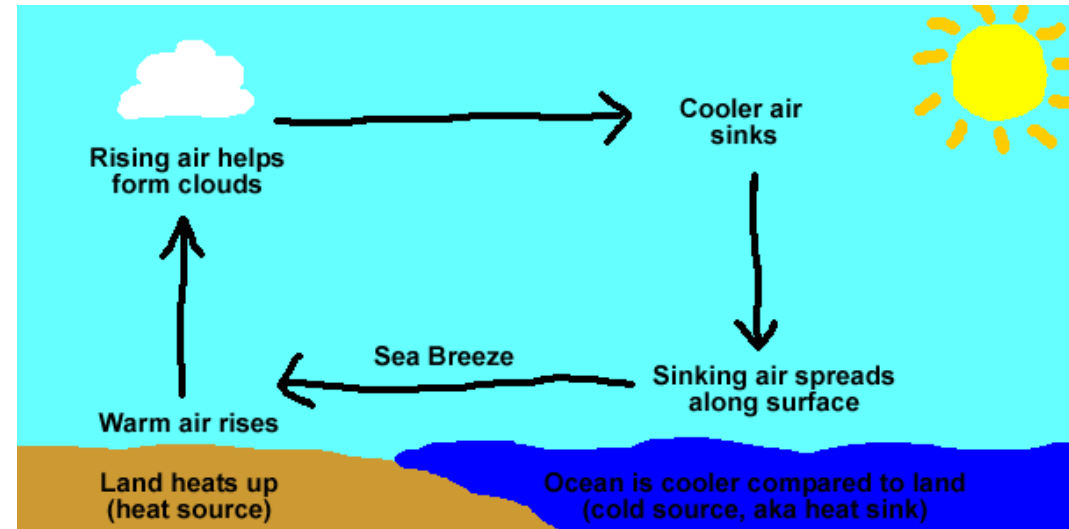
## 4. Heat stress in high yielding cows

- In extreme conditions of heat stress high yielding cows will be more affected compared to the other group of cows.
- High yielding cows produce a lot of heat compared to other groups of cows, high yielding cows for one take more feed in a given time hence produce more heat as a by product of metabolic activities this can be increased if feed is high in fibre content (low digestibility).
- When cows produce a lot of heat it is often hard for the cows to get rid off the excess heat from their body, coupled with extreme climatic heat conditions this will affect the wellbeing of the cow.
- This is the reason that under extreme climatic heat conditions it may be challenging to keep and manage high yielding cows.



## 5. Major climatic (thermal) factors

- The climatic conditions are influenced by for example:
  - Air temperature – (measure of how hot or cold air is), it is the immediate surrounding influenced by heat exchange
  - Relative humidity – (ration how much water vapour is in the air compared to the maximum possible), water vapour content in the environment affects capacity of heat loss.



## 5.1 Major climatic (thermal) factors cont'd...

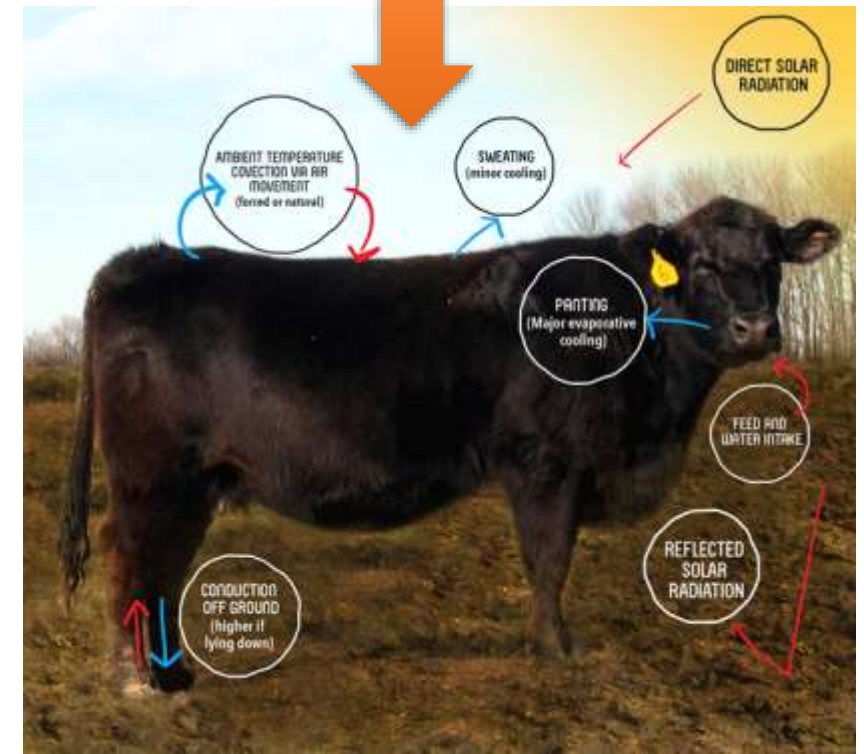
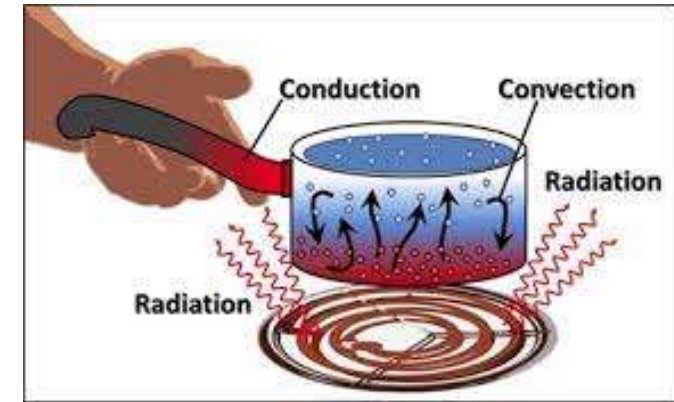
- Air movement (wind).
- Solar radiation (heat transfer method).
- Precipitation – (any liquid or frozen water that forms in the atmosphere and falls back to the Earth), comes in the form of for example: rain, hail.



## 6. Understanding heat exchange in the environment

- The different ways that heat flows (exchanges) in the environment is dependant on the temperature gradient of the environment and the surface (cow's skin).
- Temperature of the skin establishes gradient for body heat exchange with the environment by different avenues.
- There are 4 ways of heat exchange with the environment namely:
  1. Radiation (sun)
  2. Convection (air movement)
  3. Conduction (objects-direct contact)
  4. Evaporation (point of exchange)

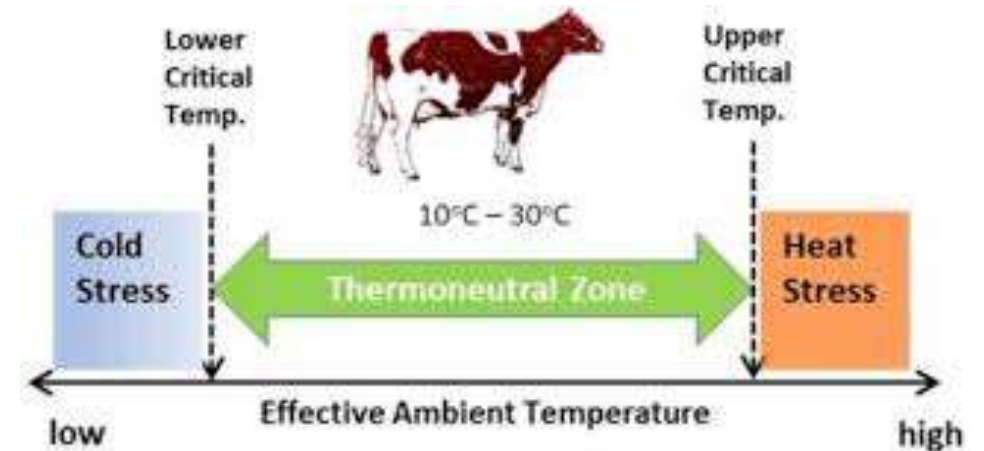
- Check module on: Heat stress in dairy cattle nutrition





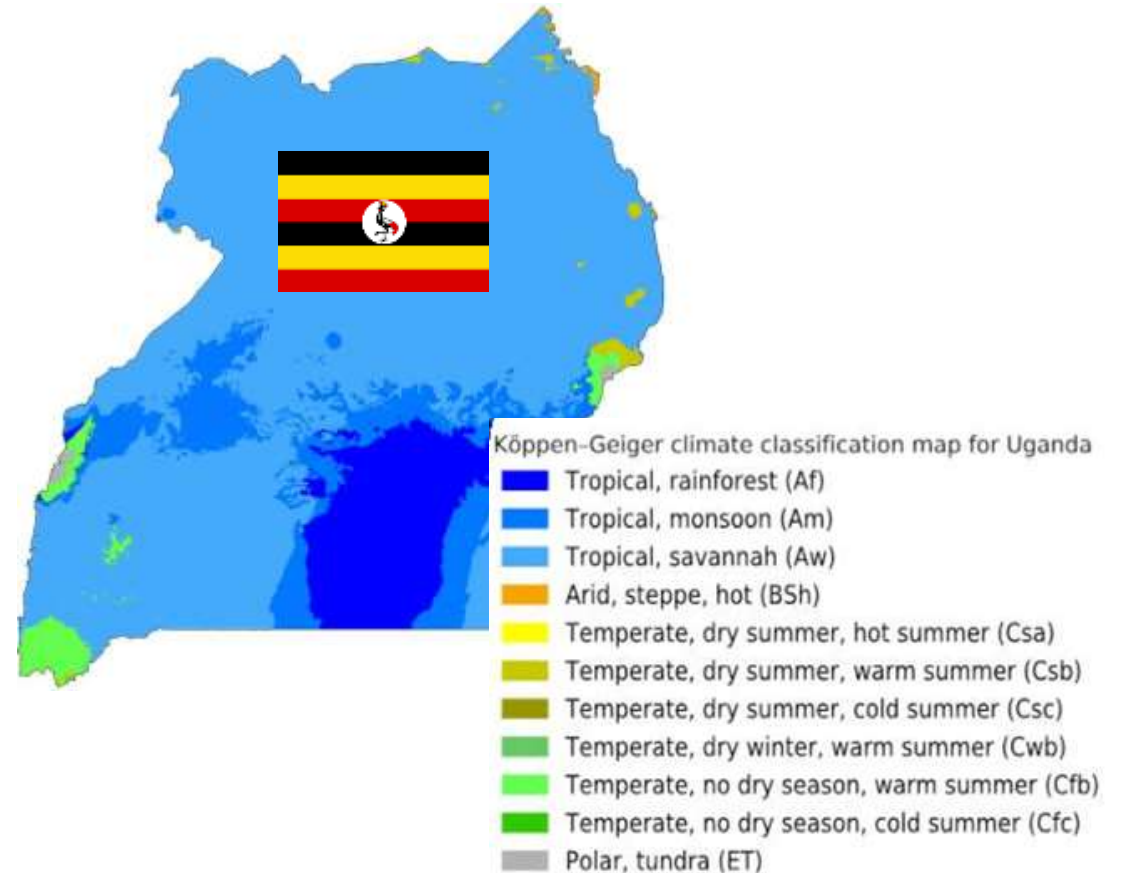
## 7. Heat exchange in the environment vs cow's body

- The environmental temperature and cows skin temperature influences heat exchange.
- Blood flow through the skin is an important determinant of the skin temperature rising or falling.
- In a neutral environment (not cold or hot) and zero skin blood flow, the skin temperature will be the same as that of the environment.
- When blood flow to the skin rises, its temperature will rise upwards towards blood temperature.
- When blood flow to the skin falls/decreases, the skin temperature will take up and mimic the environmental temperature, this reduces the temperature gradient and heat loss.



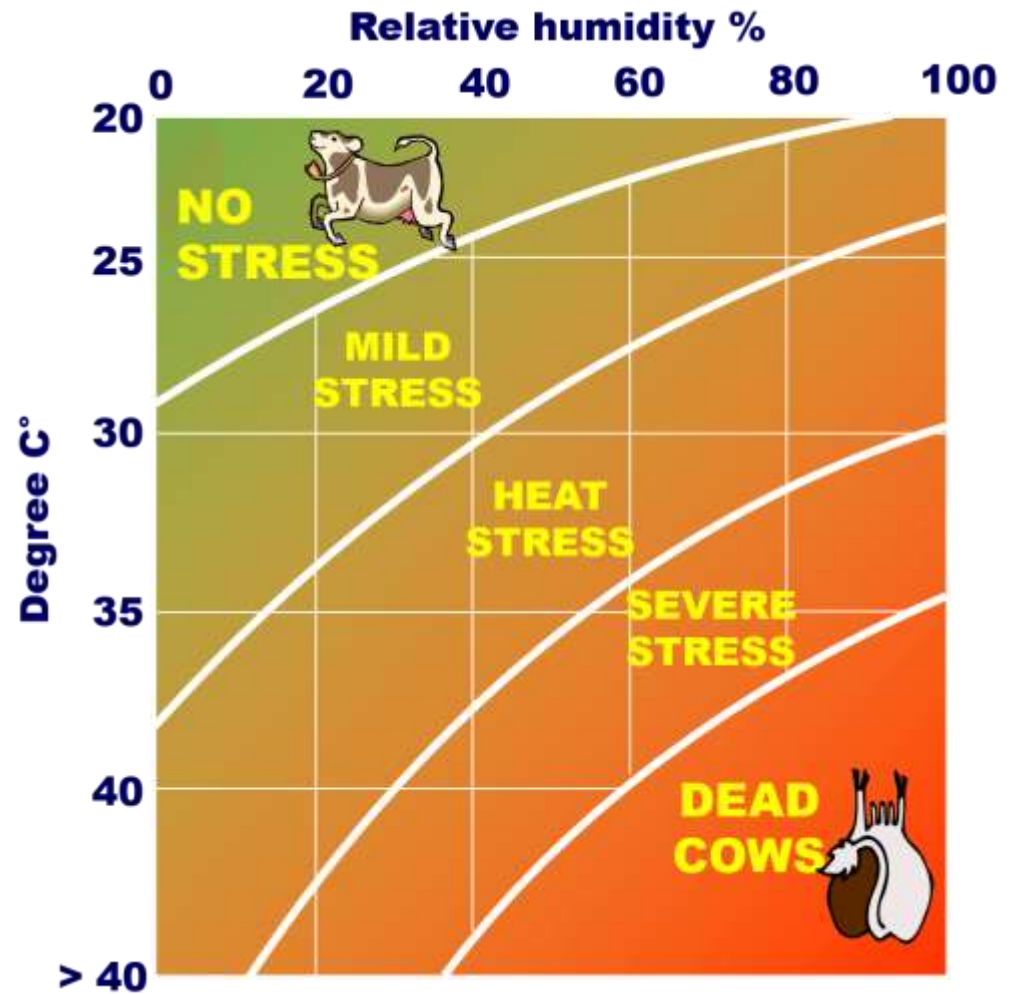
## 8. Climate in Uganda

- Uganda is generally a tropical climate and rainy. However, the northeast region of Uganda is semiarid.
- Rainy seasons are between the months of March to May and from the months of September to November.
- Uganda has two dry season that is between December to February and June to August with the months of December to February being the hottest.
- Uganda is said to be a warm tropical climate with average temperature range falling between 25-29°C.
- Even during hottest seasons evenings can be cool with temperature range between 17-18°C.



## 9. Temperature humidity index (THI)

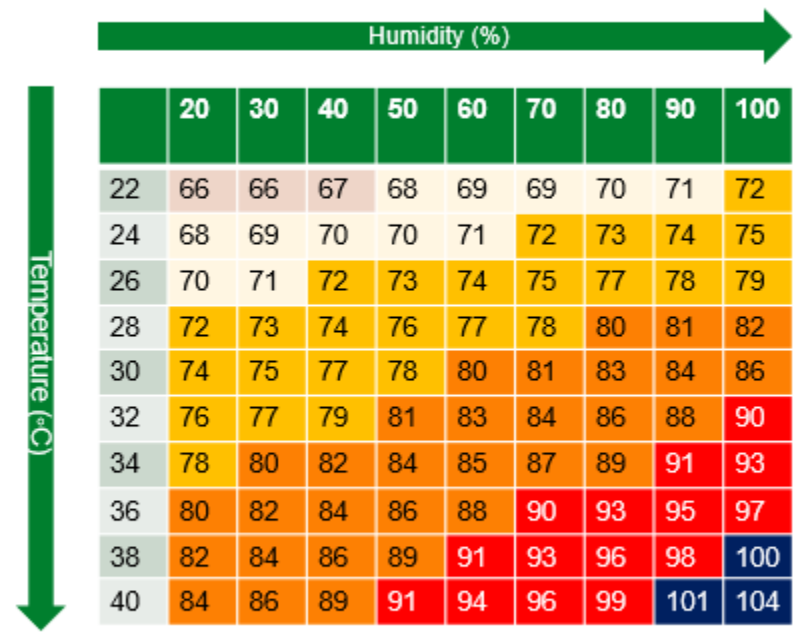
- Temperature and humidity levels determine heat stress level in animals.
- Temperature humidity index (THI) is used to measure approximate level of heat stress in cattle by looking into the level of both air temperature and relative humidity.
- Estimation of THI done using a color coded chart.
- This chart help identify if heat stress is mild or severe.
- A THI above 72 (>72) is considered to indicate heat stress in dairy cattle.



# 9.1 Temperature humidity index (THI) tables

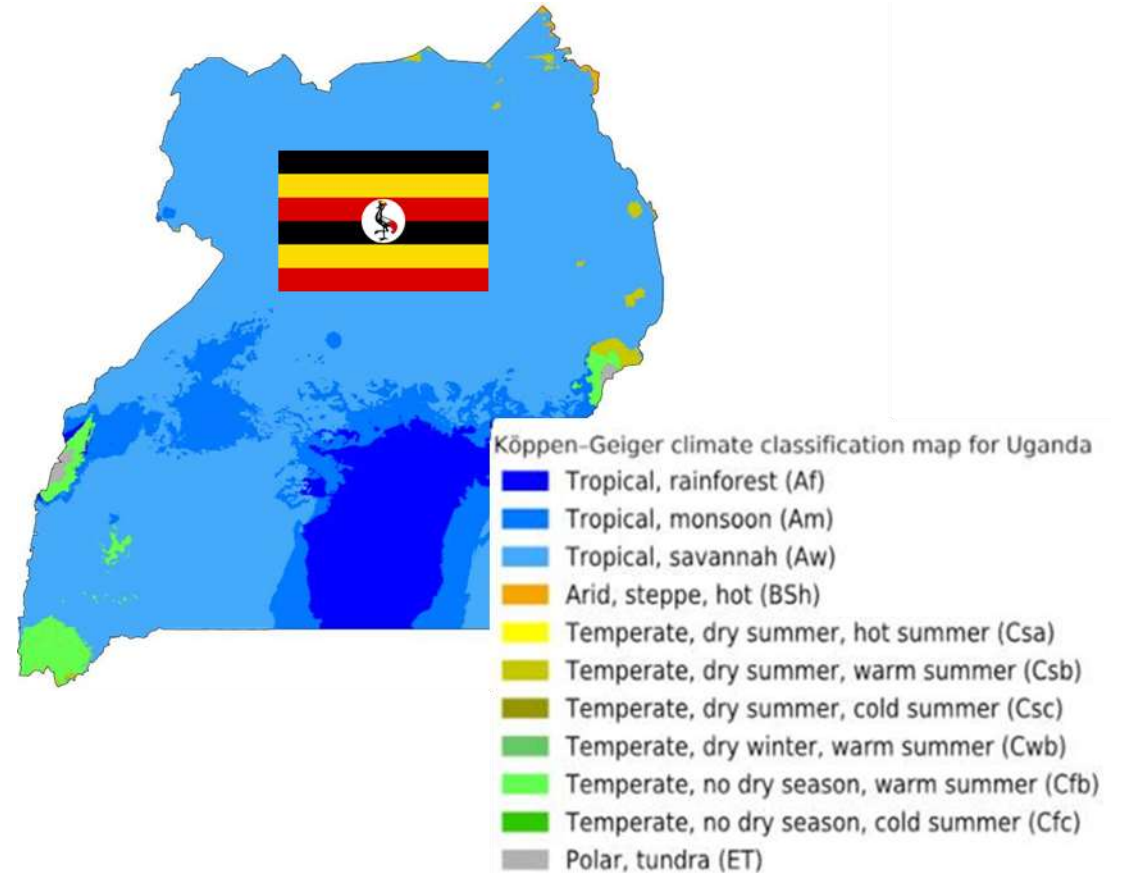
Temp (°C)	% Relative Humidity																		
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
22	64	65	65	65	66	66	67	67	67	68	68	69	69	70	70	70	71	71	71
23	65	65	66	66	66	67	67	68	68	68	69	69	70	70	71	71	71	72	72
23.5	65	66	66	67	67	67	68	68	69	69	70	70	70	71	71	72	72	73	73
24	66	66	67	67	68	68	68	69	69	70	70	71	71	72	72	73	73	74	74
24.5	66	67	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75
25	67	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75	76
25.5	67	68	68	69	69	70	70	71	71	72	73	73	74	74	75	75	76	76	77
26	67	68	69	69	70	70	71	71	72	73	73	74	74	75	76	76	77	77	78
26.5	68	69	69	70	70	71	72	72	73	73	74	74	75	75	76	76	77	78	79
27	68	69	70	70	71	72	72	73	73	74	75	75	76	77	77	78	78	79	80
28	69	69	70	71	71	72	73	73	74	75	75	76	77	77	78	79	80	81	81
28.5	69	70	71	71	72	73	73	74	75	75	76	77	78	78	79	80	80	81	82
29	70	70	71	72	73	73	74	75	75	76	77	78	78	79	80	80	81	82	83
29.5	70	71	72	72	73	74	75	75	76	77	78	78	79	80	81	81	82	83	84
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31	72	72	73	74	75	76	76	77	78	79	80	81	81	82	83	84	85	86	86
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34	74	75	76	77	78	79	80	80	81	82	83	84	85	86	87	88	89	90	91
34.5	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92
35	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93
35.5	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93
36	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
36.5	76	77	78	80	80	82	83	83	85	86	87	88	89	90	91	92	93	94	95
37	76	78	79	80	81	82	83	84	85	87	88	89	90	91	92	93	94	95	96
38	77	78	79	81	82	83	84	85	86	87	88	90	91	92	93	94	95	96	98
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41	80	81	82	84	85	87	88	89	90	91	93	94	95	97	98	99	101	102	103
41.5	80	81	83	84	85	87	88	89	91	92	94	95	96	98	99	100	102	103	104

THI	
Light	(68-71)
Moderate	(72-79)
Severe	(80-89)
Very severe	(>90)
Deadly	(>100)



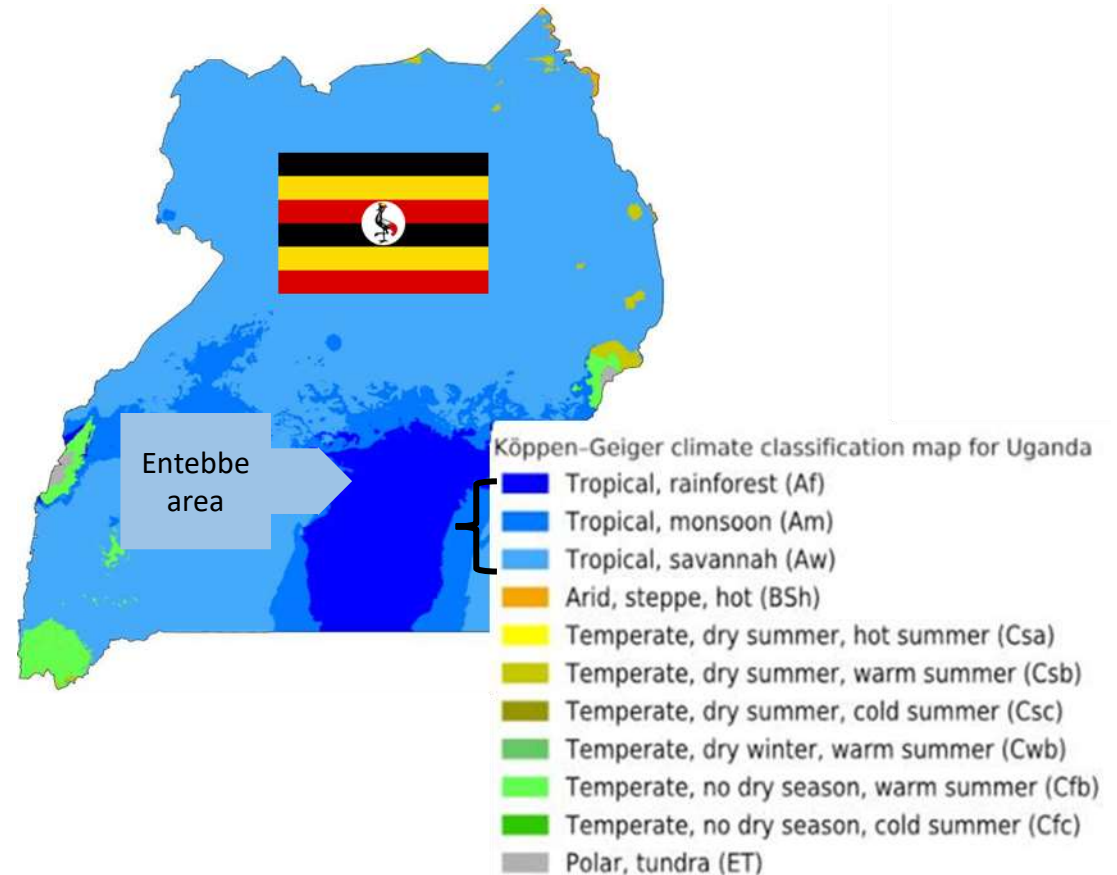
## 10. Planning animal housing in different THI zones in Uganda

- We are going to focus on 3 THI zones in different climatic zones in Uganda.
- This includes for example:
  - Tropical zone
  - Temperate zone
  - Arid zone
- While considering the climate its important to consider both indoor and outdoor environments while keeping in mind animal housing considerations.



## 11. Example of tropical, zones in Uganda

- Tropical savanna climate is experienced in the central south of Uganda around the equator.
- For example: In the lake region in Wakiso district, Entebbe's climate is tropical.
- It has temperature that is rarely below 17°C or above 29°C.



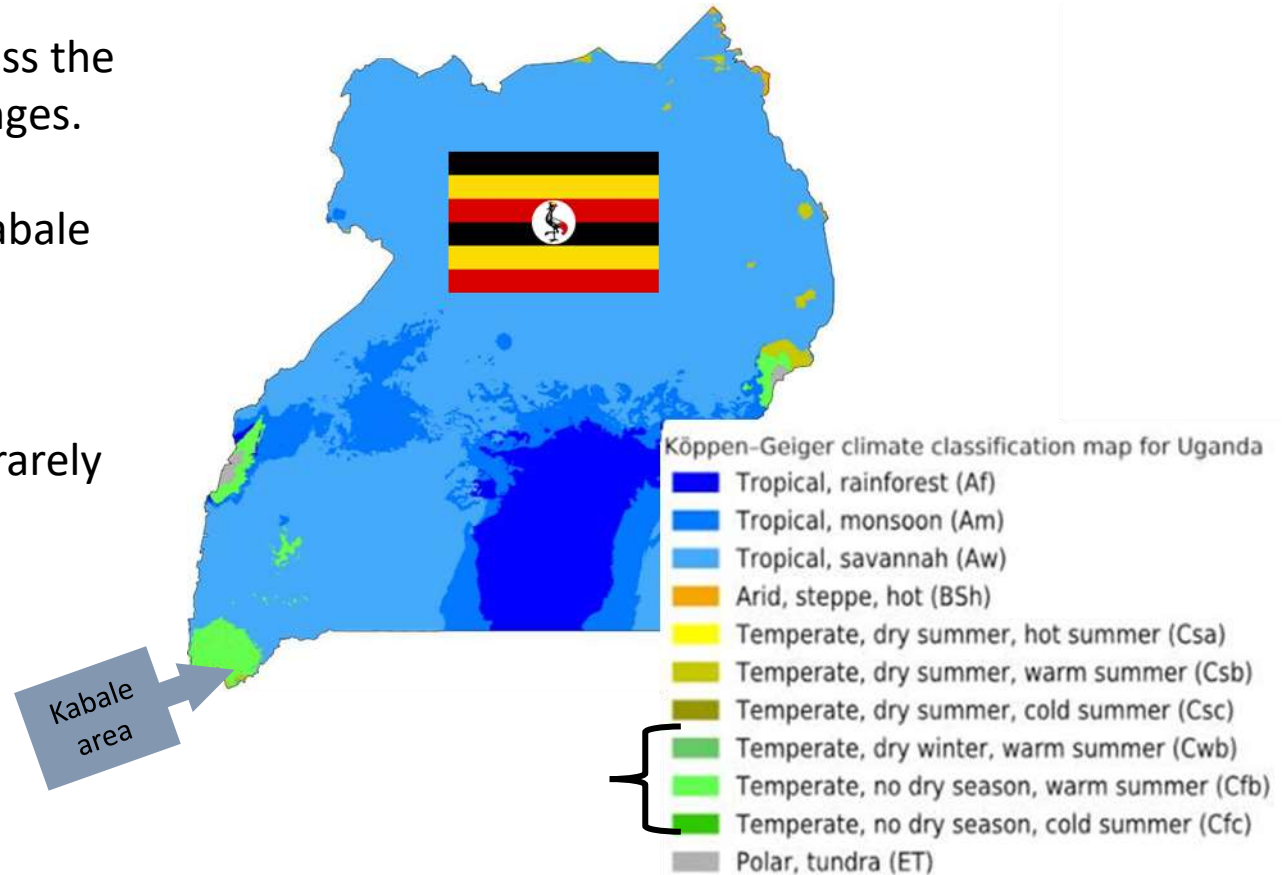
## 11.1 Planning animal housing in tropical areas in Uganda

- In areas of high temperature farmers should consider easing the heat load in cows especially during hottest periods of the day/month.
- In the tropics housing should be kept at a minimum.
- Shade can be provided by trees, shade nets or roofing structures.
- Erect half side walls to the height of the cow's height, approximately 165 cm if you decide on building a confined animal housing building.



## 12. Example of a temperate area in Uganda

- Climate with moderate rainfall spread across the year, and have more distinct seasonal changes.
- For example: In the Southern highlands, Kabale which lies 2,000M above sea level(ASL) is located west of Uganda.
- It experiences yearly temperatures that is rarely below 12°C or below 27°C.





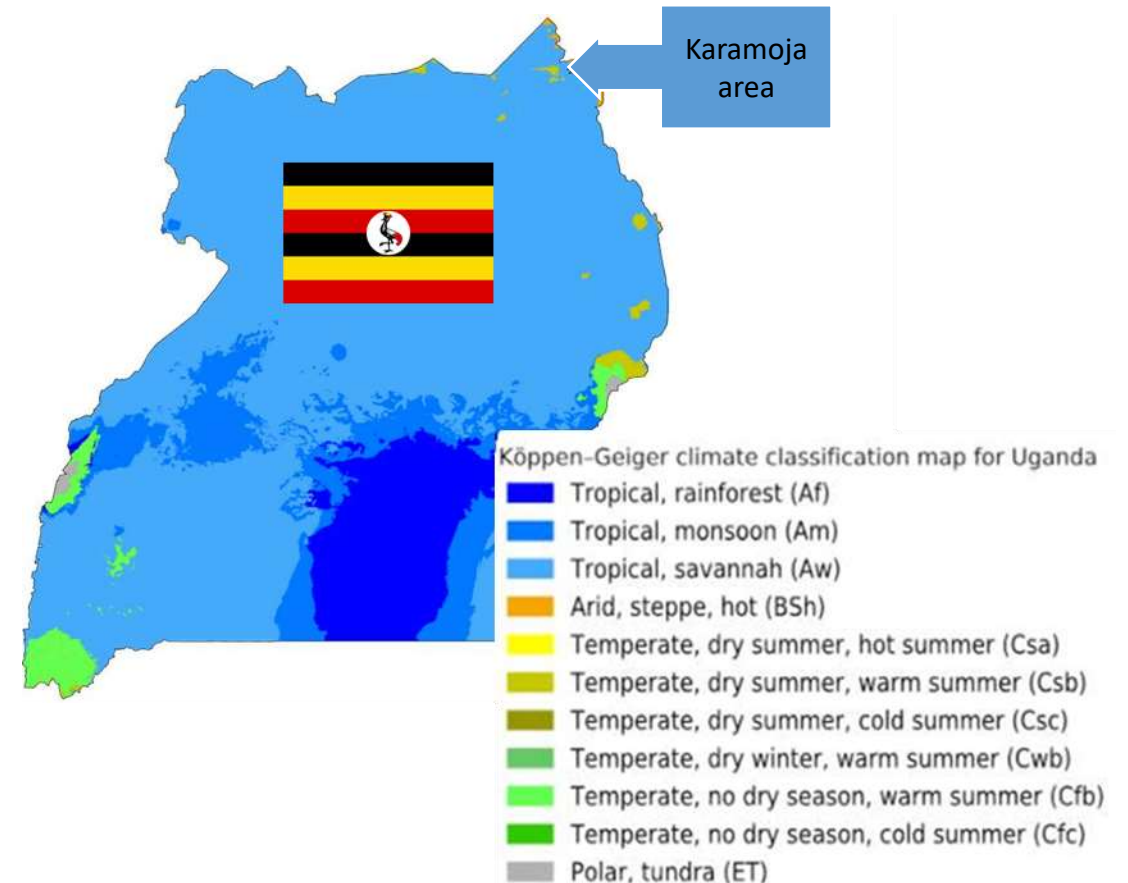
## 12.1 Planning animal housing in temperate areas in Uganda

- Dairy production in such an area when considering animal housing, cow barn can be fully confined.
- However, should be well ventilated for adequate air circulation.
- Heat stress is not a major problem. However, at hot periods of the day or month, cows should be shaded in pasture fields.
- Adequate clean, fresh water should be provided.



## 13. Example of arid area in Uganda

- For example: In the Northern region (North East), Karamoja area.
- The region has two rainy seasons and an intense hot and dry season from October to April, while December and January are the driest months with strong winds.
- It experiences yearly average temperature of 29°C but can reach 40°C.



## 13.1 Planning animal housing in arid areas

- Uganda within the tropic, in its arid areas, it is recommended to only provide shade, natural shade especially.
- Temporary and permanent shading areas are recommended for animals in arid areas.
- Providing a cool environment is the aim in arid areas especially during the hottest periods of the day.
- Variety of watering points should be provided, note watering area should be shaded.



Outdoor shade



Indoor housing

## 14. Temperature humidity index (THI) tolerance levels

Heat stress level	Temperature humidity index (THI)	Respiration (breaths per minute)	Body temperature (°C)
No heat stress	Less than 68 (< 68)	40-60	38.6-39.2
Mild heat stress	68-71	60-75	39.2-39.5
Mild to moderate heat stress	72-79	75-85	39.5-40
Moderate to severe heat stress	80-90	85-100	40-40.6
Severe heat stress	90-99	100-104	Over 40.6

## 15. How animal housing aids in thermoregulation

- Cow housing facilities aid in managing heat stress in the dairy farm when it is well used with consideration of herd size.
- While considering animal housing, measures of reducing the heat load on cows should be evaluated so as not to end up making losses.
- Farmers can use various methods to aid thermoregulation by cows for example: providing access to water and using mechanisms that help cool the animals body.



## 16. How to reduce heat stress in animal housing

1. Provision of a shade.
2. Ventilation through consideration of cow barn design.
3. Cooling cow, by providing either:
  - Drinking water as coolant.
  - Sprinkling water on animals body.
  - Fans (high-speed air) to cool cows.



Used at extreme moments or as a last resort

## 17. Provision of shade or shelter

- Provision of a shade goes a long way at reducing the effects of heat stress.
- This is the reason why one of the response of cows to heat stress is looking for a shaded area to stay in.
- Shelter (shade) can be provided in two different ways as follows:
  1. Shade in the natural environment (trees)
  2. Sheltering in constructed structure (cow barn)



## 18. Heat prevention through shading by a shelter

- Shading does not only have to be provided by housing structure (cow barn).
- Trees equally provide a shade for cows especially when they are in the grazing fields (pastures).
- Shade is particularly needed by the vulnerable group of cows (sick, in-calf, young and old animals) as heat stress greatly affects them.

Shading by providing roofing and net suspension





## 18.1 Heat prevention through shading by a shelter Cont'd...

- Farmers should maintain adequate supply of quality feed (forage that is relatively low in fibre).
- Also provide fresh, clean water and a shady area for animals (natural (trees) or constructed).
- Where roofing systems may be hard to avail, farmers can suspend shade net in holding area/boma/pen to protect against direct sunlight.

Shading by providing roofing and net suspension



## 19. Shade from the natural environment

- Pastures fields also provide opportunities to provide suitable and natural environment for feeding & resting.
- Outdoor housing entails maintaining animals in groups.
- Trees provide the best shade, they have a cooling effect because leaves absorb heat.
- Thick bushes/hedges used as fences provide protection from sun, when planted especially in an east-west direction provide shade in the hottest parts of the day.
- Trees that are well trimmed allows wind flow for cooling.



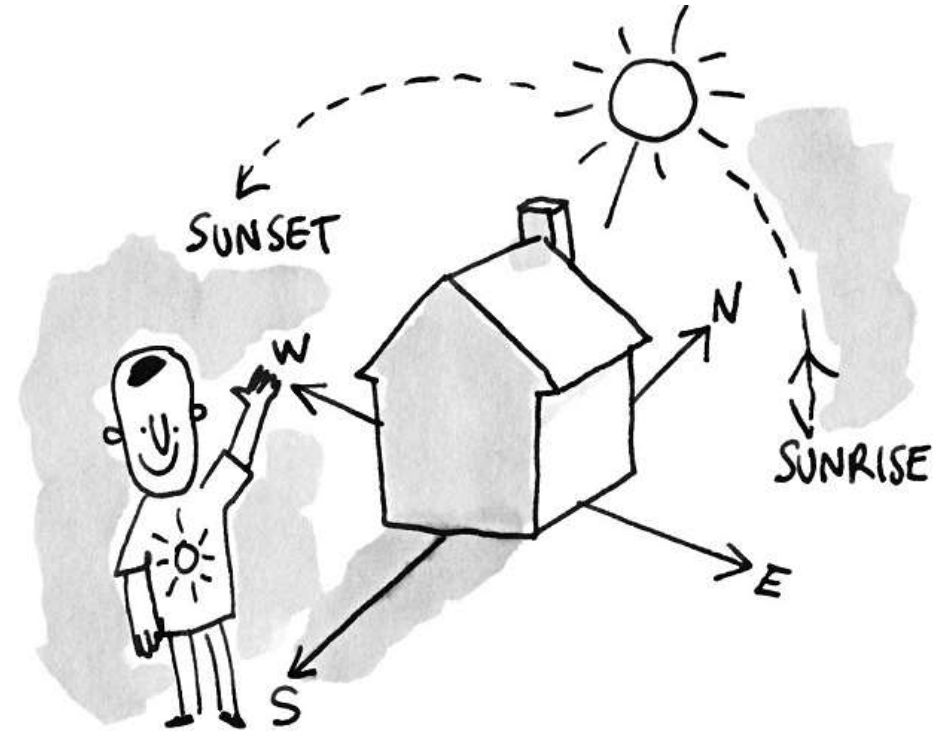
## 20. Shelter from raised structures (cow barn)

- Shade structure needs to consider all the cows in the herd and meet their needs for a cool and comfortable environment.
- Construct shelters using materials that reflect more heat during hot times of the day or periods.
- There are factors to consider when considering a cow barn that will go a long way in reducing instances of heat stress building up in the cow barn.
- For example:
  - Site location for the cow barn.
  - Dimension of the cow barn.
  - Material to be used for the shade.
  - Improving housing efficiency



## 20.1 Site location

- For the construction of any cow barn structure, there should be a consideration of the site location.
- Factors that aids in determining the site location are for example:
  - Direction of prevailing wind and sun in the area.
  - Position of the barn in corelation to the movement of the sun-axis of the length of the house should be from east to west.
  - Height of the roof.
  - Drainage of the site in question.
  - Connection of the cow barn and other farm buildings.



## 20.2 Dimensions of the cow barn

- The dimensions of the cow barn differ depending on the size of cows, larger sized cows need more space and vice versa.
- However, there is a recommended dimension that works for cows.
- Shade structure should be a height of 3 meters high to enable enough air supply and ventilation.



## 20.3 Material for cow barn

- Material used for cow barn floor area, walls or roof from farm to farm depending on availability, preference and ease of maintenance differ.
- Existing climatic conditions of a region also dictates this.
- Aluminium/galvanised steel (insulated roofs) are ideal roofing materials since they are good at reflecting the sun's radiative rays.
- Insulating roofs is relevant for reducing cow heat load especially in closed cow barns. However, it is important to note that reflective ability wears out with time.
- Thereby other means like ventilation & raising the roof higher should be used in combination with this to effectively reduce effects of the radiative rays of the sun.



## 20.4 Improving housing efficiency

- Solar heat gain refer to the heat increase of a structure/object because of absorbed solar radiation in space.
- Increase in thermal energy leads to rise in air temperature therefore leading to discomfort.
- Solar heat gain can be reduced by improving external shading devices, materials and design.



## 20.4.1 Methods of improving housing efficiency:

### Wall or No wall?

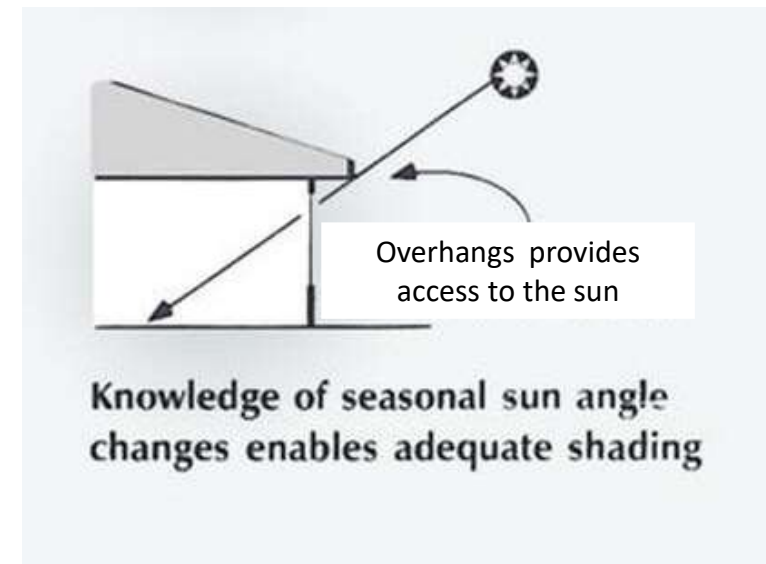
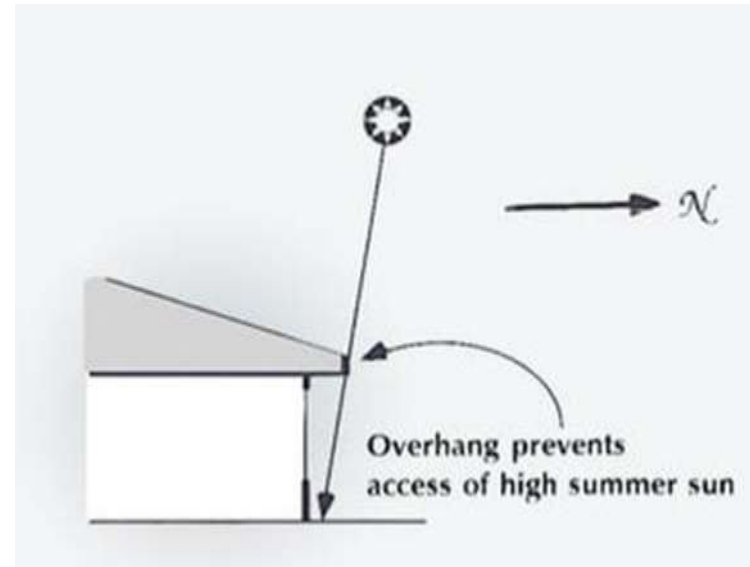
- The climatic conditions in East Africa generally does not encourage farmers to build up side walls in cow barns.
- It proves to be an added expense in housing. It is recommended to build cow barns without walls and if necessary one can build up a half wall.
- Half walls can be a height similar to cow's height approximately 165 cm.
- No walls and half walls encourages better air flow by reducing build up of warm air within the barn with hot air rising and getting removed from the cow barn.





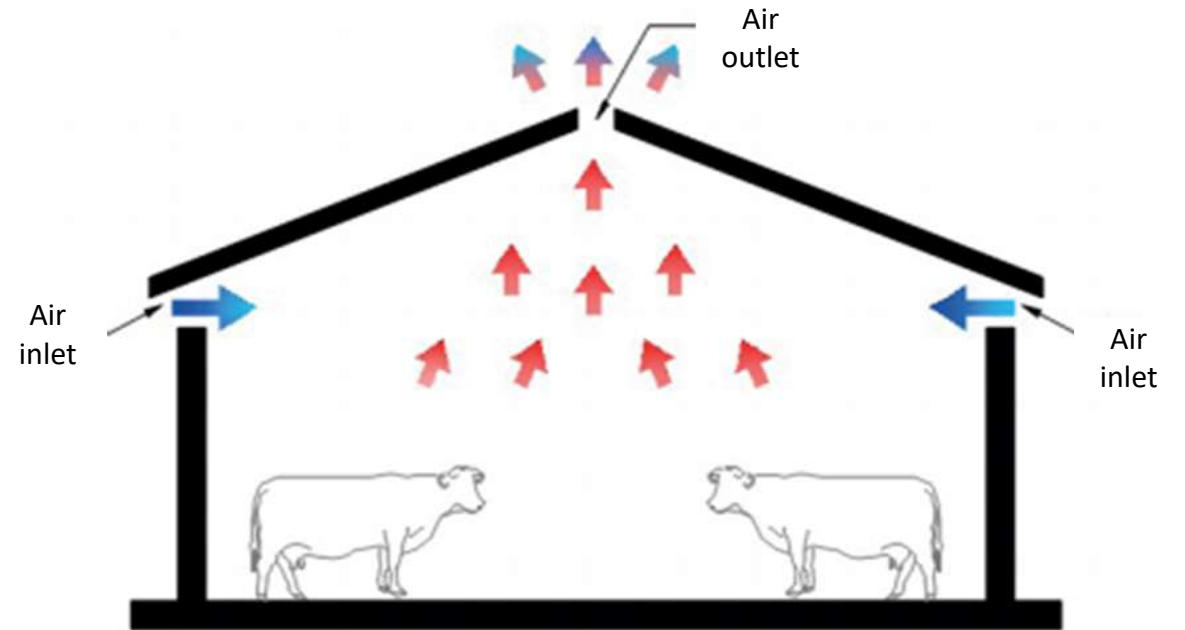
## 20.4.2 Methods of improving housing efficiency: Roofing design

- Roofing design should as much as possible aimed at limiting direct sunlight.
- Direct sunlight results in majority of heat gain.
- Depending of local conditions and advise from local experts, farmers should carefully consider thatching roofs or using timber shingles.
- Roof overhangs go beyond protecting house exterior it also limits sunlight penetration.
- When roof overhangs are of the wrong size the house will overheat.



## 21. Aiding ventilation through cow barn design

- The design of the cow barn significantly contributes to the management of heat inside the cow barn through the exchange of air inside the cow barn and outside.
- Factors like direct evaporative cooling and air movement is affected by how good or bad ventilation is in a cow barn.
- Good air exchange/ventilation removes hot moist air and rate of convective heat loss.
- Whether it be the interior or exterior design, this can be done in various ways such as:
  1. Design of ventilation system applied.
  2. Spacing recommendations.
  3. Number of animals



## 21.1 Design of ventilation system

- Increasing air flow over a cow has a dramatic effect on heat loss from the cows skin through evaporation.
- To improve ventilation area around the cow barn should be a distance a way from vegetation and forage to improve air flow.
- Farmers should also consider opening up or creating side inlet ventilation and ridge outlet ventilation sites if was not earlier incorporated in the structure.
- Side inlet and ridge outlet ventilation sites are basic ventilation improvements that farmers should consider.



## 21.2 Spacing recommendations

- Animals that are tied to a rope tend to face difficulties in breathing (inadequate oxygen) and even injure themselves.
- Cows should be free to move about, during heat stress animals that are tied up get more affected due to the inability to protect themselves.
- This animals movements are constrained, where otherwise they could move to a shade or if the rope is tightly made limits proper breathing.



## 21.3 Number of animals (stocking rate)

- A highly stocked animal housing encourages heat stress-related problems.
- Highly-stocked animal housing also furthers the impact of heat stress especially during hot periods of the day.
- Flow of fresh air within a cow barn is discouraged by this.
- Poor ventilation coupled with high humidity leads to high temperature humidity index (THI).



## 22. Drinking water as a coolant

- Provision of water is critical, water is an essential need for animal nutrition as it aids many processes in the body.
- Cooling is one of the key functions that water does for cows.
- Animal housing must have watering point that is accessible to all cows whenever they may need it (should be near animal resting area).
- During periods of long dry season the lack of feed, water or both can lead to death.
- Provision of cool drinking water is important during the periods of long dry seasons to help lower heat stress load on the cow.



## 22.1 Drinking water as a coolant cont'd...

- Water troughs in the outdoors especially should be shaded to keep the water provided to cows cool as possible and close to feed source.
- Location of water should be familiar to cows , close by and should be filled up quickly to ensure ease of access when needed.
- Farmer should reduce cows walking long distances to access water and increase water location sites in hot weather.
- Cows tend to drink more water as temperature rises, water consumption can go up by 10-20%.
- There should be enough space during periods of high temperature for 25% of the herd to drink water at the same time.



## 23. Cooling by wetting a cow's body

- Provision of water can also go beyond the use as drinking water but a means of externally cooling the cows body.
- Soaking cows directly with water using a hosepipe/sprinkler helps lower the body temperature of a cow.
- Pour/sprinkle water from the shoulders all the way to the back, this water drip to the other sides of the lower body part through the neck, stomach and hind legs region.
- A farmer can also notice ease in breathing or confirm by taking a rectal temperature read to confirms reduced body temperature.
- In extreme heat stress wetting of the cows body can be done again.





## 24. Fans (high-speed air) for body cooling

- Farmers can consider to use the advantage of natural air movement of wind or breeze from shades that provide a cooling effect to cows.
- Fans remove hot, moist air that is in contact with the animal.
- In indoor housing one could consider to use fans (high speed air) to reduce heat stress.
- However, high capital investment are required for installation and maintenance of fans.



## 25. Use of water and fans to cool a cow's body

- Use of sprinkled water and fans aids reduces effects of heats stress dramatically, by increasing the air velocity over the animals skin.
- Air velocity is distance travelled by air per unit time.
- Fans (high speed air) can enhance cooling effect by assisting with evaporation when used in combination with wetting of animals.
- When using the 2 strategies it is key to wet the animals first then the use of fans can come later after that.

THI	
Light	(68-71)
Moderate	(72-79)
Severe	(80-89)
Very severe	(>90)
Deadly	(>100)

		Humidity (%)								
		20	30	40	50	60	70	80	90	100
Temperature (°C)	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	

Sprinklers are only used when THI ranges are very severe as above pointed out



## 26. Summary (Take home messages)

- ❑ There two basic factors farmers can work with to reduce the effects of heat stress, that is:
  - Adjusting the ration fed to cows
  - Adjusting the environment where the cow lives.
- ❑ Fresh palatable high quality feed ration ingredients (produce low heat production during digestion) should be available.
- ❑ Shift feeding time to cooler periods of the day.
- ❑ Minimize feed sorting by ensuring uniformity of mixed and delivered ration.
- ❑ Create a favourable environment for cows through animal housing either outdoors or indoors as discussed.

