Seminar report

IMPACT OF CLIMATE CHANGE ON LIVESTOCK AND POULTRY

By

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DECLARATION

I, Aswathi K. P. (2018-11-130) hereby declare that the seminar entitled ‘Impact of climate change on livestock and poultry’has been prepared by me, after going through various references cited at the end and has not copied from any of my fellow students.

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25/01/2020 2018-11-130

CERTIFICATE

This is to certify that the seminar report entitled ‘Impact of climate change on livestock and poultry’ has been solely prepared by Aswathi K. P. (2018-11-130) under my guidance and has not been copied from fellow students.

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1) Introduction

Climate change and its effects on existence on earth are becoming more and more relevant as physical evidence of change in our climate is beginning to mount. Livestock production and our dependence on it for survival is a reality. It is also a reality that this global source of food and income will be prone to the effects of climate change. Livestock plays an important role in livelihood and food security. Climate extremes andseasonal fluctuations adversely affect livestock production.

2) Climate change

According to IPCC (2013) climate change is change in the state of the climate that can be identified (eg. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Global climate change is primarily caused by greenhouse gas (GHG) emissions that result in warming of the atmosphere.

3) Livestock

Any creature kept for the production of food, wool, skins or fur or for the purpose of its use in the farming of land or the carrying on of any agricultural activity

4) Greenhouse gas emission from livestock

Livestock contribute 18 percent of total global greenhouse gas emission(48% N_2O, 46% CH_4 and 9% CO_2). Livestock sector emits 37 percent of anthropogenic methane (with 23 times the global warming potential (GWP) of CO_2) most of that from enteric fermentation by ruminants. It emits 65 percent of anthropogenic nitrous oxide (with 296 times the GWP of CO_2), the great majority from manure. The highest emission level of methane (CH_4) and nitrous oxide (N_2O) relates to livestock production. Enteric fermentation is the largest source of CH_4. Manure and fertilizers applied in feed production are the most prominent sources of N_2O (Bailey*et al*., 2014). CH_4 and N_2O emissions have a smaller share of global of global GHG emissions compared to CO_2 emission. However, their Global Warming Potential (GWP) is 21 and 310 times higher than CO_2. In other words, CH_4 and N_2O contribution to climate variations are 21 and 310 times more than CO_2.For example, emissions of one tone of CH_4 have the same effect on climate change as the emission of 21 tons of CO_2 over a one-hundred year period. This explanation serves to demonstrate how quantities of gases, such as CH_4 and N_2O, which seem negligible at first glance, actually contribute significantly to climate change.

5) Impact of climate change on livestock

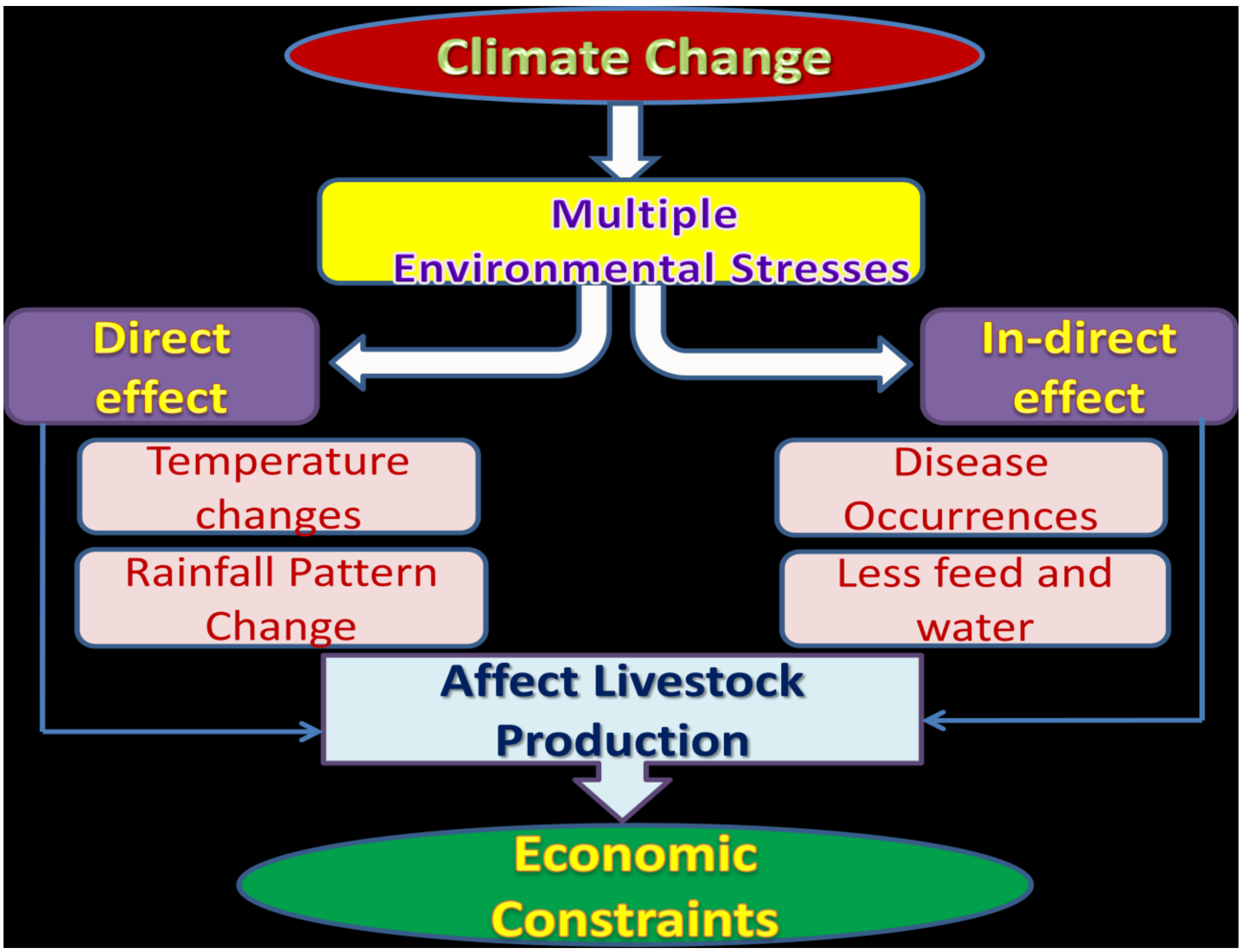


Figure 1: Impact of climate change on livestock

5.1) Effect of temperature changes

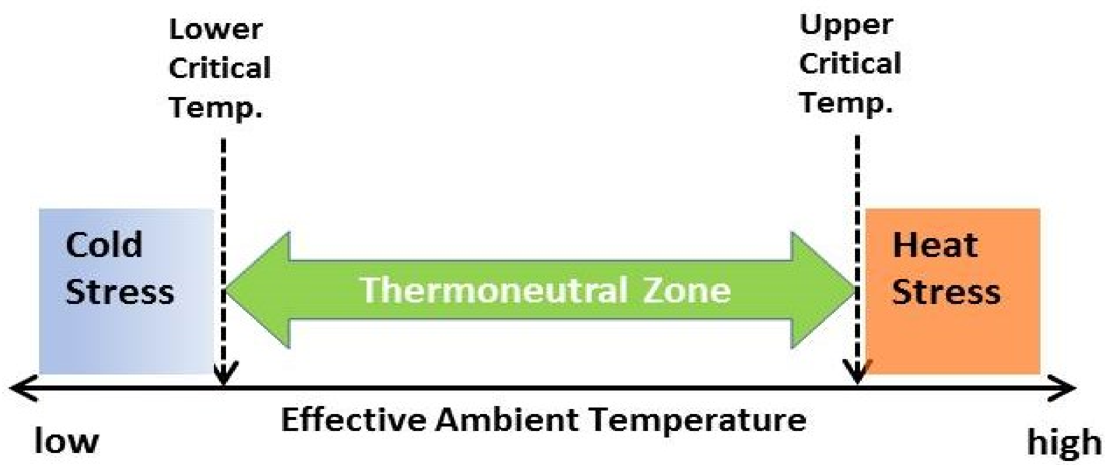


Figure 2: Environmental temperature and thermal zone

Temperature Humidity Index (THI)

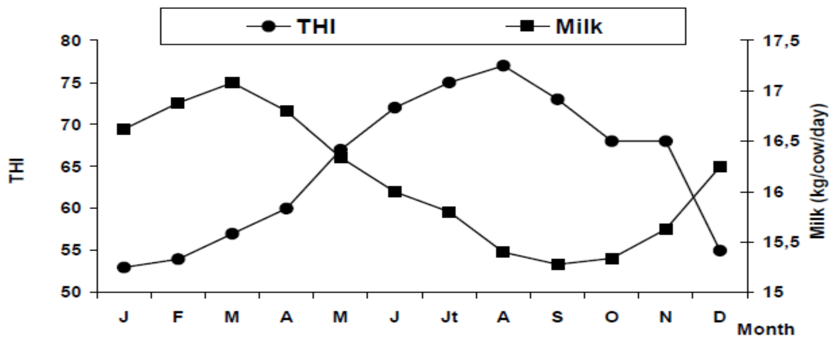
Temperature Humidity Index (THI) is a measure that has been used since the early 1990s. It accounts for the combined effects of environmental temperature and relative humidity and is a useful and easy way to assess the risk of heat stress. Heat stress experienced by livestock can be quantified using Temperature Humidity Index (THI)

5.1.1) Effect of high temperature on livestock

1) Effect on growth and milk yield
2) Effect on physiological responses
3) Effect on animal reproduction
4) Effect on meat production

5.1.1.1) Effect of high temperature on growth and milk yield

When high milk producing cattle were kept in hot climatic zones metabolic heat production was intensified and this will lead to increased respiratory rate and finally decrease in the milk production. Studies carried out in climatic chambers, described a decrease in milk yield of 35 percent in mid lactating cows (Nardone *et al.*, 1992) and of 14 percent in early lactating milk cows kept under heat stress condition.



Graph 1: Monthly variation for milk production and Temperature Humidity Index (THI) in Tunisia

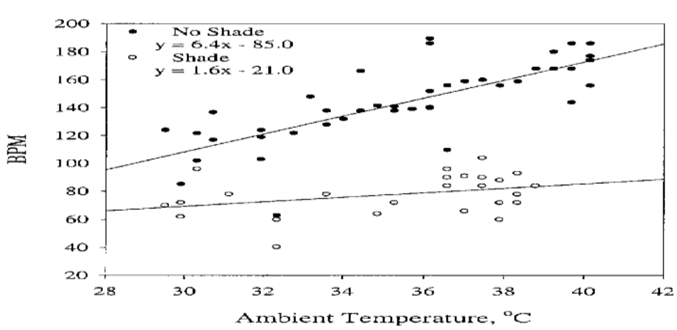
(Salem and Bouraoui, 2009)

5.1.1.2) Effect on physiological Responses

Physiological determinants of adaptations to heat stress are increased respiration rate, increased rectal temperature, pulse rate, skin temperature and sweating rate (Indu *et al.,* 2015).

5.1.1.2.1) Respiration rate

Higher Respiration Rate is observed in cattle exposed to increased ambient temperature and relative humidity (Upadhyay *et al.,* 2012). Respiration rate higher than 80 breath/minute was found to be an indicator of high quantum of heat stress in farm animals (Indu *et al.,* 2015).



BPM- Breathing per minute

Graph 2: Effect of ambient temperature on respiration rate

5.1.1.2.2) Rectal temperature

High body temperature leads to increase in rectal temperature. Rising rectal temperature even 1°C or less is enough to reduce the performance in livestock.The rectal temperature was recorded using a clinical thermometer by inserting the thermometer by 6–7 cm inside the rectum inclined towards the wall of the rectum. Rectal temperature is used as a representative measure of animal's core body temperature. Further, rising rectal temperature represents the failure of thermo-regulatory mechanism in animal's body.

5.1.1.2.3) Pulse rate

Pulse rate is affected by heat stress and therefore this physiological parameter to may act as reliable indicator of livestock in harsh environmental condition. Highest pulse rate in heat stressed Osmanabadi goats indicating its role to assessing the quantum of heat stress in these animals. Under heat stress condition pulse rate reaches to a rate of 115 beats per minutes.

5.1.1.2.4) Skin temperature

The skin temperature was measured in different parts of body (back, flank and forehead) using a skin surface thermocouple probe connected to a microprocessor-based handheld thermometer. The skin temperature increased by 0.22 °C in animals per extra degree of ambient temperature exposure.

5.1.1.2.5) Sweating rate

Dissipation of excess heat from the body through cutaneous evaporative cooling mechanisms is known as sweating. Evaporative cooling is the dominant mechanism seen in dairy cattle for heat loss when they are exposed to high temperature.

5.1.1.3) High temperature and animal reproduction

5.1.1.3.1) Effect on male reproductive system

Male testes must be cooler than the core body temperature for the production of sperm. Increased testicular temperature, impaired spermatogenic cycle, decreased semen volume and sperm concentration, increased sperm abnormality, decreased sperm motility, poor semen quality and decreased fertility(Bhakat *et al.,* 2014). Consequently, increased testicular temperature leads to infertility in male. Heat stress also leads to reduced seminal volume and sperm concentration. It is reported that ejaculate volume, concentration of spermatozoa and sperm motility in bulls are lower in summer than in winter season (Samal, 2013).

5.1.1.3.2) Effect on female reproductive system

It is reported that the heat stress reduces length and intensity of estrous period therefore less conception rate occurs. So heat stress may reduce the fertility of dairy cows in summer by poor expression of behavioral signs of estrous due to a reduced estradiol secretion from the dominant follicle. In these situations the calving interval becomes longer. So lifetime production of dairy animal comes down. Heat stress during pregnancy slows down growth of the foetus due to decreased blood supply to the uterus which causes placental insufficiency to provide maternal nutrient, so leads to decreased fetal growth and calf size. Even there is early embryonic death in cows exposed to heat stress (Seijan, 2013).

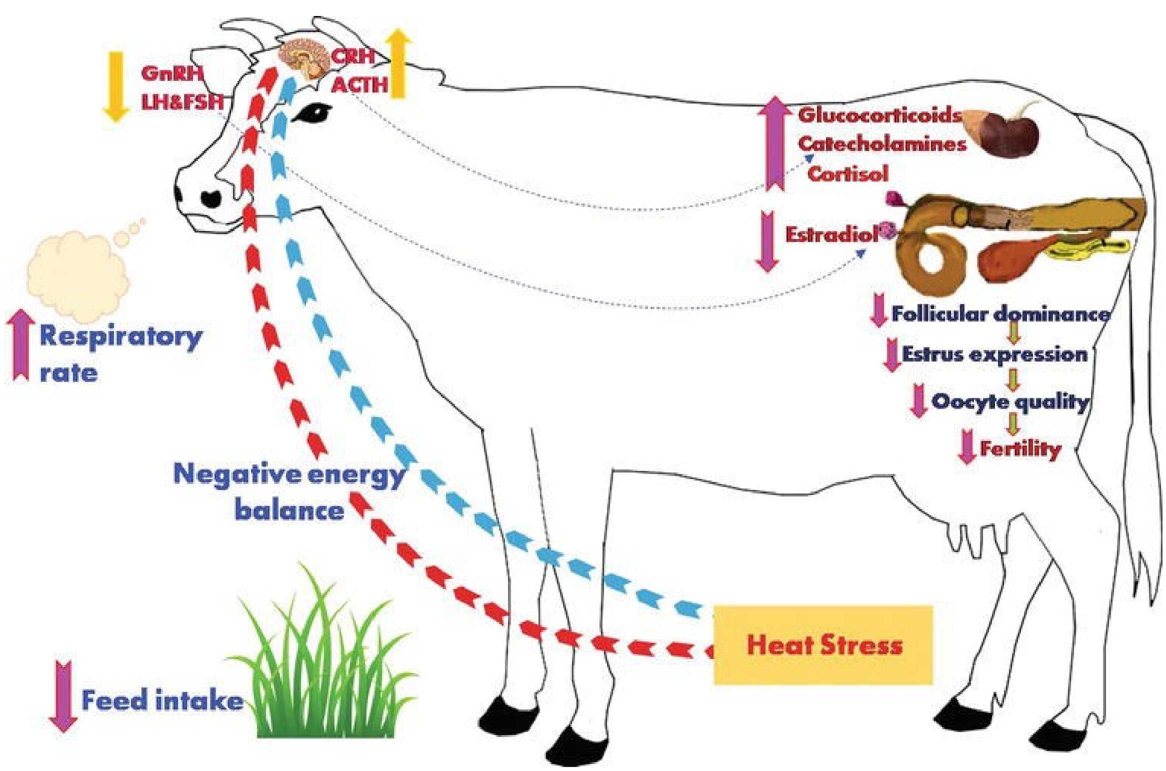


Figure 3: Effect of heat stress on female reproductive system

Graph 3: Conception rates of dairy cows in commercial farm located in the central part of Thailand

5.1.1.4) Meat production and high temperature

In cattle, high ambient temperatures can favour greater muscle marbling and fat deposition in internal depots, in place of the subcutaneous depot (Nardone *et al*., 2006) .

5.1.2) Cold stress in animals

When ruminants are exposed to cold, increase in rumination activity this will result in decreased reticulorumen motility and rate of passage of digesta(Gonyou *et al*., 1979).

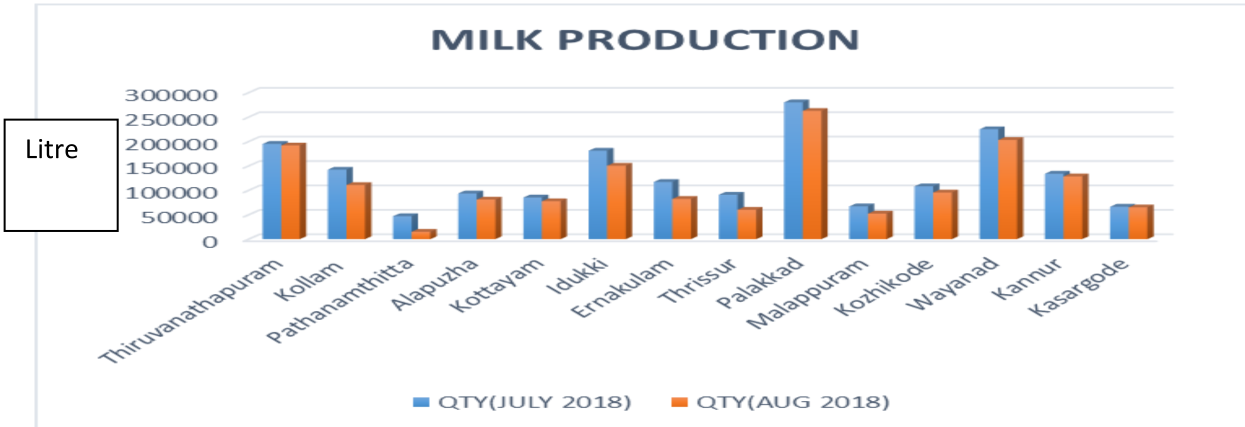
5.2) Effect of rainfall pattern change

Floods and cyclone pose both a direct and indirect effect on livestock production in developing countries. They result in a direct loss of livestock and indirectly affect livestock by destroying infrastructure such as dip tanks and paddocks. For instance, during the 2009 agricultural season, floods and cyclones damaged substantial areas of agricultural production in southern and central Mozambique, resulting in loss of livestock, livestock infrastructure and crops needed in livestock production (FAO, 2000). Preliminary estimates suggest that losses reached almost $8 million in the livestock sector. Livestock losses have been estimated at 20,000 cattle, 4,000 goats, sheep and pigs and 180,000 chickens, but it must be noted that these numbers were at the low end of a range (with the high end approximately doubling these numbers) (World Bank, 2000). As livestock play an essential social and economic role in most developing countries, livestock loss will also deeply affect regional development. Smaller species which include poultry have virtually disappeared in the flooded areas, removing another source of revenue and nutrition from the resource-poor households. In Pakistan during the 2010 agricultural season, 158,412 animals perished due to floods, cattle heads worth 106 million dollars were lost in the north-western province only. After the floods, at least 2.3 million dollars was needed for treatment of sick animals and 1.3 million livestock faced severe feed shortages. Other than the losses of livestock, infrastructure for livestock production was also severely damaged and also disputes on ownership to livestock among farmers were triggered (Xinhua News Agency, 2010). Another important factor of livestock production which can be affected by floods is labour. Labour is needed for livestock rearing, vaccination, treating sick animals as well as feeding the livestock. As a result of a flood event, people involved in livestock production may perish in extreme cases or may be affected health wise to the extent that they will not be fit to perform the duties required in livestock production. This results in the deterioration of livestock condition or death of livestock in some extreme cases. According to the World Bank (2000), the floods that occurred in Mozambique for instance forced at least 250,000 people or approximately 50,000 families to abandon their homes and their possessions which include livestock.

Officials of the Kerala Agriculture Department said the department was able to rescue at least 50,000 cattle and house them in relief shelters across eight districts. “These cattle had been left behind by their fleeing owners when the water levels rose. There is also widespread fear about a breakout of communicable cattle diseases. There is a huge scarcity of roughage, including straw and green fodder,” said officials. Kerala has an estimated six lakh milch cattle requiring nearly 600 tonnes of feed, but produces just 30 per cent locally.

Effect of Kerala flood on production

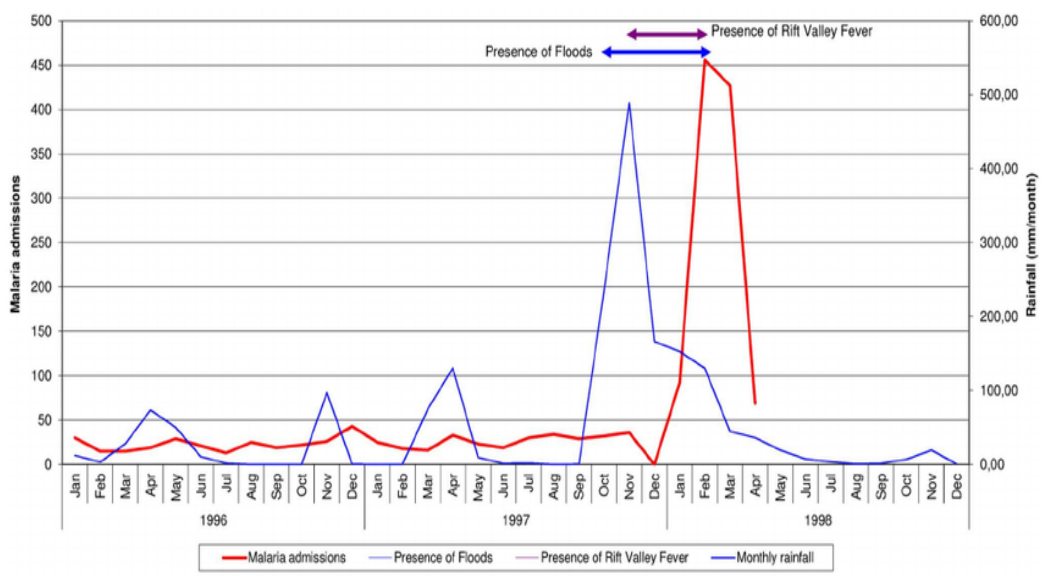
There was decrease in milk yield for about 16.24%.



Graph 4: Effect of flood on milk production for different districts of Kerala

Case Study of rift valley fever from Wajir

Presence of rift valley fever is associated with heavy rainfall events as the pathogen requires flodded condition for its growth and multiplication.



Graph 5: Relationship of rainfall and Rift valley fever diseases for different years in Wajir

5.3) Effects of climate change on livestock diseases

Increase in mean global temperature can lead to tremendous changes in hydrological cycles and the overall global climate manifested by an increase in the frequency and intensity of extreme events such as heavy precipitation, flood, heatwaves, drought and extreme tidal events. These changes have direct and indirect effects on infectious diseases in animals and people.There is limited knowledge on the key processes involved in disease causation due to lack of reliable long-term climate and disease data, substantial influence from socio-economic drivers and other mechanisms affecting disease transmission dynamics, such as herd immunity (Patz *et al*., 2005).

1) Effect on host
2) Effect on vector
3) Effect on pathogen

5.3.1) Effect of high temperature on host

Changesin temperature also trigger the secretion ofstress hormone (including cortisol which suppress immunological responses includingthe functioning of the white blood cells, tipping the host-pathogen interactions in favour on the pathogen. Experiments on fish observed that heat waves associated with global warming may Immuno compromise host. Potentially aiding the Spread of infectious Pathogens (Dittmar *et al*. 2014).

5.3.2) Effect on vector

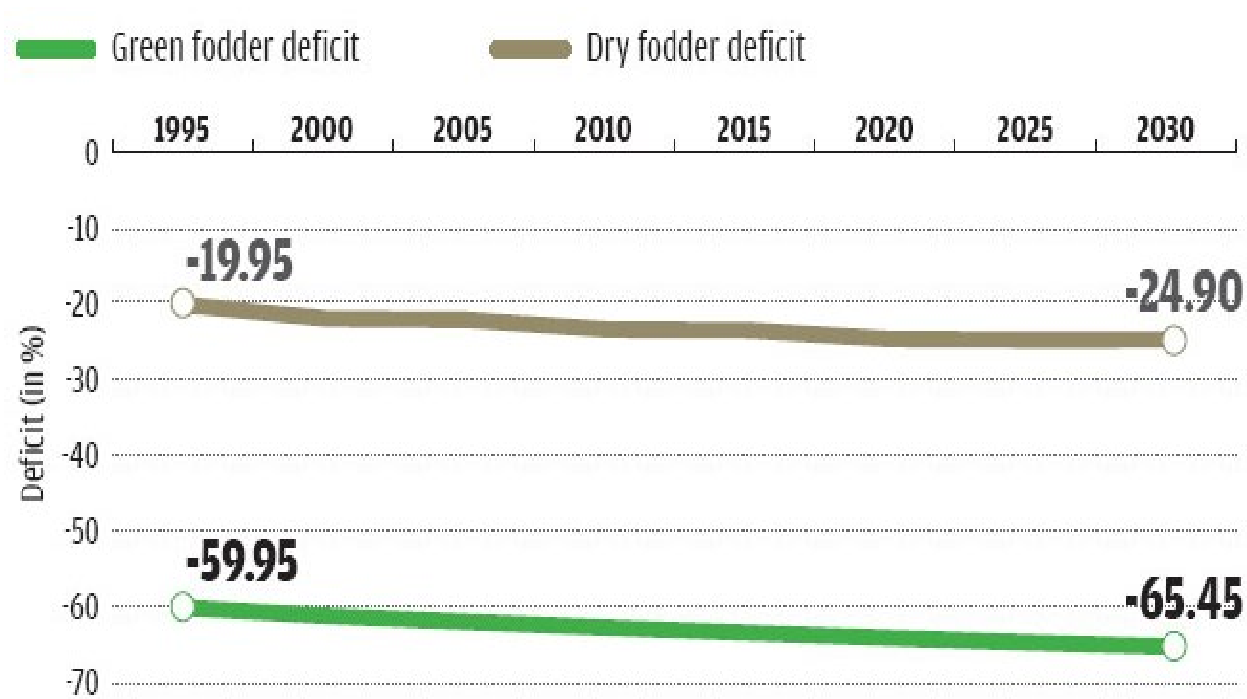
Many livestock diseases are transmitted by invertebrate vectors. Thus liver flukes are transmitted through lymnaeid snails, and a range of arboviruses, many of which have RNA genomes, are transmitted by arthropods including biting midges, ticks and mosquitoes. Livestock viruses transmitted by Culicoides biting midges and are not zoonotic. However, many mosquito-transmitted livestock viruses are zoonotic. Climate change may affect not only the geographical range and abundance of vectors, but also the interaction between a pathogen and a vector. The emergence of BTV in Europe since 1998 has been facilitated by both mechanisms. Temperature has big impact on the development rate ofarthropod vectors and the transmission dynamics ofvector-bornediseases.Theseeffects are thought to be more apparent within thelower and upper temperature extremes of14–18˚C and 35–40˚C, respectively(Githeko*etal*.,2000).

5.3.3) Effect on pathogen

Outbreak of Leptospirosis is associated with rainfall and flooding have also been reported in diverse areas including Nicaragua, Brazil, India, Southeast Asia, Malaysia and United States (Lau *et al*., 2010).

5.4) Effect of climate change on feed and water availability

Climate change will lead to reduced nutrient availability for animals and ultimately to a reduction in livestock production. Adverse impact of climate change on crop production will further increase the gap between availability and requirement of feed and fodder. Higher temperatures increase lignin formation in plant tissues and thereby reduce the digestibility and rates of degradation of fodder and crop residues in the ruminants.



Graph 6: Fodder deficit under projected climate change scenario

Water Requirement in Livestock

Water use in livestock sector not only includes not only the water used at farm level for drinking and growing the crops but also other servicing and product processing role. Livestock sector accounts for about 8% of global water use and an increase in temperature may increase animal water consumption by a factor of two or three(Nardone *et al*., 2010).

Water demand under climate change scenario

Simple water demand model for cattle and estimate that under Australian conditions, water requirements of beef cattle are likely to increase by around 13% of climate scenario simulated (Howden and Turnpenny, 1997).

6) Impact of climate change on poultry

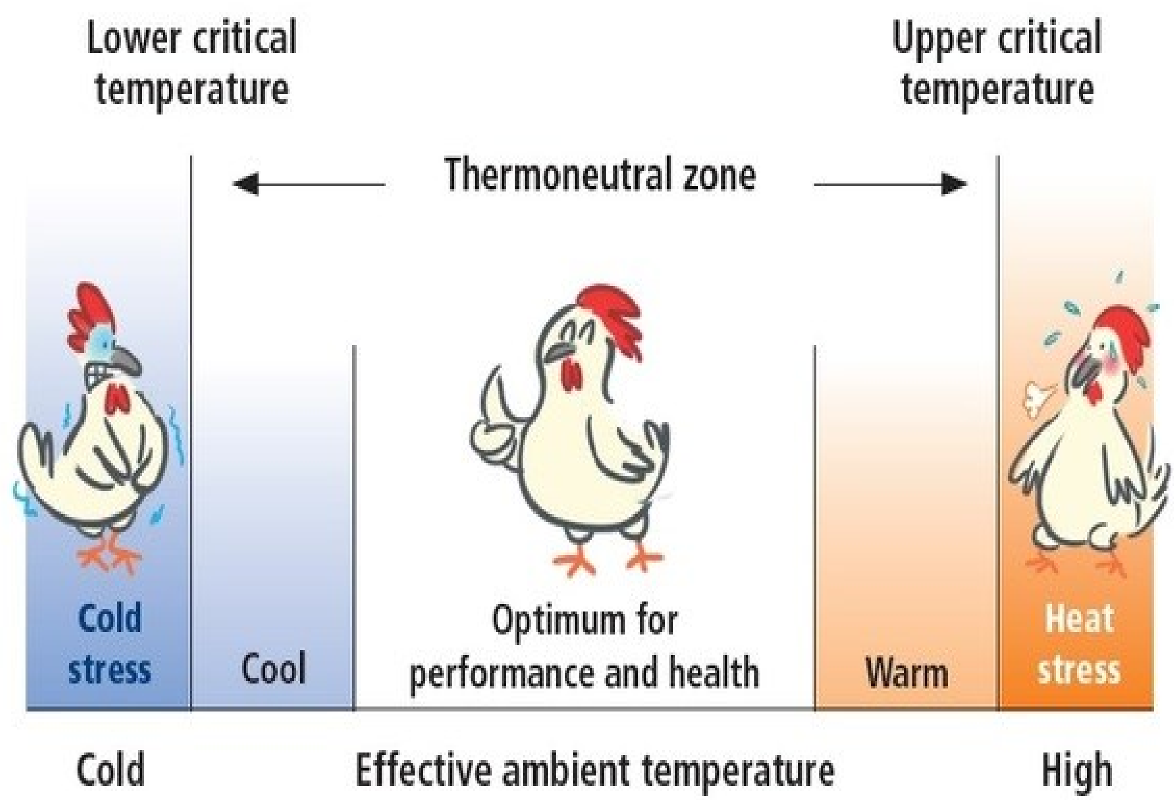


Figure 4: Environmental temperature and thermal zone

6.1) Effect of heat stress on poultry

6.1.1) Behavioral and physiological effect

Different types of birds react similarly to heat stress, expressing some individual variation in intensity and duration of their responses. Birds subjected to heat stress conditions spend less time feeding, moving or walking, more time drinking and panting, more time with their wings elevated and more time resting.

6.1.2) Effect of high temperature on immune response

Environmental stressful conditions, as the bird's body attempts to maintain its thermal homeostasis, increased levels of reactive oxygen species occur. As a consequence, the body enters a stage of oxidative stress, and starts producing and releasing heat shock proteins (HSP) to try and protect itself from the deleterious cellular effects of ROS. Moreover, reduced macrophages performing phagocytosis, as well as reduced macrophage basal and induced oxidative burst were observed in heat-stressed broilers.

6.1.3) Impact of heat stress on meat production

Heat stress is associated with depression of meat chemical composition and quality in broilers (Dai *et al*, 2012). Chronic heat stress decreased the proportion of breast muscle, while increasing the proportion of thigh muscle in broilers. Moreover, the study also showed that protein content was lower and fat deposition higher in birds subjected to heat stress (Zhang et al,2012).

6.1.4) Impact of heat stress on egg production

Heat stress cause a significant reduction of egg weight (3.24percent), egg shell thickness (1.2percent), egg shell weight (9.93percent) and egg shell percent (0.66 percent) (Ebied *et al.*, 2012).

6. 1.5) Impact on food security

Colonization of birds by foodborne pathogens, such as Salmonella and Campylobacter, and their subsequent dissemination along the human food chain are a major public health and economic concern in poultry and egg production. In fact, consumption and handling of undercooked poultry products constitutes one of the most commonly implicated sources of food borne illness . Many recent studies have demonstrated that bacteria, such as Salmonella and Campylobacter, are capable of exploiting the neuroendocrine alterations due to the stress response in the host to promote growth and pathogenicity.

6.2) Effect of cold stress on poultry

Heterophil - lymphocyte ratio, fluctuating asymmetry and duration of tonic immobility may be used as criteria for measuring levels of stress, welfare and fear in chickens (Parsons,1990). Hester *et al*. (1996) found that caged hens exposed to a cold environment (0°C for 72 h) had higher heterophil-to-lymphocyte ratios than those of the control environment.

7) Adaptation Strategies

Approaches to climate change management in the livestock sector depend very heavily on the level of resources that national governments or donors or both are able and willing to commit (Morton *et al*., 2002). This level of resources is determined by a country's per capita income, its size and the priority it enjoys among donors, but also by historical, political and cultural factors.

7.1) Improve access to weather focus information

None or poor provision of agricultural information is a key factor that has greatly limited agricultural development in developing countries (Bailey *et al*., 1999). Information delivery is critical in the process of enhancing the adaptive capacities of the rural areas to climate change. The lack of timely and reliable information on weather or new technologies is severe in most communal areas of developing countries. Improved early warning systems and their application may also reduce vulnerability to future risks associated with climate variability and change. Using such climate information it may be possible to give outlooks with lead times of between two and six months before the onset of an event (Thomson *et al*., 2006). Such lead times provide opportunities for putting interventions in place. If information is made available, resource-poor farmers would be able to obtain livestock movement permits or sell their livestock on time. Although considerable progress has been observed in the provision of communication systems such as telephone and cellular phone network facilities, communal farmers in developed countries still remain uninformed in terms of new weather focus information in advance as they use outdated equipment that make the probability of correct prediction very low resulting in farmers not even trusting the information in most instances.

Radio and other media such as churches and gatherings like traditional beer drinking ceremonies are still used as main source of weather focus information (Musemwa *et al*., 2008). However, access by smallholder livestock farmers to radios, televisions and internet is still limited. In most cases, information is broadcasted and written in English. This makes the information irrelevant to the majority of communal farmers who in most cases understand their local languages only (Montshwe, 2006).

7.2) Use of Local Breeds

Livestock pests and diseases form a major threat to livestock production in developing countries and climate change may aggravate the situation since a warmer climate could shorten the developmental cycle of many pests and disease agents. An integrated management approach combining biological and nonbiological methods will be the best option to deal with an increased pest and disease pressure. Policies and development efforts to improve livestock production in the communal areas in developed countries such as South Africa for instance have been based on the use of fast growing imported breeds (Musemwa *et al*., 2010). These are perceived to be superior to native breeds because of their large body size (Bester *et al*., 2005). Contrary to this presumption, exotic breeds are failing to cope with the harsh climatic conditions being experienced in these areas (Muchenje *et al*., 2008). Consequently, farmers raising these imported breeds are incurring more production costs as a result of climate change. Use of local breeds such as the Nguni cattle in South Africa and the Mashona in Zimbabwe which are well adapted to the environment because they have evolved in those surroundings for thousands of years could lower the impact of climate change on livestock production in developing countries. Local breeds are known by their fertility and excellent resistance to ticks and immunity to tick borne diseases (Ferreira, 2008). Disease incidence and mortality are low in local breeds (Muchenje *et al*., 2008). For instance the South African local cattle breed (Nguni cattle) has survived without any dipping or dosing in areas where other cattle died within months. Bonsma (1980) and Muchenje *et al*. (2008) found that the Nguni carried the lowest tick numbers regardless of the species or season of the year however Muchenje *et al*. (2008) further noted that productivity of the Nguni cattle was not significantly influenced by whether they were dipped or not but Bonsmara and Angus steers showed significant drops in growth rate, liveweight and carcass characteristics . Besides their resistance to tropical diseases and parasites, the local livestock breeds are highly adaptable to poor quality grazing and conditions of excessive heat and humidity (Musemwa *et al*., 2010). They also have adaptive traits such as walking ability, which enables it them to walk long distances in search of grazing and water (Ferreira, 2008). They are excellent foragers and can graze and browse on steep slopes and in thick bushes alike. Higher levels of blood urea have been recorded in the Nguni cattle than in other breeds (most significant during winter months) and although this finding is subject to ongoing research certain facts have been identified as possible catalysts:

- Nguni have a system of recycling urea through controlled kidney function and even drinking the urine of other animals in the herd during times of nutritional stress
- Nguni are capable of selecting diet efficiently through higher intake of browse for increased protein ingestion
- The digestive system of the Nguni is more efficient in terms of cellulose break-down, release of nutrients and digestion of micro-organisms present in the system, millions of which are carried into the small intestines

7.3)Shades and Ventilation

During times of high temperatures resourcepoor farmers cannot afford to purchase materials to build either artificial or permanent shades. This therefore means poor resource livestock farmers can use trees as natural shade. In an experiment by Valtorta *et al.* (1997) the artificial shade structure did not differ from tree shades in terms of the effects on animal wellbeing. Trees are an excellent natural source of shade on the pasture. Trees are not effective blockers of solar radiation but the evaporation of moisture from leaf surface cools the surrounding air. A simple shade can reduce the animals’ radiant heat load by 30% or more (Bond *et al*., 1967). According Valtorta *et al*. (1997) shades are efficient in reducing heat stress in livestock. They found that protected dairy cows presented lower afternoon rectal temperature and respiration rate, and yielded more milk and protein. In beef cattle with access to shade, Mitloehner *et al*. (2001; 2002), observed a reduction in core body temperature and respiration rate.

Deliverable technology

Figure 6: Technology for measuring heat stress in animals - ASWASA

7.4) Stock Movement

Movement of livestock from regions affected by climate change i.e. droughts, for example, to alternative grazing areas is one of the strategies that can be adopted by resource-poor farmers. According to Scoones (1992), the movement of stock in drought affected regions can be done in two ways depending on the severity of the climate change impact. For instance if the drought is not too severe, movement of stock can be done locally away from the clay soil zone to the edge zone and on to the sandy soil zone areas. This is because drought has a lesser impact on grass production in the sandy soil zone. In addition the availability of key resource grazing patches is more extensive in the sandy soil zone. If the drought is severe, movement of livestock is done across regions (movement outside the boundaries of a communal area). In this process livestock can be loaned to both relatives and friends and often at some distance from the owner's home where climate change impact is less. In some instances, grazing can be hired from private land owners which is however a resource-poor farmer. However, resource-poor farmers can exchange grazingwith some of their livestock. Movement of livestock outside the boundaries of communal areas is however difficult. To begin with, movement of animals outside their dip area is illegal without a permit from the Veterinary Department. Such permits are quite complex to acquire, requiring a series of visits to official offices and the signing of a number of forms. Movement is further restricted by specific veterinary regulations related to the control of Foot and Mouth Disease and required by the most developing countries (Musemwa *et al*., 2010). Policy restrictions on movement thus hamper flexible climate change response through stock movement.

7.5) Housing management in poultry

Shed for livestock is considered essential to minimize loss in milk production and reproductive efficiency. Sheds can improve animal comfort and productivity and should be designed to maximize ventilation and protection from the solar load. It is reported that well designed shed would reduce heat load on animal around 30-40 percent. The design and management of shed for dairy cattle vary in different areas and climates

7.6) Genetic selection and production of thermo tolerant animals

Production of heat resistant strains of animals. Heat tolerant animals can be selected for cross breeding programmes to improve genetic variation and cooling ability (Kimothi and Ghosh, 2015). *Bos indicus* cattle exhibit increased number of oocyte, oocyte viability, blastocyst rate and reduced rate of nuclear fragmentation in in-vitro produced blastocyst compared to *Bos taurus* (Baruselli *et al*., 2012).

Goat – most adaptive species of livestock to climate change

Goat was considered to be most adaptive livestock species due to their higher ability to produce, survive and reproduce in the climate change scenario.

7.7) Breeds adapted to climate change

Salem Black goat is better breed to adapt heat stress than Malabari and Osmanabadi goat. Salem black goat express high levels of plasma leptin and HSP 70 genes under heat stress. This makes Salem black goat more suited for climate resilient farming.Sindhi breed were better adapted to climate change than Gir.

7.8) Adaptation by nutritional intervention

Allow cattle graze at night time in hot weather, rather than cows to feed in hot weather. Walking to feed increases a cows heat load, so reduce their walking during the hottest time of the day. So, night grazing may be practised for 2-3 hours to fulfil nutrient requirement partially and have sufficient exercise for normal physiological function. The use of antioxidants such as Vit. E, Vit. A and selenium helps in reducing the impact of heat stress by oxidant balance, resulting in improved reproductive efficiency and animal health (Sejian *et al.*, 2014).

8) **Conclusion**

The impact of climate change in developing countries to resource-poor livestock farmers is increasing significantly due to the fact that the farmers have limited adaption strategies. If policies which include allowing free movement of stock during periods of harsh climatic conditions could be put in place, the impact of climate change could be reduced quite significantly. The use of local breeds which are well adapted to harsh climatic conditions could also play an important role in minimizing the effect of climate change to livestock production. An integrated tree-livestock farming system could play a role in minimizing the impact of extreme temperature on livestock. The trees act as shades during times of high temperature reducing heat stress on livestock hence promoting livestock productivity. The provision of reliable weather focus information in developing countries in a user friendly manner could also provide livestock farmers with opportunities for putting interventions strategies in place before a bad event happens hence reducing the impact of climate change to livestock.

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KERALA AGRICULTURAL UNIVERSITY
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AGM 591: Master's Seminar

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Admission No : 2018-11-130 Date : 07-11-2019
Major Advisor : Dr. Ajith K. Time : 10.00 am

Impact of climate change on livestock and poultry

Abstract

Animal husbandry contribute a major portion of income to the farmers. In India, livestock sector plays an important role for livelihood and food security. Global demand for egg, meat and dairy products is growing and it is apparent that the livestock sector has to be expanded. In a climate resilient mixed farming system livestock is a major component. Extreme weather events and seasonal fluctuations due to climate change adversely affect livestock and poultry production.

Climate change imparts multiple environmental stresses on animals which affect the livestock production directly and indirectly. Direct effects include impact due to change in temperature and rainfall pattern. Indirect effects include disease incidence and decreased availability of feed and water.

Thermo neutral zone is the range of temperature in the immediate environment at which a healthy adult animal can maintain a normal body temperature without using energy beyond its normal basal metabolic rate. Above that range animals will feel heat stress and below that they will suffer from cold stress. Heat stress affect growth, milk yield, animal reproduction and meat production. Increased temperature results in different physiological responses in livestock like increased respiration rate, rectal temperature, pulse rate, skin temperature and sweating rate.

Rainfall and flooding associatedoutbreak of Leptospirosis have reported in diverse areas including Nicaragua, Brazil, India, Southeast Asia, Malaysia and United States (Lau *et al*., 2010). Livestock sector accounts for about 8% of global human water use and an increase in temperature may increase animal water consumption by a factor of two or three times (Nardone *et al*., 2010).

When ambient temperature reaches above critical upper temperature, birds may reduce feed intake to maintain a constant body temperature (Chand *et al*., 2014). High temperature under projected climate change will also affect immune response, meat production, egg production and food safety.Heat stress cause a significant reduction of egg weight (3.24%), egg shell thickness (1.2%), eggshell weight (9.93%) and eggshell percent (0.66%) (Ebied *et al.*, 2012).

Livestock production and our dependence on it for survival is a reality. It is also a fact that this global source of food and income is prone to the effects of climate change. Challenge of climate change in livestock sector requires formulation of appropriate long term adaptation strategies and mitigation options. Adaptation to this adverse effect of climate change can be done by housing management, nutritional and reproductive management.

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13) Discussion

1) Can we use invitro fertilization to increase the fertility?

   Yes. Invitro fertilization and supplementation of progesterone can be done.

2) Is there any methods to escape from cold stress?

   Animal shade can be modified for escaping from cold stress.

3) Did any disease outbreak happened after Kerala flood?

   Yes. Incidence of Leprosis was severe after Kerala flood. Because the pathogen requires a moist condition for its growth and multiplication.

4) Is there any change in mean weight of poultry due to heat stress?

   No. But the propotion of breast musles decreases, which is mostly preferred by people.

5) What is the range of temperature required for healthy growth?

   So that is really a broad question. The range will depend on the animal.

6) What is the purpose of using anti-oxidants ?

   Reactive oxygen species is produced during heat stress condition, which is detrimental to animal body. Inorder to reduce the effect of this reactive oxygen species, we are using anti-oxidants.

7) Is there any change in milk quality due to increased temperature?

   Yes. Glucose content in the milk decreases due to the breakdown of same because of increased respiration,