BUILDING RESILIENCE TO CLIMATE SHOCKS: CAMEL PRODUCTION IN THE FACE OF CLIMATE CHANGE: A REVIEW

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1. INTRODUCTION

- Climate change is affecting livestock productivity by altering ecosystem services like **water availability**, **soil, forage quality and quantity**

- Climate change alters livestock production & animal genetic resources
  - feed resources
  - water supply
  - diseases outbreak
  - animals stress due to heat shock

- Increased surface temperature influences quality of forage production by lignification of plant tissue
  - leads to poor feed utilization by altering digestibility and degradation rate.

- Among pastoral livestock species, camels are multipurpose farm animal, provides
  - **milk, meat and draft power**
  - **Social prestige** is remarkable among the pastoral societies

- Large populations of pastoral livestock species are highly threatening by climatic disasters and inhospitable production environment.

- Camel is found to be the fittest of all animals in this area due to its unique **anatomical, physiological and behavioral adaptive** features to harsh and hostile environmental condition.

- There are about 4.5 million heads of camels in Ethiopia, of which about 26.37% heads were dairy camels.

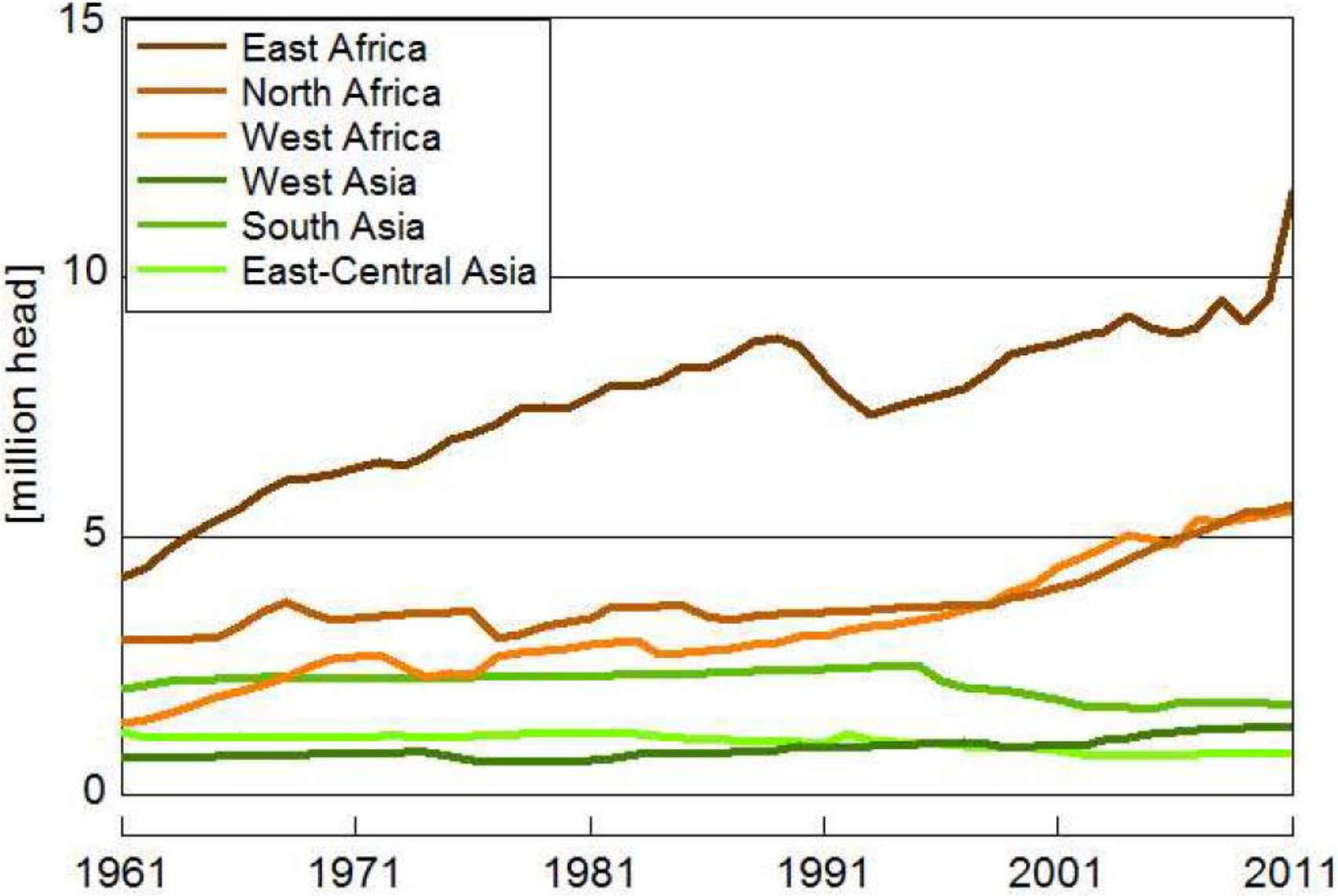

Fig: Change of camel numbers by region since 1961

Source: FAOSTAT 2013

- Camel is the most productive **dairy animal**

- Afar pastoralists are rearing both cattle and camel,
  - **1 to 1.5** liters of milk from cattle
  - while **4 to 5** liters of milk

- Camel is productive species than any livestock classes under inhospitable and changing climatic condition.

- **Objective**
  - to provide an overview of the resilience ability of camel in the face of changing climate

IMPACT OF CLIMATE CHANGE ON LIVESTOCK

- Lack of water can often cause a decline in crop and animal yields, and thus, farmer's loss their regular income.

- Plant and animal species can suffer tremendously due to long-term droughts

  - In 2015, approximately 655,000 pastoral community members in Ethiopian Somali and Afar regions were affected

  - decline in the number of livestock species namely cattle, goats, sheep and donkey was remarkable due to climate change.

  - Most of the animals were died in 2005 and 2008.

- daily and lactation milk yields of cattle were declined steadily and dramatically at about 89% between 1981/82 and 2009.

- In 2018 more than 2 million cattle were at risk and in need for feed aids in Bale and Guji zones
  - Due to recurrent drought in the last successive three years

- Sub-Saharan livestock producers remain jammed by several effects of recurrent drought which deplete available livestock feed resources and reduced water supply for plants and animals.

Surface temperature Vs Livestock Thermoneutral zone

- Of tropical livestock species, cattle gain about 65 to 75% of heat from solar radiation and 25 to 35% of heat obtained from metabolic sources.

- When the atmosphere is warming, additional heat also gained in the form of
  - Long wave radiation from the hot surface
  - when an atmospheric temperature exceeds skin temperature additional heat is gained through conduction

- substantial decline in animal performance inflicting heavy economic losses when subjected to heat stress.

- Climate change especially increases in temperature, has a direct impact on increasing heat stress in animals

- Heat stress due to **high ambient temperature** accompanied by **excess humidity** cause infertility and adverse effect on reproductive performance of farm animals

- In Lowland areas, the temperature variation is much greater, and the heat in the desert areas is extreme (42°C), occasionally as high as 60°C.

- Camel has wider thermo-neutral zone **(35 to 42 °C)**

Impacts of climate change on livestock Feed production

- Lowland areas are most affected by climate change shocks interchangeably, like **floods and recurrent drought**.
- These both shocks affect quality and quantity of available livestock feeds resources
- For most plants, these changes are so rapid and they become powerless to respond with the extant genetic diversity.
- However, some species extant genetic diversity may develop adaptive capacity in response to such rapidly changing condition
- Thus, those plant species with poor genetic diversity are being affected by rapid environmental changes.

- Drought plague regions are experiencing **water stress** as a result of climate change.

- This trend deteriorates livestock forage and pasture availability, and quality

- Thus, it is advised to shift to drought-resistant forage species and verities
- Livestock feed resources like forage and rangeland productivity are directly affected by drought.

- Above all prolonged drought as a result of climate change has remarkable impacts on quality of feed resources and lead to change habitat species composition, and modify the species of livestock that feed on them

- The natural habitat of **the camel** is basically arid and semi-arid areas
- The plant grew in these areas undergone various adaptation mechanism to withstand such harsh environmental condition
- Reduction in leaf size, replacements of the leaf with thrones to reduce surface evaporation, and sparse distribution of plants to minimize soil water competition
- Slightly lengthier and sparse distributions of pasture species (shrub/bushes) in lowland (arid desert) areas are more prominent
- **Camels are considered as habitat responsible animals (unlike goat chewing to the root)**

Camel Milk Production

- For camel producers, camel milk is not the only source of food but also provide their main income

- Camels are the most milk productive animal and the **fittest** livestock species for semi-arid and arid desert areas.

- As a result, a camel can produce a larger volume of milk than other milk producing farm animals,
  - more than **4x milk per day** than that of cattle and
  - much more than goat

- The average lactation periods of dairy camels range from 12 to 18 months under the harsh environmental condition

- It was reported that some individual camel can produce up to 40 liters/ day,
- Pakistani and Afghanistan camel : up to 30 liters/day
- Maghrebi she-camels: up to 25.5 liters/day under intensive magt

- There is a great genetic potential to produce high yielding specialized camel milk breeds.
  - Camel is the hope the future of food security

Climate change and advantages of rearing camel over other livestock

- Camel production is integral parts of food security and income in drought-prone areas because of their special adaptation
- Most of the homoeothermic mammals supposed to maintain their body temperature in the narrow range of 37 to 38 °C with a few exceptions.
- **In this regard, camels possess a broad range (34 - 41°C) of body temperature regulating mechanism.**
- Both of these extreme temperatures would be fatal to other livestock species.
- Camel does not need to sweat until the upper limit of heat storage is reached and its body temperature exceeds 42°C and sweating is not continual

- As a result of this adaptation mechanism, camel's loss small amount of water through respiration.

- Camels capable of drinking equivalent to 30% of their body weight at any one time
- Climate change forcing the farmer to shift their vulnerable livestock species to camel and goat.

- Under the risk of climate change, camel producers found to be in a safe condition

- Long leg and neck of camel help to feed on the tip of long plants up to 3.5m

- Now a day world is preparing itself to cope up the risk of climate change and pastoralist are shifting their animals to camel to acclimatize to the changing climate.

Role of heat shock proteins (HSPs) in camel adaptation to climate shocks

- The increased environmental temperature in tropics and sub-tropics & projected to be rise in future too.
- Thermo-neutral zone for most of the livestock species is less than 25°C environmental temperature.
- Though, it alters the animal physiological process and even survivability in some cases.

- Heat shock response is a rapid molecular mechanism, transient, and short acting which emerges via production of heat shock proteins (HSPs), subsequent to exposure of the cells to sublethal stress
- The heat shock response involves both heat shock factors (HSFs) and HSPs.
- It is induced by accumulation of mis-folded proteins in the cytoplasm and is mediated by HSFs.
- **HSF-1, HSF-2, HSF-3, and HSF-4** have been identified

- HSF-1 plays a major role in heat shock response
- HSF-2, HSF-4 are activated after prolonged stress or participate in normal cellular processes, embryonic development, and cellular differentiation.

- The activated complex can then enter the nucleus and initiate transcription of heat shock proteins.

- HSPs are released from the skin epithelium during heat stress
  - act as an **alarm system** to assist in mobilising the acute response to thermal shock

- It has been hypothesised that secreted HSP acts as an alarm signal for the **immune system** and several measures of innate immunity

- HSPs have also been shown to improve survival of neural cells subjected to environmental and metabolic stressors

- Therefore, livestock species that withstand such increasing atmospheric temperature by evolving heat shock protein are needed in the face of climate change.

- The animal who evolved HSP has less affected by high ambient temperature since the heat shock protein concentration increase with increasing environmental temperature

- HSP are stimulated by heat so that the animal responds to overheating environmental temperature.

- Camel's inhabitant in desert environments in which extensive sun's ultraviolet radiation and the extreme environmental temperature is more prevalent

- The concentration of HSP in desert animal cell rises when animal exposed to extremely high temperature, above 40°C in the case of a camel for example.

- HSPs could be classified based on molecular weight and physiological function.

- Such as HSP10, HSP 25, HSP 27, HSP40, HSP60, HSP70, HSP90, HSP100 and HSP110.

- Among HSP families HSP70, HSP90, HSP25, and HSP27 has developed mainly for environmental thermo-tolerance in most livestock species.

- However, a goat found to be expressed almost all of HSP families in response to heat stress

- Specific HSP expression in response to environmental overheating has not been well-known in camels but HSP70 was slightly quantified during heat stress in camel

- The stressful environmental condition affects semen at cellular level and has a negative impact on semen quality.
- **HSP70**, which, located in reproductive tissues, has critical roles in **spermatogenesis**
- Single nucleotide polymorphisms occurring in the Hsp70 promoter region may impact **stress tolerance**, and haplotypes of Hsp70 were related to cow fertility and heat tolerance

Climate Change and Camel Diseases

Disease types	Agents/transmission	Climate factors	References
Anthrax	Bacteria	**Outbreak-associated to heavy rainfall following to high temperature**	Turnbull et al, 2007; Davies, 1960
Camelpox	Virus	**Hot and dry period helps survival and spread of the virus**	Hadeel, 2009
Trypanosomiasis	Protozoa (tsetse flies vector)	**Hot and dry condition favors survival and prevalence of tsetse flies vector**	Enwezor and Sackey, 2005; Röttcher et al, 1987
Tick infestation	External Parasite	**Outbreak-associated with high temperature and drought.**	Rodriguez et al, 2015
Rift Valley fever	Virus, transmitted by Aedes and Culex mosquitoes	**Associated with Heavy rainfall following with recurrent drought the El Niño Southern Oscillation (ENSO)**	Himeidan et al, 2014
Foot and mouth disease	Virus	**Elevated Temperature, the seasonal occurrence of dry and cold season**	Habiela et al., 2010
Bluetongue	Virus	**Related to cold temperatures due to La-Nina**	Jiménez-Clavero, 2012
Respiratory diseases	May Bacteria, viral, protozoa and others	**Associated with flooding, drought, high temperature and air dust concentration in drought-prone areas**	Yusa, et al, 2015; Fassi-Fehri, 1987
Sudden death syndrome	Unknown	**Emerging disease as a result of Higher temperature and recurrent drought condition**	Simenew, 2016
Haemonchosis	Nematodes	**Associated with prolonged drought and higher temperature**	Van Dijk et al, 2010

Conclusion and Recommendation

- Camel should get prime focus to strength climate resiliency of pastoral community
- Breeding and selection of Climate resilient and productive camels: dairy, meat or dual purpose
- Among farm animals, specific HSP expression in response to environmental overheating has not been well-known in camels
  - Therefore, it needs further investigations to quantify HSP families expressed in response to heat stress

- Global warming is increasing disease causative vectors and survival of pathogens.

- Thus,
  - Veterinary services such as medical prophylaxes and curative treatments should be provided regularly or periodically

  - Scientific investigations, renovating and strengthening of ethno-veterinary perspective of pastoralists against some camel diseases

Thank you for your attention