INITIATIVE ON
Livestock and Climate

Livestock, drylands and climate change

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Context

>80% of Kenya = arid or semi-arid

Home to both wildlife, livestock and livestock producers

50% of total livestock population

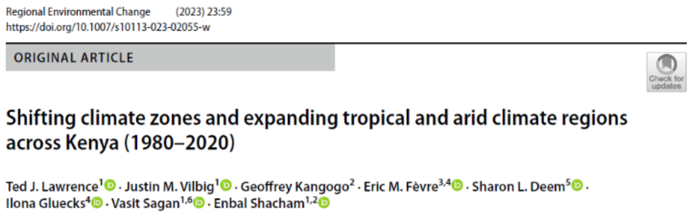
30% of total human population

75% of total wildlife population

Producing **90%** of the meat consumed in Kenya

Climate change

- Over the last 40 years:
  - Approximate **1°C** increase in temperature
  - **137,129 km^2** shifted from wetter to drier zones
  - Arid climate regions **expanded from 72 to 81%** (= 50,000km^2)
- Climate zones shift towards **hotter and drier conditions**
- **Climatic diversity will decline** so will ecosystem diversity and ecosystem goods and services to society


Regional Environmental Change (2023) 23:59
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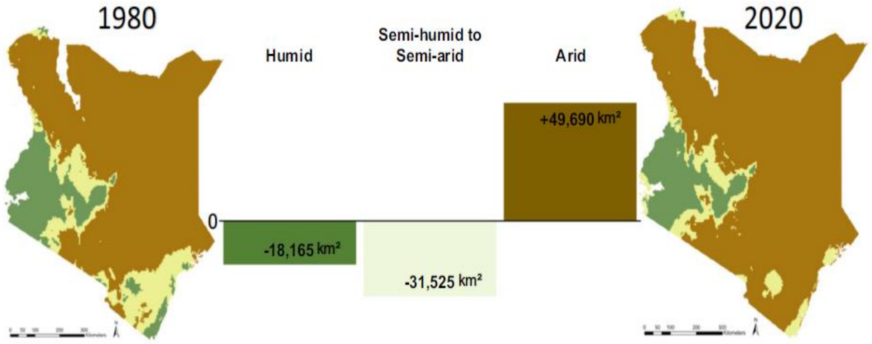
ORIGINAL ARTICLE

Shifting climate zones and expanding tropical and arid climate regions across Kenya (1980–2020)

Ted J. Lawrence[1] · Justin M. Vilbig[1] · Geoffrey Kangogo[2] · Eric M. Fèvre[3,4] · Sharon L. Deem[5] · Ilona Gluecks[4] · Vasit Sagan[1,6] · Enbal Shacham[1,2]



Impacts of CC on Livestock

Hazards/stresses:

- Δ CO_2, temperature, precipitation
- Variability and extreme events

Direct impact

- Heat stress

Indirect impact

- Water
- Diseases
- Biodiversity, Soil
- Feed and forages
- Livelihoods and systems

Impacts of CC on Livestock

Heat stress

Behavioral and metabolic changes, e.g. reduced feed intake, increased energy requirement, decreased conception rates, …

Influenced by species, genetic potential, life stage and nutritional status

Water

Rising temperature ~ higher water demand (feed production and drinking)

Δ surface and groundwater supply

Diseases

Δ development of pathogens, distribution of vectors, transmission rates

Decreased resistance of livestock

Heat stress increasing

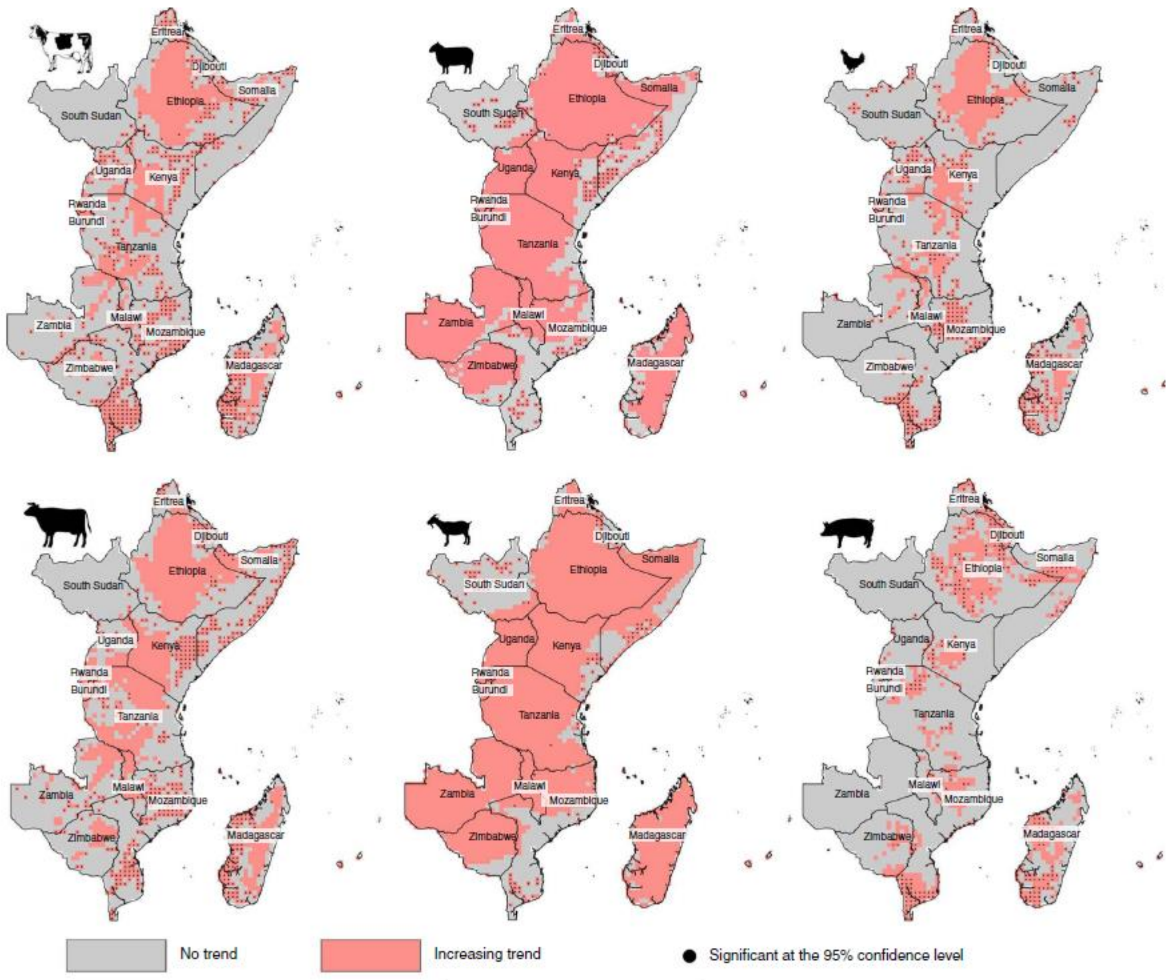
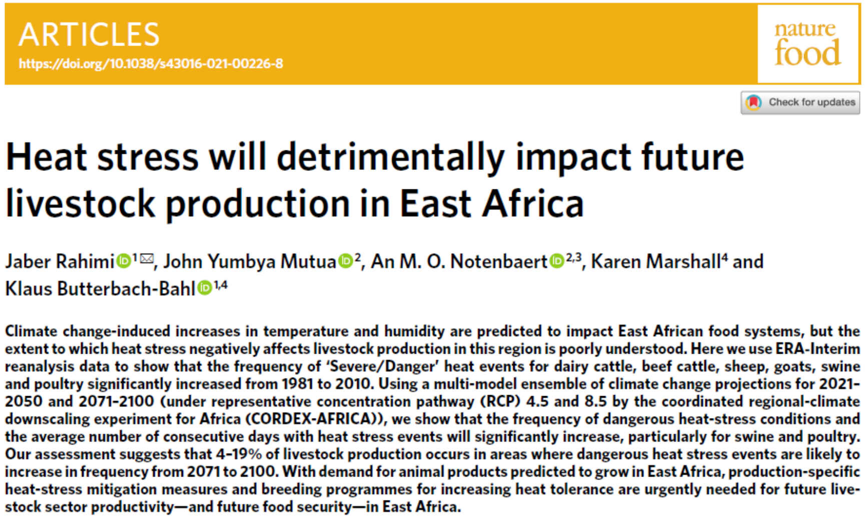


Fig. 2 | Trends in the percentage of days with Severe/Danger heat stress during the historical period. Trends in heat stress for the years 1981–2010 for different livestock categories (dairy cattle, top left; sheep, top centre; poultry, top right; beef cattle, bottom left; goats, bottom centre and swine, bottom right). Stippling indicates that trend values are significant at the 95% confidence level.



ARTICLES
https://doi.org/10.1038/s43016-021-00226-8
nature food
Check for updates

Heat stress will detrimentally impact future livestock production in East Africa

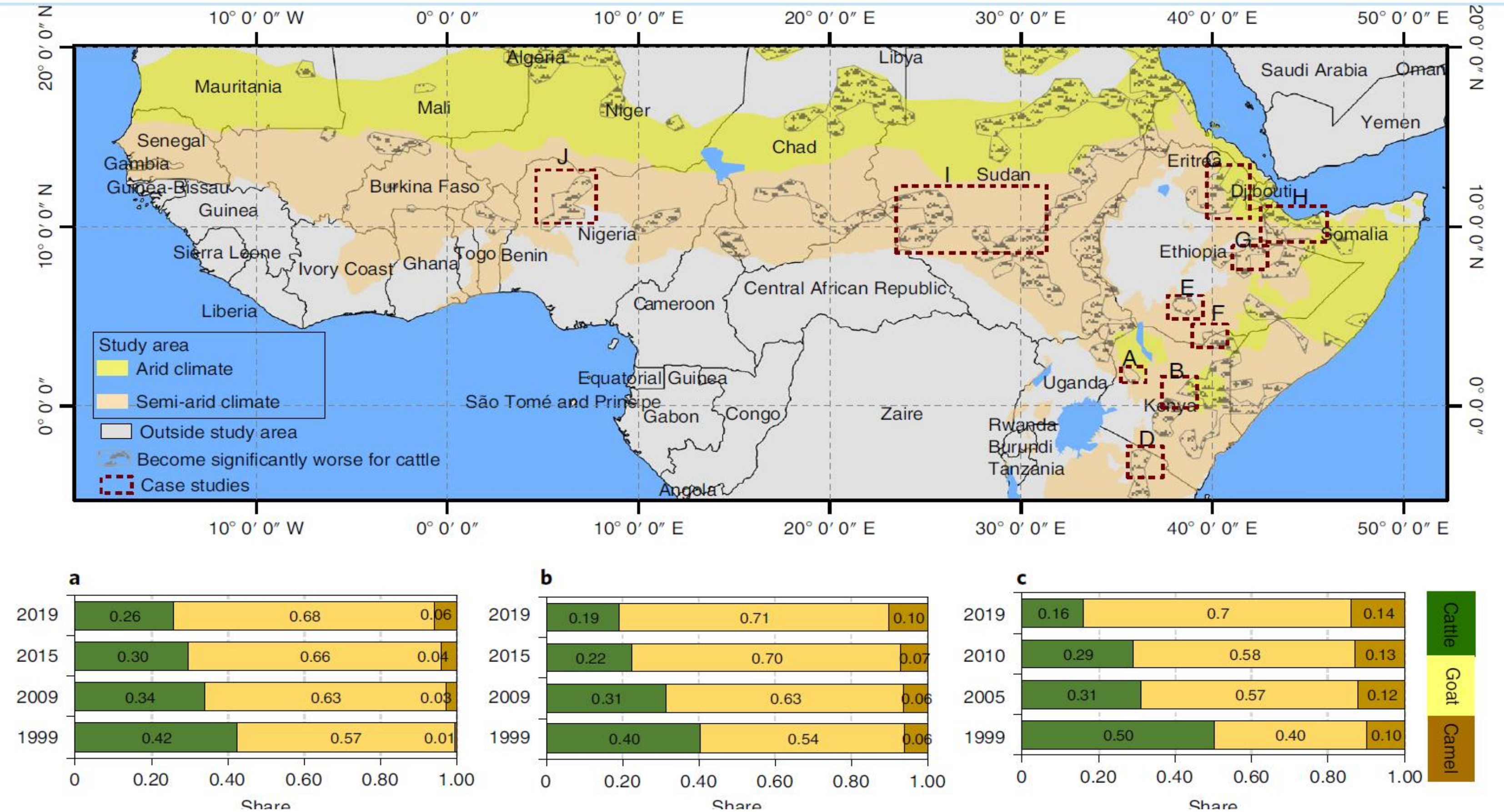
Jaber Rahimi[1], John Yumbya Mutua[2], An M. O. Notenbaert[2,3], Karen Marshall[4] and Klaus Butterbach-Bahl[1,4]

Climate change-induced increases in temperature and humidity are predicted to impact East African food systems, but the extent to which heat stress negatively affects livestock production in this region is poorly understood. Here we use ERA-Interim reanalysis data to show that the frequency of 'Severe/Danger' heat events for dairy cattle, beef cattle, sheep, goats, swine and poultry significantly increased from 1981 to 2010. Using a multi-model ensemble of climate change projections for 2021–2050 and 2071–2100 (under representative concentration pathway (RCP) 4.5 and 8.5 by the coordinated regional-climate downscaling experiment for Africa (CORDEX-AFRICA)), we show that the frequency of dangerous heat-stress conditions and the average number of consecutive days with heat stress events will significantly increase, particularly for swine and poultry. Our assessment suggests that 4–19% of livestock production occurs in areas where dangerous heat stress events are likely to increase in frequency from 2071 to 2100. With demand for animal products predicted to grow in East Africa, production-specific heat-stress mitigation measures and breeding programmes for increasing heat tolerance are urgently needed for future livestock sector productivity—and future food security—in East Africa.

Adaptation efforts will be necessary to combat the effects of increasing **heat stress** if food security challenges are to be minimized.

Adaptations include switching to more **heat-tolerant species and breeds & provision of shade.**

Camels – a solution to food security?



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OPEN

A shift from cattle to camel and goat farming can sustain milk production with lower inputs and emissions in north sub-Saharan Africa's drylands

Jaber Rahimi[1], Erwann Fillol[2], John Y. Mutua[3], Giuseppina Cinardi[4], Timothy P. Robinson[4], An M. O. Notenbaert[5,6], Polly J. Ericksen[7], Michael W. Graham[7] and Klaus Butterbach-Bahl[1,7,8]

Study: combine heat stress frequency, DM feed production, water accessibility data to understand where environmental changes in NSSA's drylands are jeopardizing cattle milk production

→ Environmental conditions worsened for 17% of the study area

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Camels – a solution to food security?

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Semi-arid zone

	Cattle	Goats	Camels
Current (%)	47.7	46.3	6.0
Ideal (%)	24.0	58.3	17.7

	Current	Ideal
Milk production (Mt)	0.88	0.93
Water for milk production (million m^3)	4,417.7	3,722.3
Feed (DM) for milk production (Mt)	1,453.4	1,286.6
GHG of milk production ($MtCO_2e$)	6,194.1	5,689.0

Arid zone

	Cattle	Goats	Camels
Current (%)	34.7	52.0	13.3
Ideal (%)	9.7	68.3	22.0

	Current	Ideal
Milk production (Mt)	1.40	1.48
Water for milk production (million m^3)	6,618.8	5,630.6
Feed (DM) for milk production (Mt)	2,145.1	1,907.6
GHG of milk production ($MtCO_2e$)	9,357.9	8,638.4

Increasing goats 14% (7.7m) and camels 10% (1.2m)

Reducing cattle 25% (5.9m)

→ 5.7% (0.14Mt) higher milk

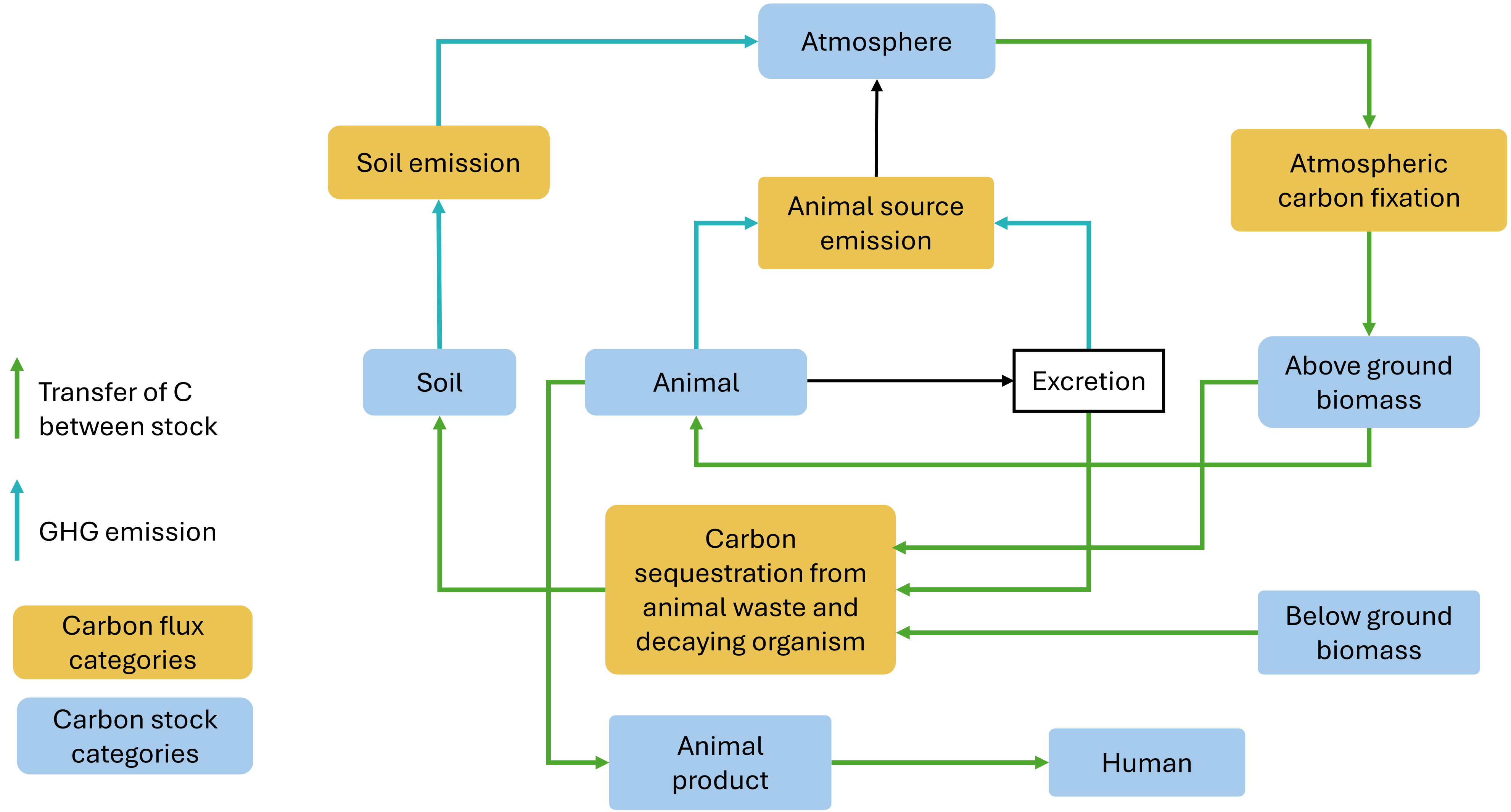
→ 15.3% (1,683.6million m3) lower water

→ 11.2% (404.3Mt) reduced feed demand

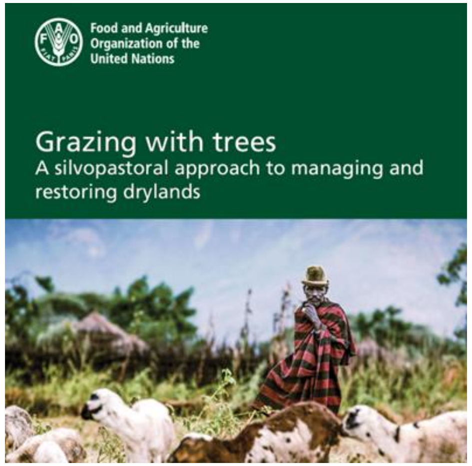
→ 7.9% (1.224.6 MtCo2e) lower emission

Shifting herd composition from cattle to inclusion of, **replacement with goats and camels can secure milk production** and secure NSSAs dairy production resilience against climate change.

Carbon Stock and Flow in Silvo-pastoral systems



Silvo-pastoral systems – "grazing with trees"



Co-benefits:

- Shade → productivity increases, animal welfare
- Carbon sequestration (and reduction in enteric CH_4)
- Biodiversity increases
- Soil Improvement: Tree roots help improve soil structure, increase organic matter, and enhance nutrient cycling
- Water Management: Better infiltration and reduced runoff improve water availability and quality
- Economic Benefits: Diversified farm income through additional products like timber, fruits, manure, others
- Animal Welfare: Better shelter from extreme weather conditions improves overall animal health.
- Reduction in Soil Erosion: Trees and vegetation help stabilize the soil, reducing erosion
- Improve N cycling: N fixation through leguminous trees increases availability of N

On-going research

- Shade-tolerant forages
- Quantification of carbon sequestration potential
- GHG Emissions Reduction
- Soil Health Improvement
- Biodiversity Enhancement/increasing
- Integration with Crop Systems

Next steps:

- Co-design and scaling of locally-adapted systems
- On-field measurements and estimations
- Explore carbon markets

Final comments

Climate Change Impact: Kenya's arid areas have expanded, leading to hotter, drier conditions that reduce ecosystem diversity and services.

Heat Stress Adaptation: Adaptation, like using heat-tolerant livestock and providing shade, is essential to combat increasing heat stress

--> Camels as a Solution: Including more goats and camels in herds can improve milk yield, reduce resource demand, and lower emissions

--> Silvopastoral System Benefits: These systems enhance productivity, carbon sequestration, biodiversity, soil and water management, and provide economic benefits

Thank you!

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