The sub Saharan Journal of Social Sciences and Humanities (SJSSH)
ISSN: 2619-8894 (Online), 2619- 8851 (Print)

Determinants of Effective Livestock-Based Drought Risk Management among Pastoral Communities: Evidence from Handeni District, Tanzania

[1]Emanuel E. Chingonikaya, Farida, S. Salehe[2] and Hebron L. Mwakalonge [3]

[1] Development and Strategic Studies, Sokoine University of Agriculture, Morogoro, Tanzania. Email: chingo@sua.ac.tz
[2]Development and Strategic Studies, Sokoine University of Agriculture, Morogoro, Tanzania. Email: faridasalehe@sua.ac.tz
[3]Tanzania Livestock Research Institute, Tanzania.

Received: January 21, 2025; **Accepted:** April 21, 2025; **Published:** May 14, 2025

Abstract: *Drought poses a persistent threat to pastoral livelihoods globally, particularly in arid and semi-arid regions where livestock-based systems are dominant. Despite the centrality of livestock to pastoralist livelihoods, empirical knowledge on the determinants of effective drought risk management remains limited. This study investigated livestock-based risk management and coping mechanisms among 160 pastoralist households in Handeni District, Tanga Region, Tanzania. A cross-sectional design was employed, using structured questionnaires, focus group discussions, and key informant interviews. Data were analyzed using SPSS, applying multiple linear regression to identify statistically significant predictors of effective drought coping mechanisms. The regression model was statistically significant ($F = 13.261$, $df = 9$, $p < 0.005$), explaining 44.3% ($R^2 = 0.443$) of the variance in drought risk management effectiveness. Key predictors included herd mobility ($\beta = 91.749$, $p = 0.001$), pastoral systems and early warning information ($\beta = 316.537$, $p < 0.001$), land size ($\beta = 2.854$, $p = 0.004$), and access to timely markets ($\beta = 11.516$, $p = 0.021$). These findings underscore the critical role of mobility and access to climate and market information in enhancing pastoral resilience to drought. Notably, herd mobility was the most adopted practice, with 66.9% of respondents indicating migration in search of pasture and water as a key adaptive strategy. The study concludes that enhancing drought early warning systems, securing grazing lands, and promoting mobility-friendly policies are vital to effective livestock-based drought risk management. It recommends the integration of local knowledge systems with formal risk analysis and planning, ensuring participatory decision-making from grassroots to national levels. Strengthening institutional support, land tenure systems, and timely market access will improve adaptive capacities and contribute to sustainable pastoral livelihoods under increasing drought conditions.*

Keywords: *Drought, Livestock, Risk Management, Herd Mobility, Coping Mechanisms, Pastoral Systems, Resilience*

1. Background Information

Drought is one of the most pervasive and recurring climate-related disasters, disproportionately affecting arid and semi-arid regions (ASALs) across Sub-Saharan Africa, where livestock-based livelihoods predominate (IPCC, 2022; FAO, 2023). In Tanzania, pastoralist communities in regions such as Handeni face mounting challenges from recurrent droughts that severely undermine livestock production systems, the backbone of their socio-economic existence (URT, 2021; Nindi *et al.*, 2020). These droughts not only reduce forage and water availability but also intensify livestock morbidity, market volatility, and resource-based conflicts (Shah *et al.*, 2021; Nganga *et al.*, 2022). With climate change projected to increase the frequency, intensity, and duration of droughts, particularly in East Africa, the urgency for effective drought risk management (DRM) among pastoralists is greater than ever (Niang *et al.*, 2014; IPCC, 2022).

Extant studies have documented various adaptive and coping strategies adopted by pastoralists, such as herd mobility, diversification of livelihoods, early warning systems, and communal resource management (Nassef & Hesse, 2009; Galvin, 2009; Little *et al.*, 2019). These strategies resonate with the Sustainable Livelihoods Framework (SLF), which underscores the importance of access to livelihood assets (natural, human, financial, physical, and social capital) in shaping households' adaptive capacity and resilience (Chambers & Conway, 1992; Scoones, 1998). However, significant gaps remain in our understanding of the determinants that underpin the effectiveness of these strategies. Many studies are either conceptual or focused at macro scales, failing to capture localized drivers of effective drought risk management at the household level, particularly in under-researched areas like Handeni District (Mekuyie *et al.*, 2018; Fratkin & Roth, 2020).

Moreover, while early warning systems, market access, and land tenure security are widely cited as enablers of resilience, empirical evidence quantifying their influence remains limited (Gebresenbet *et al.,* 2021; Tessema *et al.,* 2022). There is also a need to integrate indigenous knowledge systems with formal DRM interventions to foster more participatory and contextually relevant solutions (Davies *et al.,* 2018; Omollo *et al.,* 2023). The lack of nuanced, evidence-based understanding of local determinants restricts the formulation of inclusive policies that enhance drought resilience among pastoralists.

This study addresses these gaps by investigating the determinants of effective livestock-based drought risk management among pastoralist households in Handeni District, Tanzania. Grounded in the Sustainable Livelihoods Framework, the research aims to identify socio-economic, institutional, and ecological variables that influence the effectiveness of coping strategies employed by pastoralists. Specifically, it seeks to answer: *Which factors significantly influence the effectiveness of drought risk management and coping mechanisms among pastoralists in Handeni?* The findings are intended to inform policy and practice on how to enhance pastoral resilience in the face of increasing climate-induced risks.

2.0 Theoretical Idea Underpinning the Conceptual Framework

This study is anchored in the Sustainable Livelihoods Framework (SLF) developed by the UK Department for International Development (DFID, 1998), which provides a comprehensive lens for understanding how households combine different resources to pursue livelihood strategies and achieve desirable outcomes under varying levels of vulnerability. The SLF posits that sustainable livelihoods result from the effective use of a set of capital assets, natural, financial, human, physical, and social, which are accessed and mobilized in specific institutional and environmental contexts (Scoones, 2015; Béné *et al.,* 2018). The framework emphasizes that people's access to these assets is mediated by broader structural and contextual factors such as shocks (e.g., droughts, disease outbreaks), trends (e.g., climate change, demographic shifts, political and economic transitions), and seasonality (e.g., rainfall patterns, grazing cycles, and employment fluctuations).

In pastoralist systems like those in Handeni District, where livelihoods are predominantly dependent on livestock and natural resources, the SLF is particularly relevant for diagnosing vulnerability and resilience. Pastoralists' access to critical assets, such as pasture, water, animal health services, livestock markets, extension services, credit, and education, is shaped not only by biophysical conditions but also by institutional and policy contexts (Ayele *et al.,* 2020; Ngondya *et al.,* 2022). As such, the SLF enables a holistic understanding of the drivers and dynamics of poverty, resource scarcity, and adaptive behavior among pastoral communities (Domínguez, 2017; Krätli & Schareika, 2019).

Moreover, the SLF acknowledges the dynamic nature of risk, recognizing that drought and other climate shocks can erode asset bases and disrupt livelihood strategies. It is within this context that livestock-based drought risk management strategies, including herd mobility, destocking, pasture preservation, and indigenous early warning systems, are deployed (Kihara *et al.,* 2023). The framework also allows for the integration of traditional ecological knowledge, which pastoralists have developed over generations to anticipate and respond to environmental variability (Kipkemoi *et al.,* 2022; Krätli, 2020).

The underlying assumption of this conceptual framework is that the effectiveness of drought risk management among pastoralists is a function of their access to livelihood assets, the institutions that mediate this access, and the knowledge systems they use to navigate uncertainty. Thus, interventions aimed at strengthening resilience should simultaneously address asset-building, institutional reform, and the recognition of indigenous knowledge (Eriksen *et al.,* 2021). This conceptual orientation provides a robust theoretical basis for examining how socio-economic and institutional variables influence drought preparedness and adaptive capacity in Handeni District.

The underlying assumption of this conceptual framework is that the effectiveness of drought risk management among pastoralists is not a standalone phenomenon but rather a multifaceted outcome determined by their access to livelihood assets, the institutional structures that facilitate or hinder that access, and the knowledge systems, both indigenous and modern, that they rely upon to manage climatic risks and navigate uncertainty. Specifically, pastoralist households are embedded in an environment where natural assets such as grazing land and water points are increasingly under pressure due to climate variability and land-use change (Kihara *et al.,* 2023), while financial assets such as credit or insurance remain largely inaccessible or underdeveloped in rural Tanzania (Ngondya *et al.,* 2022).

Access to these assets is further mediated by institutional dynamics, including policies, local governance mechanisms, customary tenure arrangements, and the availability of extension and veterinary services (Ayele *et al.,* 2020). Weak or exclusionary institutions can significantly compromise the capacity of pastoralists to plan, adapt, and respond effectively to drought. For example, ineffective rangeland governance or restrictive land policies may limit livestock mobility, which is one of the most critical coping strategies during dry spells (Krätli & Schareika, 2019). At the same time, indigenous knowledge systems, including traditional

The sub Saharan Journal of Social Sciences and Humanities (SJSSH)
ISSN: 2619-8894 (Online), 2619- 8851 (Print)

weather forecasting, rangeland rotation, herd diversification, and customary reciprocity networks, continue to play a central role in drought anticipation, response, and recovery (Kipkemoi *et al.*, 2022; Krätli, 2020).

Therefore, any meaningful intervention aimed at enhancing pastoralist resilience must recognize and integrate these multiple dimensions. Asset-building efforts such as improving access to water infrastructure, markets, or livestock health services can enhance adaptive capacity. Likewise, institutional reforms that promote inclusive governance, secure land tenure, and responsive service delivery are essential for removing structural barriers to resilience. Importantly, the validation and integration of indigenous knowledge into formal disaster risk reduction (DRR) frameworks ensures that interventions are culturally relevant, context-specific, and locally owned (Eriksen *et al.*, 2021; Béné *et al.*, 2018).

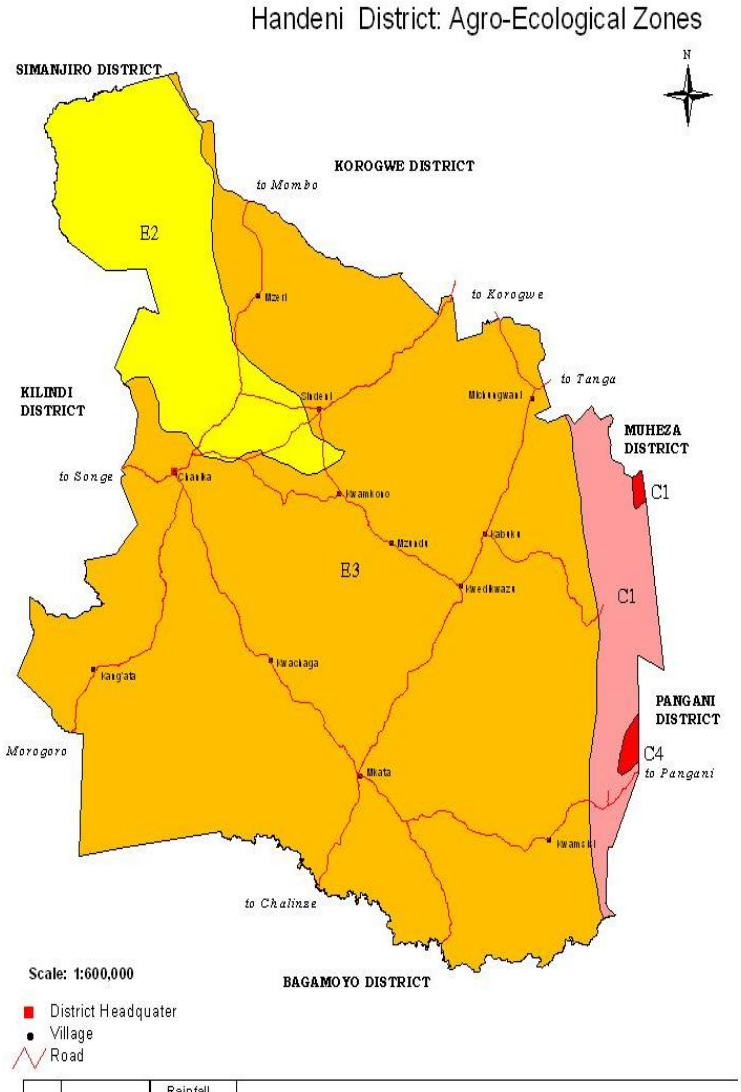
This conceptual orientation thus provides a robust theoretical foundation for examining how various socio-economic and institutional factors interact to shape the vulnerability and adaptive capacity of pastoral communities in drought-prone areas like Handeni District. It allows for a nuanced understanding of resilience, not just as a technical or ecological concept, but as a socially and institutionally embedded process shaped by power, knowledge, and access to resources.

3.0 Methodology

3.1 Study Location

This study was conducted in Handeni District, located in the south-western part of Tanga Region, Tanzania. The district was selected due to its vulnerability to recurrent droughts and the predominance of livestock-based pastoralism as a primary livelihood. Handeni represents a typical semi-arid rangeland ecosystem where pastoralists face climatic and institutional challenges affecting drought preparedness and response. The district spans approximately 6,433 km², with altitudes ranging from 600 to 1,000 meters above sea level. The area's seasonal rainfall patterns, dwindling water sources, and overburdened grazing lands create a high-risk environment for pastoral livelihoods.

Eight villages from four wards and two administrative divisions were purposively selected based on livestock population density, drought experience, and accessibility. These villages exhibit characteristics that are representative of the wider drought-prone areas in Tanzania's ASALs (Arid and Semi-Arid Lands).



Code	Altitude (masl)	Rainfall (mm/year)	Physiography
C1	<200	1000-1200	Nearly level to rolling plains, slopes 0-10%developed on Quaternary sediments
C4	<200	1200-1400	Flat ,low attitude riverine floodplains and deltas with varying flood regimes
E2	500-1200	400-800	Undulating to rolling plains and plateaux alti 500-200 m developed in gneiss
E3	200-750	800-1000	Flat to rolling plains low to altit developed on intermediate metamorphic rocks

Figure 2: Map of Handeni District, Tanga Region, Tanzania, showing the location of the study villages across selected wards.

3.2 Research Design

A cross-sectional research design was employed to capture the socio-economic, ecological, and institutional determinants influencing livestock-based drought risk management. This design is effective for identifying relationships among variables at a specific point in time and has been widely adopted in pastoral studies to assess adaptive capacity and vulnerability (Ayele *et al.*, 2020). The design also enabled integration of both quantitative and qualitative methods, providing a robust basis for triangulation and contextual understanding.

3.3 Sampling Techniques and Sample Size

A multistage sampling approach was used. First, wards and villages were purposively selected based on exposure to drought, presence of pastoralist communities, and prior reports of drought-related livestock losses. At the household level, systematic random sampling was applied to select 160 pastoralist households, consistent with sample sizes in related studies. This size is considered statistically adequate for regression analysis and allows for variability in socio-economic characteristics.

3.4 Data Collection Methods

Multiple methods were used to capture both quantitative and qualitative data:

- ***Structured questionnaires*** were administered to household heads to gather data on socio-demographic profiles, livelihood assets, coping strategies, institutional support, and perceptions of drought risk management. This method allows for statistical generalization and consistency in measurement.
- ***Focus Group Discussions (FGDs)*** were held with elders, women, and youth to collect nuanced information on traditional drought coping mechanisms, indigenous knowledge systems, and community-level constraints. FGDs helped capture the cultural and gendered dimensions of risk management that may not be fully evident through surveys (Kipkemoi *et al.*, 2022).
- ***Key Informant Interviews (KIIs)*** were conducted with extension officers, livestock field officers, traditional leaders, and representatives from NGOs. These stakeholders provided insights into institutional support mechanisms, early warning systems, market access, and policy gaps, aligning with similar approaches in recent DRM studies (Ngondya *et al.*, 2022).

3.5 Data Analysis

Quantitative data were coded and analyzed using SPSS (Version 25). Multiple linear regression analysis was employed to identify statistically significant predictors of effective drought risk management among pastoralist households. This technique allows for the control of confounding variables and provides clarity on the direction and strength of relationships. The regression model's validity was checked through diagnostic tests including multicollinearity, homoscedasticity, and normality of residuals.

The model was expressed as:
$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + ... + \beta_nX_n + \varepsilon$,
where **Y** is the effectiveness of drought coping strategies, $\mathbf{X_n}$ are predictor variables (e.g., herd mobility, access to early warning systems, land size, market access), and **ε** is the error term. Similarly, the model was also expressed as:

SE(PHH) = ß0 + ß1(AGEHH) + ß2(EDULHH) + ß3(FSPHH) + ß4 (MSPHH)+ß5(SPHH)+ß6(LOPHH)+ß7(MEPHH)+ß8(PSPHH)+ß9 (MPPHH) + ei

Where SE (PHH) is the Socio-economies of pastoral households (Measured in number of animals possessed)
ß1 (AGEHH) Age of head of household (in years)
ß2 (EDULHH) Education level of head of household (in years spent in schoo)l
ß3 (FSPHH) Household size (measured in number of family in household)
ß4 (MSPHH) Marital status (1 married 2 Single 3 Divorced)
ß5 (SPHH) Sex of interviewed head of household (1 male and 2 female)
ß6 (LOPHH) Land ownership (measured in size of the land owned in acre)
ß7 (MEPHH) Management practices (1sedentary syesten and 2 nomadic)
ß8 (HMPHH) Herd moblity (measured in number of pastoralits migrated)
ß9 (MAPHH) Market availability (1 available 2 and not available)
ß10 (AEPHH) Availability of early warning syesytem (1 available and 2 not available)
ß(1-10) coefficient of the independent variables
e_i = random error

Qualitative data from FGDs and KIIs were transcribed and analyzed using thematic content analysis, following coding of recurring themes such as mobility, indigenous knowledge, institutional constraints, and adaptation barriers. This approach facilitates the integration of community voices into the analysis of empirical findings (Eriksen *et al.*, 2021; Krätli, 2020).

3.6 Ethical Considerations

Ethical clearance was sought from the relevant research and ethics committee. Informed consent was obtained from all participants, with assurances of confidentiality, voluntary participation, and the right to withdraw at any time. Culturally sensitive protocols were followed, particularly during FGDs and interviews involving traditional leaders and women, in accordance with ethical research practices in pastoralist communities (Domínguez, 2017).

4.0 RESULTS AND DISCUSSION

4.0 RESULTS AND DISCUSSION

4.1 Factors Influencing Risk Management and Coping Mechanisms to Drought among Pastoral Households

Table 1 presents the results of a multiple linear regression analysis used to identify the factors significantly influencing livestock-based drought risk management among pastoral households in Handeni District. The regression model was statistically significant ($F = 13.261$, $df = 9$, $p < 0.005$),

explaining 44.3% (R^2 = 0.443) of the variance in effective drought risk management. Four variables emerged as statistically significant predictors: herd mobility, pastoral systems, land size, and access to early warning systems and markets.

Table 1: Regression Results on Factors Influencing Risk Management and Coping Mechanisms

Variable	Unstandardized Coefficient (B)	Std. Error	t	p-value
(Constant)	-377.035	325.884	-1.157	0.249
Herd mobility	91.749	26.821	3.421	0.001
Pastoral systems	316.537	60.252	5.254	0.000
Age of respondent	-0.451	1.854	-0.243	0.808
Marital status	-53.979	279.482	-0.193	0.847
Education level	34.821	51.113	0.681	0.497
Ownership of land	58.898	69.971	0.842	0.401
Size of land	2.854	0.970	2.942	0.004
Family size	3.379	5.002	0.676	0.500
Access to early warning systems & markets	11.516	23.266	0.495	0.021

Model Summary: SS = 202,228,571.445; MS = 995,904.383; df = 9; F = 13.261; p < 0.005; R^2 = 0.443

The significant role of herd mobility underscores its importance in adapting to drought conditions. As Galaty (2013) and Roth (1996) argue, mobility enables optimal resource use, mitigates disease risks, and enhances adaptive capacity. Similarly, the prominence of pastoral systems indicates that structured traditional systems, often reliant on communal land governance (Nori *et al.*, 2008; Senda *et al.*, 2022), are crucial for coordinated responses. Larger land size correlates with increased capacity to buffer against drought due to diversified forage availability.

4.2 Drought Management and Coping Mechanisms Employed

Pastoralists predominantly rely on herd mobility to cope with droughts. Table 2 illustrates that 66.9% of respondents practiced migration in search of pasture and water, while 31.9% employed both migration and splitting herds into smaller groups. These strategies enable temporal and spatial optimization of resources, reducing overgrazing and maintaining herd health (Homewood & Rodgers, 1991; Ndikumana *et al.*, 2000).

Table 2: Management Practices Adopted during Drought

Management Practice	Frequency	Percent
Migration for pasture and water	107	66.9%
Splitting of herds	2	1.3%
Both practices	51	31.9%
Total	**160**	**100.0%**

These coping mechanisms align with findings by Shem et al. (2005), who emphasize the risk-reducing effects of migration, including avoidance of disease-prone areas and reduced pressure on local resources. However, mobility also has downsides: increased risk of farmer-pastoralist conflicts, limited access to education and health services, and challenges in land ownership (Nassef & Hesse, 2009; Shem *et al.*, 2005).

4.3 Measures Suggested for Mitigating or Coping with Drought

Table 3 outlines additional measures proposed by respondents to mitigate or cope with drought. Notably, 45.6% supported the development of insurance mechanisms for livestock, while 36.3% advocated for an integrated approach combining early warning systems, market access, and insurance. Only 6.3% prioritized market arrangement alone.

Table 3: Suggested Measures for Drought Mitigation and Coping

Suggested Measure	Frequency	Percent
Provision of early warning system	19	11.9%
Arrangement of timely market	10	6.3%
Developing insurance mechanisms	73	45.6%
Combination of all measures	58	36.3%
Total	**160**	**100.0%**

These findings are consistent with Adger *et al.* (2003), who emphasize that socio-economically marginalized populations are most vulnerable to climate extremes like drought. Therefore, institutional mechanisms such as insurance and early warning systems are pivotal in enhancing resilience.

4.4 Comparative Discussion and Literature Integration

This study reinforces earlier conclusions by Kates (2000) and Adger *et al.* (2003) that vulnerability to drought is largely mediated by socio-economic factors and institutional capacity. It adds to empirical findings that pastoral systems relying on mobility are adaptive under variable climates (Homewood & Rodgers, 1991; Ndikumana *et al.*, 2000). However, without supportive policy and institutional frameworks, such systems face degradation and conflict (Senda *et al.*, 2022).

Moreover, the study highlights the role of integrated, multi-faceted risk management approaches. The positive influence of land size and access to early warning systems and markets reflects the importance of both natural capital and institutional support in building pastoral resilience. The need to combine traditional knowledge with modern risk management systems echoes the call by Bollig & Lesorogol (2019) and David & Michael (2016) for hybrid governance approaches in pastoral development.

Therefore, this study provides clear evidence that herd mobility, pastoral systems, land access, and information availability significantly influence drought risk management. Strengthening land tenure, expanding early warning systems, facilitating timely market access, and integrating livestock insurance schemes are vital. Future interventions must integrate local knowledge with formal systems through participatory governance for sustainable pastoral development.

4.0 Conclusions and Recommendations

Conclusion

This study provides clear empirical evidence on the determinants of effective livestock-based drought risk management among pastoral communities in Handeni District, Tanzania. The findings underscore the central role of herd mobility as the primary adaptive strategy used by the majority (66.9%) of pastoral households. This practice enables pastoralists to spatially optimize access to pasture and water resources, minimize the spread of livestock diseases, and reduce pressure on localized ecosystems. Herd mobility facilitates the sustainable utilization of arid and semi-arid lands, contributing to the conservation of biodiversity and mitigating land degradation.

Furthermore, the study establishes that traditional pastoral systems, landholding size, and access to early warning systems and markets are significant predictors of effective drought risk management. These variables interact to shape household resilience by enhancing access to information, expanding grazing capacity, and improving the timing and profitability of livestock sales. Collectively, these findings reinforce the importance of socio-economic and institutional factors in moderating drought vulnerability and resilience.

However, the study also notes that current mobility-based strategies, while adaptive, face increasing constraints due to land tenure insecurity, farmer–pastoralist conflicts, and weak institutional support. These challenges threaten the long-term sustainability of pastoral livelihoods in the face of more frequent and severe droughts driven by climate change.

Recommendations

1. ***Enhance Drought Early Warning Systems (DEWS):*** The government and development partners should invest in strengthening localized and real-time drought early warning systems that integrate meteorological data with indigenous knowledge. Timely access to climate forecasts and alerts can improve household-level preparedness and reduce livestock losses.
2. ***Promote Mobility-Friendly Land Use Policies:*** National and local land policies should recognize and protect pastoral mobility corridors and communal grazing areas. Securing land tenure rights and mapping transhumance routes will reduce conflicts, safeguard ecosystem services, and uphold the resilience of pastoral systems.
3. ***Integrate Local and Scientific Knowledge Systems:*** A hybrid approach that combines local coping mechanisms with scientific risk analysis and planning should be institutionalized. Participatory governance frameworks must be promoted, ensuring that pastoralists are involved in decision-making from the **village to national levels**.
4. ***Strengthen Livestock Market Access and Infrastructure:*** Improved access to timely and well-functioning livestock markets, including market intelligence, feeder roads, and veterinary services, can enhance economic returns and reduce distress sales during droughts. Support for value chain development is key to integrating pastoralists into the broader economy.
5. ***Develop Livestock Insurance Mechanisms:*** Establishing livestock index insurance schemes tailored to pastoral production systems will help mitigate financial losses during droughts. These schemes must be affordable, accessible, and supported by robust verification systems.
6. ***Conduct Longitudinal Research on Herd Dynamics and Market Integration:*** Further research is needed to generate reliable longitudinal data on herd growth, mortality, and commercialization patterns over the past 20–30 years. Understanding these trends will provide more effective drought mitigation, planning, and policy formulation at both local and national levels.

Declaration of Conflict of Interest

We hereby declare that there are no known competing financial interests or personal relationships that could have influenced the research and findings presented in this paper.

References

Chambers, R., & Conway, G. (1992). *Sustainable rural livelihoods: Practical concepts for the 21st century*. IDS Discussion Paper 296.

Scoones, I. (1998). Sustainable rural livelihoods: A framework for analysis. *IDS Working Paper* 72.

IPCC. (2022). *Sixth Assessment Report: Impacts, Adaptation, and Vulnerability*. Intergovernmental Panel on Climate Change.

FAO. (2023). *Drought and Agriculture: Building Resilient Pastoral Systems in Sub-Saharan Africa*. Rome: Food and Agriculture Organization.

Nindi, S., Mhando, D., & Mbwambo, N. (2020). Pastoralist adaptation to climate change in Tanzania. *Pastoralism*, 10(1), 1–12.

Shah, A. A., Ali, A., & Ullah, R. (2021). Risk management strategies and climate resilience in livestock systems. *Climate Risk Management*, 33, 100345.

Gebresenbet, F., Mekonnen, D., & Kassie, B. T. (2021). Early warning systems and resilience building among pastoralists. *Journal of Arid Environments*, 191, 104567.

Mekuyie, M., Jordaan, A., & Melka, Y. (2018). Understanding resilience and adaptive capacity of pastoralists in Ethiopia. *Climate and Development*, 10(3), 271–284.

Fratkin, E., & Roth, E. A. (2020). *As pastoralists settle: Social, health, and economic consequences of the pastoral sedentarization in Marsabit District, Kenya*. Springer.

Tessema, W. K., Briske, D. D., & Teague, W. R. (2022). Land tenure and rangeland governance in East African pastoral systems. *Ecology and Society*, 27(2), 18.

Omollo, L. A., Opiyo, F., & Wasonga, O. V. (2023). Indigenous knowledge and adaptive strategies for climate change resilience among pastoralists. *Climate and Development*, 15(4), 367–380.

Little, P. D., McPeak, J., Barrett, C., & Kristjanson, P. (2019). Challenging orthodoxies: Understanding pastoral poverty in East Africa. *Development and Change*, 50(2), 409–429.

Ayele, S., Catley, A., & Cullis, A. (2020). Livestock and resilience in dryland communities of East Africa: A review of evidence and knowledge gaps. *Pastoralism*, 10(1), 1–13. https://doi.org/10.1186/s13570-020-00171-2

Béné, C., Headey, D., Haddad, L., & von Grebmer, K. (2018). Is resilience a useful concept in the context of food security and nutrition programmes? *Global Food Security*, 26, 100370. https://doi.org/10.1016/j.gfs.2018.10.001

DFID (Department for International Development). (1998). *Sustainable Livelihoods Guidance Sheets*. London: DFID.

Domínguez, L. (2017). Pastoralism and development in Africa: Dynamic change at the margins. *Routledge.*

Eriksen, S., Nightingale, A. J., & Eakin, H. (2021). Reframing adaptation: The political nature of climate adaptation. *Global Environmental Change*, 71, 102373. https://doi.org/10.1016/j.gloenvcha.2021.102373

Kihara, J., Mwangi, M., & Gitau, J. (2023). Climate-smart livestock systems for resilient pastoral livelihoods in East Africa. *Journal of Arid Environments*, 204, 104787. https://doi.org/10.1016/j.jaridenv.2022.104787

Kipkemoi, S., Kibet, L., & Kairu, J. (2022). Role of indigenous knowledge in drought risk reduction among pastoralists in Kenya. *Disaster Prevention and Management*, 31(1), 114–130. https://doi.org/10.1108/DPM-06-2021-0203

Krätli, S. (2020). Valuing pastoralism: Retrospective assessment of a development paradigm. *Nomadic Peoples*, 24(1), 2–27.

Krätli, S., & Schareika, N. (2019). Living off uncertainty: The intelligent animal production of dryland pastoralists. *European Journal of Development Research*, 21(4), 606–625. https://doi.org/10.1057/ejdr.2009.28

Ngondya, I., Nsemwa, L. T., & Lyimo, J. (2022). Enhancing drought resilience through livestock insurance and community-based adaptation in semi-arid Tanzania. *Climate and Development*, 14(4), 303–314. https://doi.org/10.1080/17565529.2021.1937071

Scoones, I. (2015). *Sustainable Livelihoods and Rural Development.* Practical Action Publishing.

Ayele, G., Desta, S., & Catley, A. (2020). *Institutional constraints and opportunities for livestock drought resilience in East Africa*. Pastoralism, 10(1), 1-15.

Eriksen, S., Nightingale, A. J., & Eakin, H. (2021). Reframing adaptation: The political nature of climate change adaptation. *Global Environmental Change*, 35, 523–533.

Kipkemoi, S. K., Ngutu, M., & Ochieng, J. (2022). Indigenous forecasting and community early warning systems in East African pastoralist communities. *Climate Risk Management*, 36, 100445.

Krätli, S. (2020). *Valuing pastoralism in policy: Towards better investment decisions*. IIED.

Ngondya, R., Chingonikaya, E., & Sangeda, A. (2022). Market access and drought risk: Evidence from rural Tanzania. *African Journal of Rural Economy and Development*, 8(2), 67-81.

Domínguez, P. (2017). Livelihood transitions and institutional change among pastoralists in sub-Saharan Africa. *Human Ecology*, 45(3), 335–350.

Adger, W. N., et al. (2003). *Adaptation to climate change in the developing world*. Progress in Development Studies.

Bolling, M. & Lesorogol, C. (2019). *Land tenure and pastoral governance*. African Journal of Rural Studies.

David, K. & Michael, H. (2016). *Sustainable pastoral systems in East Africa*. Drylands Research.

Galaty, J. G. (2013). *Land grabs and pastoral resistance in East Africa*. Journal of Peasant Studies.

Homewood, K., & Rodgers, W. A. (1991). *Maasailand ecology: pastoralist development and wildlife conservation*. Cambridge University Press.

Kates, R. W. (2000). *Cautionary tales: Adaptation and the poor*. Environment Magazine.

Kaye-Zwiebel, E. (2010). *Co-management of pastoral rangelands in Kenya*. Nomadic Peoples.

Nassef, M., & Hesse, C. (2009). *Pastoralism and climate change*. IIED Briefing.

Ndikumana, J., et al. (2000). *Coping mechanisms and strategies for pastoralists in sub-Saharan Africa*. ILRI.

Nori, M., Taylor, M., & Sensi, A. (2008). *Browsing on fences: pastoral land rights, livelihoods and adaptation to climate change*. IIED.

Roth, E. A. (1996). *Traditional pastoral strategies and drought*. Human Ecology.

Senda, S. O., Mtengeti, E. J., Chenyambuga, S. W., & Kimbi, G. G. (2022). Community-based drought management systems. *Journal of African Livelihood Studies*, 7(2), 134–150.

Shem, M. N., Mwilawa, A. J., Lekule, F. P., & Mgheni, D. M. (2005). Livestock mobility and land use conflict: A study of pastoralist communities in Tanzania. *Ministry of Livestock and Fisheries Development*, United Republic of Tanzania.