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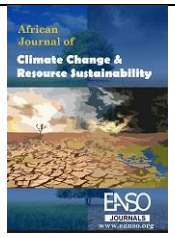

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Original Article

Determinants of Variations in Drought Vulnerability among Cattle Keeping Households in Migori County

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Drought Severity, Drought Vulnerability, Cattle Keeping Households, Migori County, Livelihood Diversification, Water Scarcity, Household Resilience.

ABSTRACT

Cattle keeping plays a crucial role in ensuring food security and fulfilling socio-cultural functions in both developed and developing regions. However, most cattle in these regions are often raised under extensive production systems, making them highly vulnerable to harsh environmental conditions. Among the most pressing challenges facing cattle production in sub-tropical regions is drought, which leads to severe water scarcity and depletion of grazing resources, resulting in reduced cattle productivity, increased susceptibility to diseases and, in extreme cases, high mortality rates. This study examined variations in drought vulnerability among cattle-keeping households in Migori County. In semi-arid areas of Migori County, cattle keeping plays vital economic and socio-cultural roles but is increasingly affected by drought-related challenges such as water scarcity, pasture depletion, and livestock diseases. The study was conducted in Nyatike and Kuria West Sub-Counties of Migori County, selected for their diverse agro-ecological zones affecting livestock farming. Data were collected through structured household questionnaires, key informant interviews, and direct observation, with a stratified sample of 383 households proportionately drawn from four wards. The study found that decreased pasture ($\chi^2 = 249.335$, $p = 0.000$), reduced milk yield ($\chi^2 = 211.607$, $p = 0.000$), and water-related stressors such as declining water points ($\chi^2 = 188.864$, $p = 0.000$) and increased distance to water ($\chi^2 = 97.545$, $p = 0.000$) were the most significant factors influencing drought severity among cattle-keeping households. Emaciation of livestock and increased incidences of cattle diseases also showed significant associations, though perceptions varied. Low cattle prices were significant but unevenly experienced. These findings underscore the importance of ecological factors over economic ones in shaping household drought vulnerability. Households with limited income sources and heavy dependence on cattle were more susceptible to drought effects, while those engaging in diverse livelihood activities showed greater resilience. Environmental stressors and inadequate access to resources further exacerbated vulnerability. The study underscores the importance of integrated interventions such as water infrastructure development, improved veterinary services, and livelihood diversification to enhance household resilience.

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INTRODUCTION

Drought is increasingly recognised as a major threat to livestock-based livelihoods, particularly in arid and semi-arid regions (ASALs) where cattle rearing forms the backbone of household economies. Globally, the frequency, intensity, and duration of drought events have escalated in recent decades, intensifying pressure on grazing lands and water sources while exposing cattle to disease outbreaks, reduced body condition, starvation, and declining market value (Nyamusamba *et al.,* 2017; Speranza, 2010). These cascading effects often erode household resilience and deepen vulnerabilities, especially in households heavily reliant on rain-fed agriculture (Turner, 2000).

In sub-Saharan Africa (SSA), where over 70% of the population depends on livestock and cattle contribute approximately 90% of the region's food supply, the vulnerability to drought is stark (Rosegrant *et al.,* 2002; Roseboom *et al.,* 2016; Esikuri, 2005). Factors such as overdependence on natural pasture, limited access to water, and inadequate veterinary infrastructure exacerbate this vulnerability. Moreover, endemic cattle diseases are often aggravated during or after droughts, hence causing household-level losses. For instance, outbreaks of Foot and Mouth Disease (FMD), contagious bovine pleuropneumonia, and trypanosomosis reduce productivity and animal value, impacting household income and food security (Knight-Jones & Rushton, 2013; FAO, 2015; Jemberu *et al.,* 2014).

Kenya serves as a focal point for studying these dynamics due to its large cattle-rearing population, especially in ASALs, where over 80% of the land is drought-prone (Mbogo *et al.,* 2014). Despite livestock contributing 12% to national GDP and 40% to the agricultural GDP, recurring droughts have recorded 28 major ones over the last century, with increasing frequency having significantly disrupted cattle farming systems (Behnke & David, 2011; GoK, 2013; MoALF, 2017). These drought events lead to diminished forage availability, water shortages, and increased cattle mortality, thereby affecting households differently depending on their capacity to cope and adapt.

Household vulnerability to drought impacts is not uniform. It varies with socio-economic, environmental, institutional, and management factors, including access to resources, herd size, livestock health, market access, early warning systems, and government support structures (Mupawenda, 2009; Schreiner *et al.,* 2018). In Kenya's Migori County, particularly in Nyatike and Kuria sub-counties, cattle farming is a core livelihood activity. However, the semi-arid nature of these regions, combined with frequent drought events, has increasingly threatened household

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wellbeing (GoK, 2019). Livestock assets in these communities not only serve economic functions but also fulfil vital social and cultural roles, further complicating household vulnerability assessments.

Understanding the factors that contribute to varying degrees of household vulnerability to drought among cattle keepers is vital for effective policy and program development. Targeted interventions must be informed by localised data to strengthen household resilience and ensure sustainable livestock production in the face of climate variability.

MATERIALS AND METHODS

Study Area

The study was carried out in Nyatike and Kuria West sub-Counties, Migori County, which covers an area of 188 square kilometres with a population density of 427 persons per square kilometre and a land area of 2,613.5 square kilometres. The county is located between latitudes 1° 6′ 51′′ S, towards north 0º 45′ 34′′ S, and longitude towards west 34º 2′ 24′′E and to the eastern part 34º 21′42′′E and covers an area of 2,596.5 $km^{2,}$ including approximately 478 km^2 of water surface. The study faced several limitations whereby many respondents could not accurately recall or quantify past droughts, which made the researcher to focus on the more recent and memorable episodes of 2019, 2020, and 2021. Some participants were also reluctant to complete questionnaires. This was addressed by clearly explaining the study's purpose and assuring them of confidentiality and voluntary participation. Due to the large size of Migori County, only four wards within Nyatike and Kuria West sub-counties were sampled, chosen for their representation of different agro-ecological zones; Upper Midlands and Lower Midlands.

Ethically, the study ensured informed consent was obtained, verbally or in writing, after explaining the objectives and procedures. Respondents were assured that their data would remain confidential and would be used only for academic purposes. Cultural sensitivity was maintained throughout the process. The study area, covering parts of Migori County, was chosen for its ecological diversity, helping to assess the impact of drought across different livelihood zones.

Data Collection

Primary data was collected using a structured household questionnaire and a key Informant Interview schedule. Findings from key informants indicated that respondents had been significantly affected by drought. In Migori County, based on insights related to support systems, preparedness, and adaptation strategies among cattle farmers, administrators, livestock officers, and a representative from the Water Resource Users Association (WRUA) reported as follows:

Masaba Sub-Chief

> *To safeguard water resources, I actively discourage ploughing along riparian zones and promote the responsible use of dams, boreholes, and other water sources. Some cattle farmers have drilled boreholes, planted trees, and regularly apply acaricides to control ticks. They also adopt practices such as pasture planning and preservation, maintaining manageable herd sizes, purchasing livestock insurance, and attending short agricultural seminars. In addition, donations of farm inputs have played a key role in helping farmers adapt to the effects of drought.*

Kanyarwanda Sub-chief

> *As an administrator, I sensitise farmers during public forums (barazas) and encourage regular consultations with livestock officers. I emphasise the importance of self-preparedness, particularly in maintaining cattle health. Some farmers store maize stalks after harvest for use as fodder during drought and frequently take cattle to dips. Support from the Ministry of Livestock through seminars, regular public awareness efforts, and increasing the number of livestock officers is vital. During droughts, the government occasionally buys livestock to prevent losses, and at times slaughters older*

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cattle to provide food for the community. Organisations like Child Fund and Nuru Kenya also assist by buying milk for yoghurt production, offering farmers an alternative income source.

Muhuru Sub-Chief

Farmers are encouraged to plant drought-resilient fodder like Napier grass. In response to the harsh conditions, many have begun keeping hardier animals such as goats. However, government support is essential and timely advice, resources, and engagement from both county and national levels should not be left solely to the farmers.

Kanyarwanda Sub-Chief

I advise farmers to plant Napier grass and regularly spray their cattle against ticks, especially during dry periods. The County Government has supported farmers in areas like Mikey by drilling boreholes for irrigation to support Napier grass growing. Due to challenges like tick infestation and drought, many residents have shifted from cattle rearing to alternative livelihoods such as gold mining. Maintaining functional cattle dips and supporting training through NGOs and CBOs are crucial for improving cattle farming practices.

Livestock Officer

Our team deploys livestock officers during field days to train farmers on fodder irrigation and conservation, livestock insurance, and disease control through regular vaccinations. We raise awareness about drought impacts and encourage proper grazing practices, feed conservation, and the use of hardy breeds. Farmers are also encouraged to avoid overgrazing and embrace sustainable methods like pasture irrigation. Through programs such as 'One Dairy Cow per Sugarcane or Tobacco Farmer', the Migori County Government promotes dairy farming over less sustainable crops like tobacco. This initiative provides in-calf heifers and Sahiwal bulls to improve milk production and household income.

WRUA Officer:

Community-Based Organisations (CBOs) and NGOs play a crucial role by raising awareness and constructing water infrastructure like dams and water pans, which support cattle farmers during drought periods.

The household questionnaire was administered to selected household heads, who are often responsible for key decisions regarding livestock (cattle). Direct observation was also employed in data collection, where photographs were taken to supplement questionnaire data with visible evidence of drought effects on cattle and the environment.

A comprehensive list of livestock-keeping households was developed using the 2019 census enumeration data, and households were used as the primary unit of analysis. Enumeration areas within each agro-ecological zone (AEZ) were selected purposively to ensure representativeness of the environmental conditions affecting cattle farming. The sample size for the study was determined using the Krejcie & Morgan (1970) formula. Using the formula, the required sample size was calculated, which provided a statistically valid sample size for finite populations based on desired confidence levels and margins of error:

$$S = \frac{[X^2 NP(1-P]}{[d^2(N-1)+X^2 P(1-P)]} \quad (1)$$

Where:

S = required sample size

N = the population size (39,358); according to the Kenya National Bureau of Statistics (2019)

X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841)

P = the population proportion (0.5)

d = the degree of accuracy expressed as a proportion (0.05)

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Using the formula, the required sample size was calculated to be 383 households. This sample was proportionately distributed across the four sub-locations based on household population data to ensure equitable representation. Table 1 shows the sample distribution per ward and respective AEZs. This sampling approach enabled the study to capture geographical, ecological, and socio-economic variations affecting drought vulnerability among cattle-keeping households. This stratified approach also helped reduce sampling bias and ensured the reliability of generalisations made from the collected data.

Table 1: Distribution of Sampled Households per Ward

Sub-county	Wards	AEZ	Number of Households	Sample size per sub-location	Sample size
Nyatike	Kanyarwanda	LM 4	1,818	1,818/15,685 ×383	44
	Muhuru	LM 5	6,184	6,184/15,685 ×383	151
Kuria West	Komosoko	LM 2 /LM 3	1,098	1,098/15,685 ×383	27
	Masaba	UM 2-4/LM 2	6,585	6,585/15,685 ×383	161
Total			**15,685**		**383**

Source: *Kenya National Bureau of Statistics (2019)*

Data Analysis

The study employed both quantitative and qualitative approaches to analyse factors influencing drought vulnerability among cattle-keeping households in Migori County. For the quantitative data, survey responses were collected on various drought-related factors such as decreased pasture availability, reduced milk yield, incidences of cattle pests and diseases, water scarcity, livestock emaciation, and changes in cattle prices. Descriptive statistics were first used to summarise the severity of these factors as reported by respondents, categorising them into levels such as "Very Severe," "Moderately Severe," and "Not Severe."

To determine whether these factors differed significantly across the study sites, the study applied the chi-square test of independence. This statistical test evaluated the association between the severity of each drought-related factor (independent variables) and the study location (dependent variable). The chi-square results showed that most factors had highly significant associations with the study site, indicated by p-values less than 0.05. For instance, decreased pasture, reduced milk yield, and increased incidences of pests and diseases all yielded p-values of 0.000, demonstrating strong evidence that these vulnerabilities varied significantly across the surveyed households in different locations. On the other hand, the factor "Decline in Prices of Cattle Products" did not show a significant association ($p = 0.169$), suggesting that this factor's impact was relatively uniform across the study area.

In addition to the quantitative analysis, qualitative data collection likely involved interviews or focus group discussions to capture the nuanced experiences and perceptions of drought impacts from the cattle farmers. The qualitative data were analysed through thematic coding, identifying common themes such as coping strategies, livelihood changes, and the contextual realities of drought vulnerability. These qualitative insights help explain the statistical findings by providing depth and context, for instance, clarifying why certain factors like pasture decline are more severe in some of the study areas, or how households adapt differently based on local conditions. Integrating qualitative and quantitative data thus provided a comprehensive understanding of drought vulnerability, combining numerical evidence with rich, descriptive accounts from the community.

RESULTS AND DISCUSSION

This section presents findings on the factors responsible for variations in drought vulnerability among cattle-keeping households. The study employed the chi-square to assess the factors that

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significantly contribute to drought vulnerability. Table 2 presents the results of Chi-square tests assessing the relationship between various drought-related stressors and the severity of their effects on cattle-keeping households. The analysis reveals that seven out of eight variables showed statistically significant associations ($p < 0.05$) with perceived drought vulnerability, while one variable did not.

The quantitative analysis revealed that decreased pasture was the most critical drought-related stressor ($\chi^2 = 249.335$, $p < .001$), with 263 of 382 households rating it as "very severe." One interviewee captured this vividly: *"The grass dries so fast during the drought that our cattle wander days in search of fodder."* This mirrors findings from pastoral regions in Africa and Asia, where pasture scarcity consistently emerges as a primary factor driving livestock vulnerability (Tofu *et al.,* 2023; Naumann *et al.,* 2020). For instance, in the Borana zone of Ethiopia, over 99% of households reported similar pasture depletion during droughts (Tofu *et al.,* 2023).

Similarly, reduced milk yield ($\chi^2 = 211.607$, $p < .001$) was reported as very severe by about 63% of respondents. One farmer stated, *"When feed is low, we only get two litres a day – far less than we need."* This aligns with research from Odisha, India, where feed shortages were directly linked to significant declines in milk production (Panda, 2017). Panda's study emphasises the direct, detrimental relationship between drought-induced feed limitation and dairy productivity.

Disease outbreaks and pest incidence also showed significant variation across sites ($\chi^2 = 221.032$, $p < .001$), though the severity differed greatly among households—13% rated it "very severe," 43% "moderate," and 44% "not severe." As one respondent noted, *"Some villages got treatments fast, others waited since the vet had no car."* This discrepancy is consistent with Odishan's findings, where drought conditions were linked to increased livestock disease patterns (Panda, 2017). It suggests that access to veterinary services and local resilience can buffer disease impacts.

Water-related factors—declining water points ($\chi^2 = 188.864$, $p < .001$) and increased distance to water sources ($\chi^2 = 97.545$, $p < .001$)—were also highly significant, underscoring the centrality of water access. One pastoralist lamented, *"Now the borehole is empty; we walk ten kilometres for water."* This resonates with research from Borana, where water scarcity led to prolonged journeys and adversely affected both cattle health and household labour (Naumann *et al.,* 2020).

The impact of livestock emaciation ($\chi^2 = 100.058$, $p < .001$) was underscored by distressing accounts such as "You see ribs showing … some just collapse near the kraal," reflecting the severe health consequences of feed and water shortages. Studies in similar pastoral contexts report widespread weight loss and increased mortality under drought stress (Tofu et al., 2023).

Although low cattle prices showed a significant association ($\chi^2 = 33.321$, $p < .001$), respondents' experiences varied. One farmer explained, *"We were forced to sell at a loss; buyers knew we had no choice."* This situation resembles Kenya's 2008–2009 drought, during which distress livestock sales deepened economic hardship for pastoralists (Kenya Drought, 2009).

In contrast, a decline in prices of cattle products (butter, ghee) was not statistically significant ($\chi^2 = 3.558$, $p = .169$), and respondents largely did not perceive a change: *"Milk we use at home; we can't tell if butter prices changed."* This aligns with observations that processed product prices are influenced more by regional or national market trends than local drought conditions.

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Table 2: Factors Influencing Drought Vulnerability among Cattle-Keeping Households

Variable	Very Severe	Moderately Severe	Not Severe	Chi-Square	P-Value
Decreased Pasture	263	105	14	249.335	0.000
Decreased Milk Yield	241	132	9	211.607	0.000
Increased Incidences of Cattle Pests and Diseases	49	163	163	221.032	0.000
Declining Water Point	109	245	28	188.864	0.000
Emaciation of Livestock	180	164	35	100.058	0.000
Increased Distance to Water	157	187	38	97.545	0.000
Low Cattle Prices	179	93	108	33.321	0.000
Decline in Prices of Cattle Products	142	112	126	3.558	0.169

Source: *Survey Data 2023*

To understand the ground realities, the researcher conducted field visits to selected areas within Migori County. Primary data were collected through direct observation, and photographs were taken to supplement questionnaire data with visible evidence of drought impact on cattle and the environment.

The plates below provide visual insights into the variations in vulnerability to drought among cattle-keeping households. These images captured different coping mechanisms and environmental conditions that shape how households respond to drought stress in diverse settings.

Plate 1, showing stall grazing, illustrates an adaptive strategy employed by better-resourced households. By relying on controlled feeding systems, these households are able to shield their livestock from the direct impacts of pasture degradation, thereby enhancing resilience during periods of drought (Ndikumana *et al.,* 2000; Herrero *et al.,* 2010). This approach highlights the role of financial and infrastructural capacity in mitigating climate risks.

Plate 2 shows cactus plants, which are increasingly used as drought-tolerant fodder. This reflects both traditional knowledge and local innovation in coping with climate variability. The cultivation and use of drought-resilient fodder such as cactus is a strategy being adopted in many dryland areas to improve livestock survival during dry seasons (Mutabazi & Wambugu, 2017; Gebremedhin *et al.,* 2021). These low-cost, indigenous solutions represent important elements of climate adaptation at the household level.

In contrast, Plate 3 shows cattle grazing freely on open rangelands. This method is more commonly practised in arid and semi-arid lands (ASALs), where households are heavily dependent on natural pastures. As a result, these communities are more vulnerable to drought, since their livestock is directly affected by fluctuations in forage availability and quality (FAO, 2018; Thornton *et al.,* 2009).

Finally, Plate 4 depicts dry, degraded land, a stark reminder of the environmental challenges faced by cattle keepers in drought-prone regions. Land degradation not only reduces pasture productivity but also exacerbates household vulnerability, especially among those with limited resources or limited alternative livelihood options (Reed et al., 2015; UNEP, 2020). In totality, these images highlight both the environmental pressures and the divergent coping mechanisms that contribute to varying levels of household vulnerability to drought. They underscore the importance of socio-economic status, local knowledge, and environmental conditions in shaping resilience among cattle-keeping households.

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Plate 1: Stall Grazing

Plate 1: Cattle grazing/the farmers practice tethered or stall grazing where cattle are confined to specific area by a rope allowing them to graze only within a limited range.

Source: FIELD WORK, 2023

Plate 2: Cactus Plants

Plate 2: some of the areas were inhabited with cactus an indication that the area is dry.

Source: FIELD WORK, 2023

Plate 3: Cattle Grazing Freely

Plate 3: Cattle grazing; sometimes cattle are left free with a herding boy to help farmers better manage grazing.

Source: FIELD WORK, 2023

Plate 4: Dry Rough Land

Plate 4: This photo shows that the area is dry with a rough terrain.

Source: FIELD WORK, 2023

CONCLUSION AND RECOMMENDATION

The study revealed that vulnerability to drought impacts among cattle-keeping households is not uniform but varies significantly due to multiple interrelated socio-economic and environmental factors. The findings of this study reveal that drought effects on cattle-keeping households are predominantly shaped by ecological and

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production-related factors. Variables such as decreased pasture, reduced milk yield, livestock emaciation, and limited water access were found to be highly significant in influencing the severity of drought impacts, as indicated by their high Chi-square values and extremely low p-values.

These factors directly affect livestock health and productivity, underscoring their central role in shaping pastoral vulnerability during drought periods, while increased incidences of livestock diseases and low cattle prices also showed statistically significant associations. Their effects were less uniformly perceived across households, pointing to context-specific variations in how these challenges are experienced. Conversely, the decline in prices of cattle products was not significantly associated with drought severity, suggesting that such market dynamics may be influenced by broader economic conditions rather than drought alone.

To build drought resilience among cattle-keeping households, a coordinated and community-centred approach is essential. Key strategies include improving water access through sustainable infrastructure, promoting better land and pasture management, and enhancing veterinary services to prevent livestock diseases. Supporting the adoption of drought-resilient cattle breeds and diversifying household livelihoods also helps reduce economic vulnerability. Strong policy frameworks and early warning systems are needed at both local and national levels to ensure long-term preparedness. These measures, when implemented collaboratively by governments, NGOs, research institutions, and communities, can significantly strengthen the adaptive capacity of pastoralist households.

Based on the study's findings, it is recommended that the government, in collaboration with local institutions and development partners, prioritise the development and implementation of localised drought resilience policies that focus on ecological and production-related vulnerabilities**.** Specifically, policy should support the expansion of sustainable water infrastructure**,** the rehabilitation and management of grazing lands**,** and the strengthening of veterinary services to address the most statistically significant factors affecting livestock health and productivity, such as pasture degradation, reduced water access, and increased disease incidence.

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