Household-Reported Climate Variability and Food Security among Pastoral and Agro-Pastoral Households in Mandera County, Kenya

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ABSTRACT

Climate variability threatens pastoral livelihoods and food access in Kenya's arid and semi-arid lands. This article examines household-reported climate events, food-security conditions and perceived climate–food-security pathways in Mandera County. Although the wider research adopted an explanatory sequential mixed-methods design, the present analysis uses only documented cross-sectional household-survey summaries. Of 264 targeted households across six wards, 224 completed the questionnaire (84.8%). Five-point agreement items were summarised using percentages and means. Longer and more severe dry spells had the highest mean (4.35), followed by more frequent heatwaves (4.32), unpredictable rainfall (4.29) and recurrent drought (4.24). On food access, 66.1% disagreed that their households could buy or produce sufficient food during drought, 62.5% disagreed that local food prices were affordable and 58.9% disagreed that they could afford a balanced diet. Overall, 89.3% agreed that climate variability had increased food insecurity in their households. These descriptive responses suggest a perceived connection between pasture and water stress, livestock production, household income and food purchasing power; they do not establish causality. Integrated preparedness should combine water and forage management, livestock protection, functional markets, climate information and targeted support for food access.

Keywords: climate variability; drought; food security; pastoral livelihoods; agro-pastoralism; Mandera County; Kenya

1. INTRODUCTION

Food security in dryland areas depends not only on the physical availability of food but also on households' ability to sustain livestock production, income and market access during climatic shocks. Food security is commonly understood through the connected dimensions of availability, access, utilization and stability (Food and Agriculture Organization of the United Nations [FAO], 2008). This relationship is especially important in northern Kenya, where pastoral and agro-pastoral households depend heavily on rainfall for pasture, water and livestock production. Prolonged drought or unreliable rainfall can reduce milk output, weaken animal condition, increase water and fodder costs and reduce the income available for food purchases. Climate stress can affect food availability, access, dietary quality and stability at the same time.

Mandera County lies in Kenya's arid north-eastern region and is highly exposed to recurrent drought, high temperatures and rainfall uncertainty. Pastoralism remains central to household livelihoods: in the wider thesis, 67.9% of respondents depended on pastoralism or agro-pastoralism as their main livelihood. This dependence makes pasture, water, livestock condition and livestock markets central to household welfare and food access.

Evidence from northern Kenya shows that drought-related food insecurity is shaped by both ecological and economic conditions. Rono et al. (2023) found that food security was associated with household resources, food expenditure, education, livestock ownership and access to improved water. Kirui et al. (2022) showed that repeated drought can move pastoral households towards livelihood pathways characterised by smaller

herds and lower incomes, while Mauerman et al. (2023) found that multi-season droughts can cause substantial livestock losses and prolonged herd recovery. Alulu et al. (2024) further showed that improved forage conditions can strengthen food security through livestock productivity, food prices and household coping capacity. Recent work also shows that pastoral adaptation in Kenya depends on access to mobility, livelihood opportunities and livestock-management options rather than on climatic conditions alone (Bostedt et al., 2023; Ojango et al., 2023).

Official assessments underline the continuing vulnerability of Mandera's food system. National Drought Management Authority assessments have documented food and nutrition pressures alongside changes in pasture, water, livestock condition, milk production and market conditions (National Drought Management Authority, 2024a, 2024b, 2025). More recently, FAO reported renewed drought pressure in Mandera following failure of the 2025 short rains (Food and Agriculture Organization of the United Nations, 2026). These assessments show why food security in pastoral areas must be understood as a seasonal livelihood and market problem as well as an environmental one.

Despite this wider evidence, locally grounded household data remain important because Mandera combines recurrent water stress, pastoral mobility, border-market conditions and strong dependence on livestock. Existing studies establish that drought can erode herd assets and income and that forage, household resources and market access are associated with food-security outcomes. Less clearly documented at household level in Mandera is how reported climatic stress sits alongside everyday conditions of food sufficiency, affordability, dietary adequacy and stability, and how households themselves describe the pathways connecting these conditions.

This paper addresses that gap by examining household-reported climate variability, food-security conditions and perceived climate-food-security pathways among pastoral and agro-pastoral households in Mandera County. Its contribution is to connect three elements that are often reported separately: climatic exposure as experienced by households; food access and affordability; and the livelihood mechanisms through which pasture and water stress can affect livestock, income and purchasing power. The survey evidence is treated as household perception and experience rather than independent proof of long-term meteorological trends or causal effects.

In pastoral systems, livestock provide food directly through milk and meat, generate cash through sales and store household wealth. Climatic stress can place pressure on households in two ways. Poor rainfall can reduce pasture and water, weaken livestock condition and lower milk output, while deteriorating animal condition can reduce sale value just as households need more cash for food, water or fodder. Food may remain physically available in markets while becoming economically inaccessible to households whose livestock income and purchasing power have declined.

Three questions guide the analysis: Which climate-related changes were most strongly reported by surveyed households? What do household responses show about food sufficiency, affordability, dietary adequacy and stability? Through which pathways do respondents perceive climate variability to affect household food security?

2. CONCEPTUAL PERSPECTIVE

The Sustainable Livelihoods Framework provides the main interpretive lens for this paper, supported by vulnerability and resilience thinking and a limited Human Ecology perspective. The framework is appropriate because it explains how livelihood outcomes are shaped by access to assets, institutions and livelihood strategies within changing environmental and economic conditions (Scoones, 1998). Food security in pastoral areas similarly depends on how climatic exposure interacts with livelihood assets, institutions and household capacity to respond. Natural capital includes pasture and water; financial capital includes livestock value, cash and savings; physical capital includes water and market infrastructure; human capital includes labour and knowledge; and social capital includes kinship and community support.

The expected pathway begins with climatic exposure, particularly recurrent drought, prolonged dry spells, heat and unreliable rainfall. These conditions can reduce pasture and water availability, affecting livestock condition, milk production, herd value and mobility. Ecological stress can develop into an economic shock: households may receive less food directly from livestock and less income from animal sales while food, water or fodder costs rise. Food security is therefore examined through the connected dimensions of availability, access, dietary adequacy and stability rather than food supply alone.

Vulnerability and resilience thinking adds an important distinction between exposure, sensitivity and adaptive capacity. Households facing similar climatic hazards may experience different food-security outcomes because their herd assets, savings, water access, market connections, livelihood options, social networks and public support differ. Human Ecology complements this interpretation by recognising that rainfall, pasture and water are embedded in mobility, settlement, labour and market relations rather than operating as isolated biophysical factors.

Research from northern Kenya supports this interpretation. Drought has been associated with smaller herds and lower incomes (Kirui et al., 2022), successive droughts can prolong herd recovery (Mauerman et al., 2023), and improved forage conditions have been associated with better household food security through livestock productivity, food prices and coping capacity (Alulu et al., 2024). Studies of pastoral adaptation in Kenya also show that mobility, diversification, fodder management and livestock-management practices remain important parts of household response to environmental and livelihood change (Bostedt et al., 2023; Ojango et al., 2023; Rotich et al., 2023). In this paper these perspectives are interpretive rather than variables in a formal causal model. The survey measures reported climatic stress, food-security conditions and perceived effects; it does not directly measure every livelihood asset or resilience component.

In this paper, the relationship is understood as follows: reported climatic stress affects pasture and water; these pressures affect livestock production and asset value; changes in own-food production and purchasing power shape food access, dietary quality and stability; and household adaptive capacity can strengthen or weaken these relationships. The results are interpreted against this pathway while remaining within the limits of cross-sectional household data.

Figure 1. Conceptual pathway linking climate variability and household food security in pastoral livelihoods

Climatic exposure **Drought, heat, rainfall variability**	**Pasture and water stress** **Forage loss, water scarcity**	**Livestock and asset effects** **Milk, herd condition, market value**	**Economic access** **Income, food prices, purchasing power**	**Food-security outcomes** **Availability, access, diet, stability**

Household adaptive capacity - including assets, water access, markets, social networks and public support - can strengthen or weaken these pathways.

3. METHODOLOGY

3.1 Research design and study area

The wider study used an explanatory sequential mixed-methods design to examine climate variability and household food security in Mandera County. This article is restricted to the verified quantitative household survey results reported in Chapter Four of the thesis. The article presents a quantitative cross-sectional analysis of household-reported conditions and perceived pathways.

The study covered six wards: Takaba South, Fino, Wargadud, Banissa Town, Shafshafey and Rhamu Town. These sites represent pastoral and agro-pastoral settings across Mandera County. The operational sampling frame reported in the thesis contained 2,597 households, and the household was the unit of analysis, with information obtained from household heads or representatives.

3.2 Sampling and data collection

The thesis initially derived a sample of 260 households and adjusted the target to 264, allocating 44 targeted households to each of the six wards. The operational sampling frame comprised 2,597 households. According to the documented field procedure, villages were selected from available lists and households were approached systematically from an identified central point, with every third household selected. Household heads or representatives provided information on household livelihoods, climate experiences and food access. The available methodological record does not establish a random starting point or a complete household listing, limiting claims of probability-based representativeness. Of the 264 targeted households, 224 completed the questionnaire (84.8%). Achieved ward-specific counts were not available for this analysis; therefore, the equal target allocation should not be interpreted as equal completed samples across wards.

A structured household questionnaire captured livelihood conditions, perceived climate variability, household food-security conditions and perceived climate-related effects. Relevant statements used a five-point agreement scale: 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree and 5 = strongly agree. The thesis reports a pilot involving 15 households in Lagsure Town and review of the instrument for clarity and content validity. A reliability coefficient was not available for verification and is not reported. Details of fieldwork dates, questionnaire language, interviewer procedures and additional field quality checks were not documented in the material available for this article.

3.3 Data analysis and interpretation

Frequencies, percentages and arithmetic mean scores summarised Likert responses. Agreement combines codes 4 and 5; disagreement combines codes 1 and 2; and code 3 is neutral. The scale midpoint is 3, with higher means reflecting greater overall agreement with the stated item. These descriptive means are not effect sizes. The source tables identify 224 completed household questionnaires but do not supply item-level valid counts or missing-response frequencies. Percentages and means are therefore reproduced as reported, without assuming complete responses for every item. No imputation or item-level recalculation was undertaken.

3.4 Measurement and reporting safeguards

Three sets of items serve distinct analytical purposes: reported climate variability during the preceding decade; household food-security conditions; and perceived pathways through which climate variability affects food production, costs, diversity, consumption and seasonal access. No arbitrary cut-off is used to classify households as food secure or food insecure because the reported items are not presented as a validated HFIAS, HDDS or other composite scale. The interpretation instead follows the established understanding of food security as a multidimensional condition involving availability, access, utilization and stability (FAO, 2008).

Climate items are treated as respondent assessments rather than instrumental climate observations. Although the wider thesis refers to rainfall and temperature data for 1990-2023, the results analysed in this article are household perceptions. Independent confirmation of long-term climatic trends would require a separate analysis of station or gridded climate records.

Statements linking climate variability to food-security outcomes represent respondents' reported experiences and perceptions. They are interpreted cautiously because the survey is cross-sectional and does not adjust for household wealth, herd size, education, location or other potential confounders.

The wider thesis also describes interviews and focus-group discussions. These qualitative materials are outside the verified evidence base used for this article. Only traceable household survey results are reported in this manuscript.

3.5 Ethical considerations

The thesis reports voluntary participation, protection of confidentiality and anonymity, removal of personal identifiers and aggregate reporting of household responses. The available documentation does not provide the

ethics committee name, approval reference, research permit number or consent format; accordingly, this article does not assert specific approvals that cannot be verified. These administrative details should be checked against the original research records if requested by the journal.

4. RESULTS

4.1 Reported climate variability events

Household responses were dominated by prolonged dryness, heat and rainfall uncertainty. Longer and more severe dry spells recorded the highest mean score (4.35), followed by more frequent heatwaves (4.32), increasingly unpredictable rainfall (4.29) and more frequent droughts (4.24). Reduced rainfall amounts and delayed onset of the rainy season also recorded high mean scores of 4.15 and 4.10 respectively. Flooding after heavy rains was reported, but agreement was lower than for drought- and heat-related conditions.

Table 1. Household-reported climate variability events (n = 224)

Note. Agreement is the combined percentage selecting agree or strongly agree. Means use the five-point scale (1 = strongly disagree; 5 = strongly agree). The original item-level distributions and valid-response counts were not available for independent checking.

Reported climate event	Agree/strongly agree (%)	Mean
More frequent droughts in the past 10 years	86.6	4.24
Rainfall increasingly unpredictable	88.8	4.29
Delayed onset of rainy seasons	82.2	4.1
Reduced rainfall amounts	84.4	4.15
Increased flooding after heavy rains	61.6	3.61
More frequent heatwaves	88.4	4.32
Increased strong winds and dust storms	72.3	3.87
Longer and more severe dry spells	90.1	4.35
Climate shocks occur closer together	80.8	4.05
Major shifts in seasonal patterns	84.8	4.18

The pattern suggests that households experience climate stress mainly through longer dry periods and loss of seasonal predictability. About nine in ten respondents agreed that dry spells had become longer and more severe, while a similar share reported increasingly unpredictable rainfall. These conditions matter in a pastoral economy because decisions about herd movement, water use and grazing depend on the timing and duration of rainfall.

4.2 Household food-security conditions

Household food-security responses reveal several distinct, although related, pressures. Food sufficiency was constrained: 53.6% disagreed that they had enough food throughout the month, while 56.3% disagreed that food rarely ran out before the next income source. Economic access was more severely constrained, with 62.5% rejecting the affordability of local food prices and 66.1% reporting inability to buy or produce enough food during drought. Dietary adequacy was also a concern: 58.9% disagreed that they could afford a balanced diet, and 58.0% disagreed that no household member skipped meals. Seasonal stability and preparedness were weak, as 61.6% reported inadequate emergency food reserves. These are separate item-level responses, not a validated household food-insecurity prevalence estimate.

Note. Percentages combine disagree and strongly disagree for positively worded statements. A higher disagreement percentage indicates a less favourable reported condition. Means use the original five-point agreement scale. Neutral and agreement shares cannot be reconstructed from the summary data.

Table 2. Household food-security conditions (n = 224)

Food-security indicator	Disagree/strongly disagree (%)	Mean
Household has enough food throughout the month	53.6	2.71
Eats at least three meals per day	46.4	2.88
Rarely runs out of food before next income	56.3	2.61
Can afford a balanced diet	58.9	2.52
Reliable access to safe drinking water	34.8	3.28
Food prices are affordable	62.5	2.39
Able to buy/produce enough food during drought	66.1	2.36
No household member skips meals	58	2.59
Household has food reserves for emergencies	61.6	2.45
Rarely depends on food aid	50.9	2.78

Access to safe drinking water was relatively better rated (mean 3.28), yet 34.8% disagreed that access was reliable. The contrast with low mean scores for food affordability (2.39), drought-period sufficiency (2.36) and emergency reserves (2.45) indicates that access, adequacy and stability should not be collapsed into a single measure. Because the original five-category frequencies are unavailable, the combined disagreement percentages do not establish the corresponding shares who agreed or remained neutral.

4.3 Perceived relationship between climate variability and food security

Note. These items measure respondents' perceived associations, not estimated causal effects. Agreement combines codes 4 and 5. The source does not provide full five-category frequencies or item-specific missingness.

The results do not establish that reported climate events caused each household's food-security condition. They do, however, show a coherent perceived sequence: prolonged dryness and rainfall uncertainty occur alongside weak food affordability and limited household buffers, while drought, livestock losses, reduced pasture or crop yield and higher food costs are identified by respondents as pathways connecting climatic stress and food insecurity.

Table 3. Perceived climate-food security pathways (n = 224)

Perceived climate-food security pathway	Agree/strongly agree (%)	Mean
Rainfall changes reduced food production	79.5	3.98
Drought negatively affected food availability	86.6	4.23
Extreme heat affected food supplies	82.2	4.12
Unpredictable weather increased food costs	76.8	3.93
Climate variability reduced food diversity	72.3	3.81
Reduced pasture/crop yield affected consumption	82.1	4.07
Seasonal changes caused food-access fluctuations	78.1	3.97
Livestock losses increased food insecurity	83.9	4.18
Increased reliance on food aid/market purchases	72.8	3.85
Overall climate variability increased food insecurity	89.3	4.29

Taken together, the results distinguish three levels of evidence: perceived exposure to climatic stress (Table 1), reported food-security conditions (Table 2) and respondents' own assessments of climate–food-security linkages (Table 3). For example, 89.3% agreed with the statement that climate variability had increased

household food insecurity, but this figure measures endorsement of a perception, not an estimated causal effect. No household-level cross-tabulation or statistical mediation test was available to establish that the same respondents experienced each successive step of the proposed pathway.

5. DISCUSSION

The Sustainable Livelihoods Framework helps explain why the reported climatic pressures may translate into different household food-security experiences. Natural capital is represented by pasture and water; financial capital by livestock value, sale income and purchasing power; physical capital by water points, transport and market infrastructure; human capital by livestock-management knowledge, labour and interpretation of climate information; and social capital by reciprocal support and local resource-management institutions (Scoones, 1998). The survey directly documents perceived climate stress and food-security constraints but does not measure all five capital stocks. The framework therefore organises interpretation rather than supplying tested coefficients for each asset pathway.

The climate conditions reported by households are similar to those documented elsewhere in northern Kenya. Kirui et al. (2022) found that drought can contribute to livelihood transitions marked by smaller herds and lower cash income, while Mauerman et al. (2023) showed that successive droughts can cause substantial livestock losses and prolonged recovery. Bostedt et al. (2023) similarly show that pastoral adaptation choices in Kenya are shaped by the practical ability to move, diversify and manage fodder under changing livelihood conditions. In Mandera, the high reporting of longer dry spells, delayed rains and seasonal shifts suggests that households experience not only individual shocks but also reduced time for pasture, herds and household assets to recover between shocks.

Livestock provide the clearest link between environmental stress and household food access. Reduced pasture and water can lower milk production and animal condition before livestock deaths occur. Households may lose food consumed directly from livestock while also receiving less value from animal sales. Alulu et al. (2024) provide stronger panel evidence for this mechanism, showing that improved forage conditions were associated with better food security through livestock productivity, lower prices of basic foods and improved coping capacity. Ojango et al. (2023) further show that climate-resilient animal-management practices can strengthen livestock productivity and resilience in pastoral communities of northern Kenya.

Food affordability emerges as a major concern. Nearly two-thirds of respondents disagreed that local food prices were affordable, and 66.1% disagreed that they could buy or produce enough food during drought. Rono et al. (2023) similarly identified household resources, food expenditure, livestock ownership, education and improved water access as important correlates of food security in northern Kenya. The Mandera results add a local household perspective by showing how weak purchasing power can coincide with climate-sensitive livestock livelihoods.

Household buffers also appear limited. Most respondents reported inadequate emergency food reserves, while substantial shares reported meal skipping and food exhaustion before the next income source. These conditions increase sensitivity to a new drought or price shock. NDMA assessments provide useful contextual evidence because they track changes in pasture, water, livestock condition, milk access, markets and food consumption in Mandera, although differences in samples and periods mean that these assessments should not be treated as statistical validation of the survey (National Drought Management Authority, 2024a, 2024b, 2025).

Economic access is central to the observed relationship between climate conditions and food security. Climate variability in pastoral settings is not only a production problem. Environmental stress can weaken natural resources and livestock assets and then reach household food security through both reduced own-food production and reduced purchasing power. This is consistent with the food-security framework in which access depends on households having the physical and economic means to obtain adequate food, even where food is available in markets (FAO, 2008).

The policy response should address multiple, connected constraints rather than treat drought solely as a

production shock. First, water planning should maintain reliable household and livestock access while respecting mobility corridors and local grazing governance. Second, locally appropriate strategic forage reserves and anticipatory fodder support could help reduce feed gaps during prolonged dry spells. Third, timely veterinary outreach, animal-health surveillance and livestock protection may preserve milk production and herd value. Fourth, accessible livestock and food markets, transport links and market information can help protect terms of exchange and purchasing power. Fifth, usable, locally communicated seasonal forecasts and early-warning messages should inform grazing and household decisions. Finally, timely, targeted assistance, including shock-responsive cash or food support where appropriate, can protect consumption when household resources deteriorate. These are policy implications consistent with the descriptive findings, not interventions whose effectiveness was evaluated by this survey.

Water deserves particular attention because it links household consumption, livestock production and the costs of mobility. Although safe drinking water was one of the relatively better-rated food-security items, more than one-third of respondents still reported unreliable access. In dryland systems, longer journeys for livestock and household water can reduce animal condition, milk production, time and disposable income. Water interventions should be treated as part of food-security and livelihood policy rather than only as infrastructure provision.

The results also highlight the need to maintain food access across seasons and periods of climatic stress. More than half of respondents reported food exhaustion before the next income source, and most lacked adequate emergency reserves. A household may meet food needs at one point yet remain highly vulnerable to seasonal interruption when rainfall, herd condition, prices and mobility deteriorate together. This is particularly important where repeated shocks arrive before herds, savings and food reserves have recovered.

Future research should link household surveys to georeferenced rainfall, temperature, vegetation and water indicators; apply validated food-security measures such as HFIAS, Food Consumption Score or Household Dietary Diversity Score; and repeat observations across seasons. Multivariable or longitudinal models could then test whether herd assets, livelihood diversification, market proximity, water access, social protection and early-warning use modify the relationship between climatic shocks and food-security outcomes.

Several limitations qualify interpretation. The cross-sectional design does not support temporal or causal inference. Climate trends are respondent perceptions rather than independently analysed weather records, and the food-security items do not constitute a validated composite index. The published source tables lack full response-category distributions, item-level denominators and missing-response counts. Ward-level achieved samples, full selection documentation and some field procedures were also unavailable for verification. The descriptive analysis does not adjust for wealth, herd size, household composition, market distance or location. The wider thesis contains qualitative components, but unverified interview findings are not used here. Accordingly, findings should not be generalised statistically to all Mandera households.

6. CONCLUSION AND IMPLICATIONS

Households in Mandera County reported substantial exposure to recurrent drought, prolonged dry spells, high temperatures and increasingly unpredictable rainfall. At the same time, many reported difficulty affording food, maintaining balanced diets, keeping emergency reserves and securing enough food during drought. Respondents connected these conditions most clearly through reduced pasture and production, livestock losses, higher food costs and unstable access to food.

The findings support a coordinated drought-preparedness agenda that protects natural resources and livestock assets while safeguarding household economic access to food. Priority actions include reliable water access, locally governed forage preparedness, preventive animal-health services, functional livestock and food markets, accessible climate information, and targeted shock-responsive assistance. Implementation should account for mobility, local institutions and differences in household resources. Future evaluation should establish which combinations improve food access, diet and seasonal stability, using validated measures and repeated observations.

Because the evidence is based on a cross-sectional household survey, the findings represent reported experience and perceived pathways rather than independent meteorological trends or causal effects. Their value lies in identifying where ecological stress, livestock assets and economic access intersect, thereby providing a clear basis for more rigorous climate-linked and longitudinal research in Mandera.

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