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# Back to Basics: Understanding the Problem of Persistent Global Acute Malnutrition in Isiolo and Marsabit Counties, Kenya

**Helen Young, Sophie Ochola, Anastasia Marshak, Elizabeth Stites, Achiba Gargule, Elijah Odundo, Ayane Ezaki and Josue Awonon**

*Feinstein International Center, Tufts University, and Kenyatta University*

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# Acronyms

| | |
|---|---|
| AMREF | African Medical Research Foundation |
| ANOVA | Analysis of variance |
| ANC | Antenatal care |
| ASAL | Arid and semi-arid lands |
| BHA | Bureau of Humanitarian Assistance |
| BMI | Body mass index |
| cm | Centimeter |
| CI | Confidence interval |
| CRS | Catholic Relief Services |
| DHS | Demographic and Health Survey |
| ENA | Emergency nutrition assessment |
| EVI | Enhanced vegetation index |
| FAO | Food and Agriculture Organization of the United Nations |
| FG | Focus Groups |
| GAM | Global acute malnutrition |
| HAZ | Height-for-age z-score |
| HFIAS | Household Food Insecurity Access Scale |
| IPC | Integrated Phase Classification |
| KDHS | Kenya Demographic and Health Surveys |
| KII | Key Informant Interview |
| KU | Kenyatta University |
| LS | Longitudinal study |
| LST | Land surface temperature |
| MAM | Moderate acute malnutrition |
| MAHFP | Months of Adequate Household Food Provisioning |
| MDD | Minimum dietary diversity |
| MSI | Morris Score Index |
| MUAC | Mid-upper arm circumference |
| NDMA | National Drought Monitoring Authority, Kenya |
| NGO | Non-government organization |
| NDVI | Normalized vegetation index |
| OR | Odds ratio |
| PGAM | Persistent global acute malnutrition |
| RUSF | Ready-to-use supplementary food |
| RUTF | Ready-to-use therapeutic food |
| SDG | Sustainable Development Goals |
| SMART | Standardized Monitoring and Assessment of Relief and Transitions |
| TLU | Tropical livestock units |
| USAID | United States Agency for International Development |
| WASH | Water, sanitation and hygiene |
| WAZ | Weight-for-age z-score |
| WHO | World Health Organization |
| WHZ | Weight-for-height z-score |

# Executive Summary

The United States Agency for International Development (USAID) Nawiri longitudinal study (LS) in Isiolo and Marsabit Counties in northern Kenya investigates the factors behind the stubborn persistence of child global acute malnutrition (GAM) rates that surpass the 15% emergency threshold.[1] Across the two years of study, on average, wasting prevalence varied from a minimum of 15% (September 2023) to a maximum of 21% (November 2022), with an overall average of 18.6% (95% CI: 18.0–19.1%). These findings correspond to earlier trends identified in an analysis of malnutrition hotspots, indicating long-term, structurally embedded drivers of child wasting (acute malnutrition with no edema). Despite this alarming outlook, our review of seasonal variability in child wasting shows that achieving a prevalence below the emergency threshold and even below 10% is possible, as evidenced by the significant seasonal reductions in two of the four study sites.

The study investigated the drivers of child acute malnutrition—immediate, underlying, and basic—and their temporal distribution (seasonality and change over time) across four sentinel sites in Isiolo and Marsabit Counties. The sites correspond to the predominant livelihood system in each of the locations: Laisamis (pastoralism) and Loiyangalani (fisher pastoralism) in Marsabit County, and Garbatulla (agro-pastoralism) and Ngaremara (mostly mixed peri-urban with pastoralism) in Isiolo. Bimonthly surveys were conducted from September 2021 to September 2023, with extended annual surveys conducted in rounds six and twelve. Qualitative research teams made five rounds of visits to the sites to provide deeper insights into key themes and investigate quantitative findings.

This report follows the different levels of the malnutrition causal framework—from basic, to immediate, to underlying drivers of child acute malnutrition (see Figure 1). The findings begin with a review of the basic drivers to contextualize the sentinel sites, a critical step for interpretation of both the nutritional outcomes and immediate and underlying drivers covered in the following sections. Understanding how the basic drivers differ helps explain the variations in what factors are driving or mitigating child acute malnutrition in each site and across time.

## The basic drivers: contextualizing child acute malnutrition

This study provides unprecedented insights into the basic drivers of child acute malnutrition in the Kenyan ASALs and contextualizes and explains the consistently high rates of child malnutrition. The complex results reveal seasonal and spatial differences linked to livelihoods, climate, the environment and—most importantly—how these factors interact with institutions that are foundational to resilient livelihoods.

### Pastoralism is vital but under pressure

Livestock and pastoralism remain the bedrock of most livelihoods even as the system of pastoral production continues to evolve. Pastoralist systems are adapted to manage extreme climate variability. While one or even two poor rainy seasons may not overstretch the system, the increasing frequency of droughts and consecutive failed rains, combined with multiple external pressures, has placed increasing strains on these systems. Growing pressures and constraints—combined with innovations and opportunities—have led to the evolution and transformation of these systems. Privatization of land tenure undermines sustainable resource management, restricts livestock movements, and increases resource competition, while the weakening of customary authority hampers sustainable land use norms. Encroachment of urban settlements and conservation areas further limits access to pastures. Economic development has led to sedentarization but has provided minimal benefits due to limited market access and high transport costs, forcing many into marginal economic

1 All analysis was conducted on wasting (weight-for-height z-score < -2). With only 7 cases of oedema in 2 years, acute malnutrition and wasting are nearly equivalent in this context. Therefore, 'acute malnutrition' will be used when discussing broader study implications, and 'wasting' when discussing analysis of the sample.

activities. The commercialization of livestock has weakened traditional kinship systems and livestock redistribution, increasing vulnerability and undermining social support institutions, which impacts child nutrition and well-being.

## Critical linkages between pastoralism and human nutrition

Numerous institutions support the pastoralist system and the dynamic relationships between people, livestock, and the environment; these dynamic relationships underpin positive human nutrition. Strategic mobility is critical to pastoral livelihoods, influencing human nutrition by allowing herders to take advantage of the nutrient distribution in the rangelands, thereby maintaining animal productivity, which translates directly into food security, nutrition, and health benefits for humans, particularly children.

The interaction between permanent settlements and mobile *fora* also plays a crucial role in managing nutrition, with women and children moving to the *fora* to access milk and other resources. The study found significantly higher odds that a child was acutely malnourished in the sedentary settlements compared to children in the *fora* (in Laisamis), illustrating the nutritional benefits of spending time in the *fora* even during severe droughts.

Social institutions, particularly reciprocity-based networks for sharing and support, are critical for managing human health and nutrition. Childcare by secondary caregivers enables women to engage in labor to cover household needs, while the sharing of milk supports vulnerable households. Extended droughts reduce the productivity of the herd while also increasing the distance between homesteads and the *fora*, thereby further reducing access to available milk for those in settlements.

Pastoralist institutions have shown remarkable adaptability in addressing challenges through customary environmental governance and herder drought management strategies, which have extended livestock mobility and maintained intergroup relations. Despite the strain on community social support systems, sharing and reciprocity remain prevalent, providing essential food, assistance, and childcare across all sites. These institutions are not only foundational to resilient livelihoods but also serve as the frontline of disaster response.

## Livelihood diversification—the pros and cons for child wasting

The shift towards sedentarization and diversification in pastoral systems has created a mix of adaptive, coping, and maladaptive strategies affecting nutrition and resilience. The study highlights site-specific diversification, such as fishing in Loyangalani, farming in Garbatulla, and casual labor in Ngaremara. Some activities—such as fishing—may be both a survival strategy and longer-term adaptation. Diversification differs by gender, with many women taking on labor-intensive, low-return economic activities that increase their workload and time away from young children, negatively impacting caregiving and child nutrition.

The study distinguishes between diversification for survival, such as some casual labor and collection and sale of firewood during drought, and strategic adaptations, such as trade and small business, which spread risk and enhance resilience. Hence, in Loyangalani we see that fishing is protective for acute malnutrition while casual labor is protective in Ngaremara but has the opposite effect in Laisamis. Thus, diversification has varying impacts on child nutrition and so requires careful evaluation to ensure positive contributions.

## Pathways to recovery and resilience

Some stakeholders may perceive the crisis to be over with the return of the rains in 2023. For pastoralists, however, rain can bring additional problems and more livestock losses when animals are severely weakened due to protracted drought. The resumption of reproduction and re-establishment of herds is a slow process. This lack of or slow recovery is reflected in the acute malnutrition data: both showing no significant improvement in all the sites except Laisamis after the return of the rains, as well as the continued presence of critical and emergency level rates of GAM. Effective and sustainable recovery requires effective environmental governance, adaptive drought management, and a shift in women's livelihoods from high-risk, marginal endeavors to sustainable, adaptive opportunities.

The basic drivers of child wasting—climate and seasonality, systems and institutions, and livelihoods—affect entire communities, not just specific households. Both drought and conflict impact food security, water access, and disease across entire communities, not just individual

households. Given that these crises increase vulnerability for all, effective humanitarian and preventative action requires a community-wide response strategy. Ensuring the resilience and recovery of pastoralist systems involves a comprehensive approach that addresses immediate needs, supports long-term positive adaptation strategies, and fosters sustainable livelihoods for drought-affected communities.

# Nutritional outcomes

## Seasonality of wasting

The study reveals that seasonal variability in child wasting is significant, with an average difference of six percentage points between peak and nonpeak seasons, which is greater than the difference between the two years of study. For Laisamis, Ngaremara, and Garbatulla, two general peaks in wasting occur during the rainy seasons (November/December and April/May), with the lowest prevalence in the long dry season (August/September). In contrast, Loiyangalani shows different patterns, with peaks in February and June corresponding to temperature peaks, and the lowest prevalence in September. Each site has distinct primary peaks, with Laisamis showing a significant peak in April/May, Ngaremara having two significant peaks, with November/December being greater than the April/May peak, and Garbatulla showing the least seasonal variability, with one significant peak in November. The presence of two peaks in three sentinel sites and the differences between these sites and Loiyangalani indicates different drivers and protective factors across sites. Understanding these patterns is crucial for developing targeted interventions to address the drivers of malnutrition.

## Consistent characteristics of a wasted child—age, gender, and female caretaker nutritional status

The study consistently found that children aged 3–5 years have much higher odds of being wasted than younger children. This was unexpected because global trends show that the older group tends to have lower rates of wasting compared to younger children; however, the most recent Kenya Demographic Health Survey (2022) shows a similar reversal of the expected relationship between age and wasting. Qualitative data from our study suggests that younger children are less likely to experience wasting due to more time with their mothers as compared to older children. Increased women's workload means older children are often with caregivers who lack sufficient food, thereby raising the malnutrition risk for this group. The accumulation of multiple wasting episodes over time may also explain the higher risk of wasting in older children. Additionally, boys are generally at greater risk of wasting, stunting, and being underweight. The study also underscores the link between the nutritional status of female caretakers and child wasting, highlighting the vulnerability of households with lower caretaker mid-upper arm circumference (MUAC).

## A synthesis of the immediate and underlying drivers in each site

Overall, the study found that the immediate and underlying drivers of wasting varied by site and time of year, with the lowest prevalence of wasting consistently occurring during the long dry season. Diarrhea was the only driver consistently correlated with wasting across all four sites, but it was present in only 16% of wasting cases, indicating that most episodes of wasting did not coincide with diarrhea.

In Laisamis, significant seasonal drivers included fever, malaria (not confirmed), diarrhea, and the absence of household camels in the village. Fever and diarrhea consistently follow the same seasonal pattern as wasting. Seasonal patterns suggest malaria (not confirmed) is an important contributor towards the end of the rainy season, and the presence of camels contribute to lower wasting during the dry season.

In Loiyangalani, significant drivers included fever, malaria (not confirmed), diarrhea, open defecation, and lack of cereal consumption. The lowest wasting rates in August/September correspond to reduced food insecurity, and the lowest prevalence of malaria (not confirmed), fever, and diarrhea.

Ngaremara's significant drivers included diarrhea, lack of cereal consumption, and absence of cattle, with individual caretaker and household characteristics, such as caretaker disability and monogamous as opposed to polygamous households, also being important predictors of wasting.

Garbatulla's significant drivers included diarrhea, respiratory illness, use of informal water sources, lack of fruit, vegetable, and meat consumption, and

household food insecurity, with the consumption of roots and tubers indicating reliance on less preferred, lower-nutrient foods.

Despite improvements since the end of the drought, as of September 2023 most sites still faced critical or emergency levels of wasting, highlighting the need to address not only immediate and underlying drivers but also basic systemic factors contributing to persistently high malnutrition rates.

# Conclusions and implications of the findings

The evidence and analysis have significant implications for all stakeholders and potentially reflect deeper failures and missed opportunities in both development and humanitarian systems. The sustainable prevention of child acute malnutrition is a collective responsibility, from the village level to the highest levels of government, and cannot be ignored. The report concludes with implications for a range of stakeholders, summarized below.

## 1. Implications for assessments, surveys, and surveillance

The study emphasizes the need for disaggregating GAM rates by sex, age, and geography, incorporating additional anthropometric variables, understanding the implications of data aggregation, avoiding simplistic seasonal assumptions, timing data collection appropriately, improving survey representation of households who have migrated to distant pasture (*fora*), and enhancing variables for assessing food security, livelihoods, nutrition, and health.

## 2. Implications for effective responses to shocks and seasonal stresses (treatment and prevention of malnutrition)

Recommendations include reviewing age-specific project targeting criteria, extending malnutrition policies to include children up to 5 years, expanding targeting in known malnutrition hotspots, enhancing screening and treatment coverage, using simplified protocols for treating malnutrition, considering the needs of mothers, monitoring relapse rates, and tailoring response strategies to specific community drivers of acute malnutrition.

## 3. Implications for sustainable livelihoods and adaptive diversification

Global nutritional programs have increasingly focused on food systems. In Isiolo and Marsabit, a food systems approach should build on existing pastoral livelihoods and support strategic, sustainable diversification to enhance nutrition and resilience, while considering community-specific livelihood profiles and ensuring interventions are well-coordinated and contextually adapted.

## 4. Implications for strengthening systems and institutions

Resilience in pastoral communities is largely due to institutions that support mobility, manage environmental resources, and facilitate social safety nets, all of which are associated with nutritional benefits. However, these institutions are vulnerable to protracted and compounded shocks (e.g., extended drought overlaid with intergroup conflict), necessitating interventions and actions at every level to ensure that these institutions can function effectively.

## 5. Implications for learning, uptake, and systems strengthening

To drive effective policy and institutional change, evidence must be integrated into an uptake strategy that promotes evidence-based learning and systems strengthening. Dissemination and uptake must be driven by stakeholder interests and concerns. Local dissemination with strong participation is crucial to facilitate debate and priority setting among local development actors and communities to achieve sustainable solutions to malnutrition.

## 6. Methodological insights and research priorities

Longitudinal data are essential in highly variable climatic contexts, where climate directly influences household activities and exposures. Analyzing climate data is crucial rather than relying on predefined seasons. Additionally, a mixed methods sentinel site approach provides in-depth data on local livelihood systems, institutions, and their wider influences and interconnections. These findings also have methodological implications for how and when we measure wasting.

Further research is recommended on the relationship between fora migration and missing data, the connection between anthropometric indicators and functional outcomes (especially for children aged 3–5 years), and the construction of livelihood variables using quantitative data. Follow-up research should include representative samples of migrating households, as current program evaluations often exclude them, potentially biasing data and misrepresenting ASAL populations

## Conclusions

Child acute malnutrition persists in these sentinel sites, known as malnutrition hotspots, and highlights systemic failures and missed opportunities in development and humanitarian systems, underscoring the collective responsibility for sustainable prevention of child malnutrition. The analysis of basic drivers contextualizes the consistently high rates of child malnutrition, demonstrating seasonal and spatial differences linked to livelihoods, climate, and environment, and shaped by institutions and social support mechanisms. The study's implications call for a comprehensive response to address these underlying issues.

# 1. Introduction

For the past decade or more, the existence of geographic "hotspots" where child acute malnutrition exceeds emergency thresholds have been pervasive and recurring throughout the Kenyan arid and semi-arid lands (ASALs). Humanitarian action by local, national, and international actors has repeatedly responded, but despite this continuous attention and commitment of massive resources, high levels of acute malnutrition in the ASALs continue, despite general improvements of malnutrition rates elsewhere in Kenya.[2] In recognition of this persistent problem, United States Agency for International Development (USAID) Nawiri took a different approach, starting in 2020, with the goal of sustainably reducing persistent child acute malnutrition by designing and implementing an approach that supports, strengthens, and protects systems and institutions. This systems and institutions approach closely aligns with recent international nutrition directives and strategies[3] and contrasts with the short-term, often siloed program interventions at the individual and household level.

Research has played a key role within USAID Nawiri, with two unique longitudinal studies investigating changes over time and drivers of acute malnutrition that aimed to increase project and stakeholder understanding of the drivers of acute malnutrition and influence a wide range of policy, program, and institutional decision-making. This report presents the findings from the Nawiri longitudinal study led by research partners Feinstein International Center, Friedman School of Nutrition Science and Policy at Tufts University and Kenyatta University as part of the Nawiri consortium headed by Catholic Relief Services and operating in Isiolo and Marsabit Counties.

The Nawiri project uses the drylands malnutrition causal framework to identify and understand the drivers of child acute malnutrition. This framework builds on the earlier UNICEF causal framework that highlights the interconnectedness between the immediate, underlying, and basic drivers of child malnutrition, from the local to the national and global level. Despite widespread use of the UNICEF framework, the basic drivers of malnutrition have received little attention compared to the immediate and underlying causes, which align with nutrition-specific and nutrition-sensitive interventions.[4]

The basic drivers of acute malnutrition include environment and seasonality, systems and institutions, and livelihood systems (Figure 1). These basic drivers are structural, meaning they form a framework that fundamentally influences the underlying drivers of malnutrition related to food security, health, and care of women and children. At the heart of the basic drivers are wide-ranging systems and institutions, such as education systems, legal systems, economic systems, and political and governance structures. Institutions encompass the rules, norms, and practices that shape many core elements of society, including cooperation, cohesion, production, conflict resolution, and development, among others. Rules include norms of behavior and social conventions as well as formal regulations and customary rules and practices.[5]

The social, economic, and political processes that determine the underlying and immediate drivers of malnutrition are embedded within these systems and institutions, and their impact is evident in the livelihoods and lived realities of local communities. This study seeks to investigate the drivers of acute malnutrition and the systems and institutions they are part of, as this is where lasting solutions can be found.

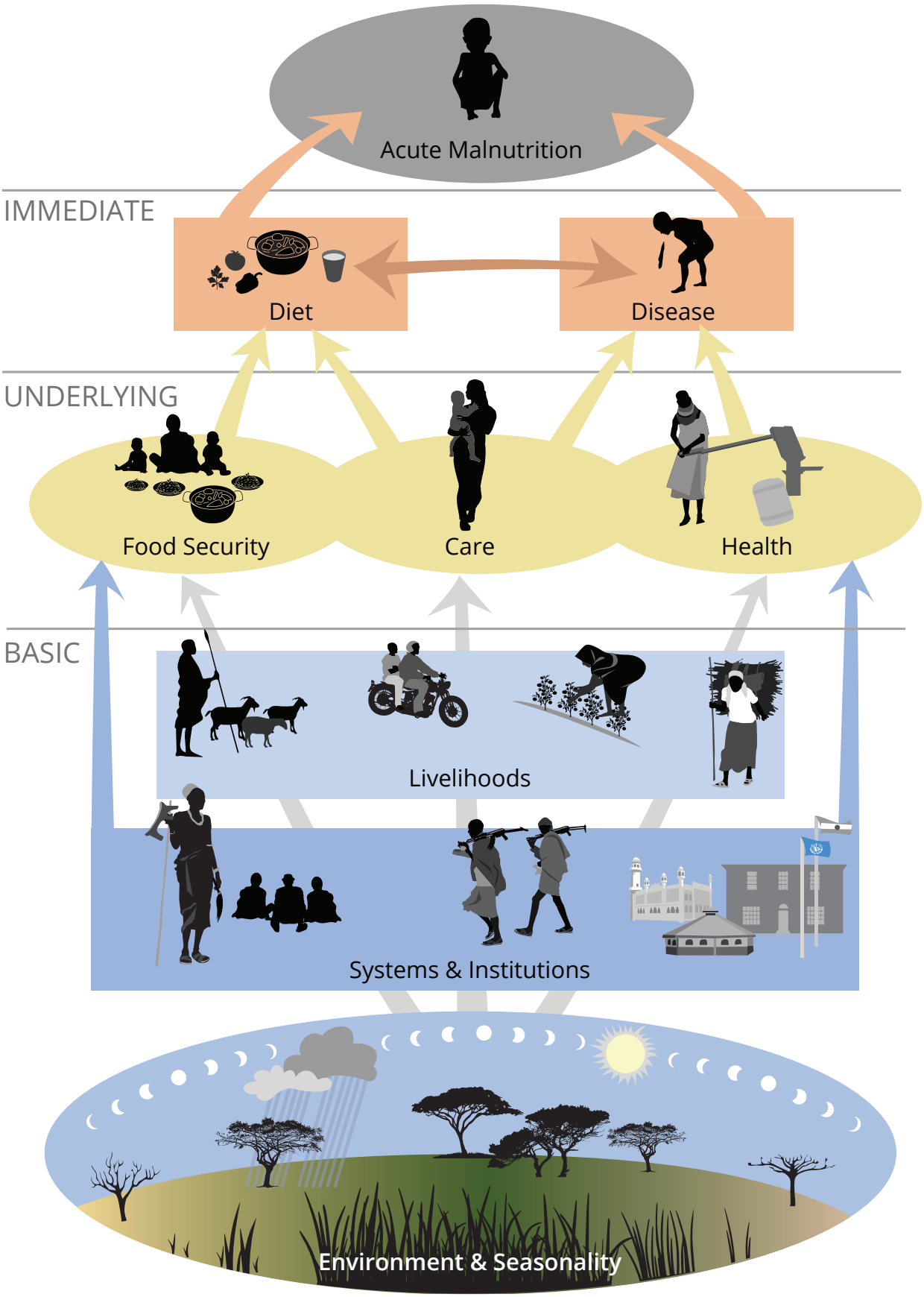
2 Kenya National Bureau of Statistics (KNBS) and The DHF Program, ICF, 2023, Kenya Demographic and Health Survey 2022. Key Indicators Report. Nairobi, Kenya, and Rockville, MD.

3 UN GAP Agencies, 2023, "Global Action Plan for Child Wasting. What is the GAP? The Challenge," accessed Mar 2, 2023, https://www.childwasting.org.

4 H. Young, "Nutrition in Africa's Drylands: A Conceptual Framework for Addressing Acute Malnutrition" (Feinstein International Center Working Paper, Feinstein International Center, Friedman School of Nutrition Science and Policy at Tufts University, Boston, MA, 2020).

5 Hodgson (2006) defines institutions as durable systems of established and embedded social rules that structure social interactions, which can be formal or informal. In the context of livelihood systems and environmental resource management, institutions are regulatory devices that define who is allowed to use what kind of resource, when, and under what circumstances (Haller, 2007). G. M. Hodgson, "What Are Institutions?" *Journal of Economic Issues* XL, no. 1 (2006): 13; T. Haller, "Understanding Institutions and Their Links to Resource Management from the Perspective of New Institutionalism" (NCCR North-South Dialogue 2, NCCR North-South, Bern, 2027).

**Figure 1. An adapted malnutrition causal framework showing the immediate, underlying, and basic drivers of child acute malnutrition (with visualizations adapted for northern Kenya)**



The longitudinal study examines the persistent issue of high rates of global acute malnutrition (GAM) in Marsabit and Isiolo Counties, Kenya, using a mixed-methods approach. The report findings are structured according to the levels of the conceptual framework. The findings start with a review of the basic drivers to contextualize the sentinel sites, then present the nutritional outcomes and examine immediate and underlying drivers. Understanding how basic drivers differ in each of sentinel sites helps explain variations in factors that are driving or mitigating child acute malnutrition.

The discussion confirms the persistence of high child GAM and presents a visual synthesis of the immediate and underlying drivers. It highlights the pressures on pastoralism, its link to human nutrition and the effects of livelihood diversification on child wasting. The discussion ends by considering pathways to recovery and resilience and shares methodological insights gained during the study. The conclusions review implications for some specific stakeholders, and for policies, programs and practices.

# 2. Methods

The aim of the study was to understand the seasonality of child acute malnutrition and its drivers, and identify what drivers are associated with acute malnutrition across different livelihood systems in Isiolo and Marsabit Counties.

The research objectives for the quantitative and qualitative research included:

a. Identify and quantify the seasonal pattern of key nutrition outcomes.
b. Identify the seasonal drivers of acute malnutrition.
c. Identify whether seasonal drivers of acute malnutrition are connected and potentially compound the problem of acute malnutrition at certain times of year.
d. Identify whether the seasonal patterns of key nutrition outcomes and their drivers vary by livelihood category, child age group, or sex.
e. Investigate the seasonality of child malnutrition and the seasonality of its drivers, with a focus on community perceptions of acute malnutrition.
f. Identify the changing nature of livelihood production systems over time, for whom these have changed, and the implications for the immediate and underlying drivers of malnutrition and their mitigation.

The study involved multiple partners. Researchers from Kenyatta University planned and facilitated the training for the quantitative data collection and provided troubleshooting and real-time data quality control during field collection, preparation, cleaning, analysis, and reporting of the anthropometric data. Caritas Isiolo and Marsabit led on communication and mobilization in the communities. CRS, with Caritas Isiolo and Marsabit, created the initial household rosters for sample selection. CRS provided overall supervision for the training, with two field managers in each county, planning logistics, timing, and survey programming. Feinstein International Center led on the overall design and analysis of the de-identified data. Feinstein also led on design, data collection, and analysis of the qualitative component. Ethical approvals were submitted to and approved by African Medical Research Foundation (AMREF) and the Tufts Institutional Review Board. See Annex A for the full description of methods, and Annex B for the annual survey instrument.

## 2.1 Quantitative survey

Sampling for the quantitative survey was based on a panel design stratified by four sentinel sites in Isiolo and Marsabit Counties. We purposefully selected sentinel sites based on two criteria. First, we identified wards that were previously identified as acute malnutrition hotspots,[6] and second, we purposefully selected sites that represent the diversity of livelihood systems. The four sentinel sites included Ngaremara and Garbatulla in Isiolo County, and Laisamis and Loiyangalani in Marsabit County (see Figure 2). Ngaremara was believed to represent more mixed peri-urban livelihoods, while Garbatulla was known for agro-pastoralism, and Laisamis represented a pastoralist livelihood system. Loiyangalani site located on the shores of Lake Turkana was only added to the sample in Year 2 so as to increase the diversity of livelihoods considered in the study.

Each sentinel site is named after the ward it is situated within and includes multiple smaller locations, some of which are in different sub-locations (see Table 1). For example, Loiyangalani and Moite are sub-locations within Loiyangalani ward, and Malkadakka and Kombola are sub-locations within Garbatulla ward. In the text we refer to the sentinel site, sub-location and smaller locations visited within the sub-location.

6 Malnutrition hotspots are defined as geographical regions (counties, sub-counties, or wards, for example) with typically persistent high levels of acute malnutrition, i.e. above, 15% global acute malnutrition. S. Ochola, "Malnutrition Hotspot Analysis and Mapping for the Nawiri Project in Marsabit County" (Catholic Relief Services (CRS) and United States Agency for International Development (USAID) Nawiri, Nairobi, 2021).

**Table 1. Nawiri sentinel site locations in Marsabit and Isiolo Counties and smaller locations within sentinel sites visited by the quantitative and qualitative teams**

| County | Sub-county | Ward (Sentinel site) | Sub-Location | Smaller locations visited by qualitative team | Month and year of visit |
|---|---|---|---|---|---|
| Marsabit | Laismis | Laismis | Koya | Koya | May 22, Nov 22 |
| | | | | Sakardala[i] | Jan 23 |
| | | | *Fora*: | Togokicha | May – 22 |
| | | | | Moile | Jan – 23 |
| | | | | Kiltamany (Samburu East, Samburu County) | Jan - 23 |
| | | Loiyangalani[i] | Loiyangalani[i] | Nawoitorong | Jan - 23 |
| | | | | Nawapaa | Jan - 23 |
| | | | | Nahgan | Jan - 23 |
| | | | | Kiwanja | Jan - 23 |
| | | | Moite[i] | Moite | Nov – 22, May - 23 |
| Isiolo | Isiolo South | Garbatulla | Malkadakka | Malkadakka | Feb - 22, May 22 |
| | | | Kombola | Kombola | May -22 |
| | Isiolo North | Ngaremara | Ngaremara[ii] | Ngaremara | Feb - 22 |
| | | | | Zebra | May - 23 |
| | | | | Attir | May - 23 |
| | | | | Aregae | May - 22 |
| | | | | Kisile | May - 22 |
| | | | | Kiwanja | May - 23 |

i Locations added in year 2

ii Note some placenames are both a ward, sub-location and smaller location within the sub-location e.g. Ngaremara.

The same sample of households and children were surveyed every second month, making a total of 12 data collection rounds. We randomly selected households with children from community household registries and sampled all children between 0–59 months at the time of registration. Children who aged out were removed from the study, and children who aged into the selection criteria were added to the study.

The original sample size and site selection for the quantitative survey was based on the ability to detect (by the end of the study) a significant difference of 0.4 standard deviations in the weight-for-height z-score (WHZ) across the first three sites (excluding Loiyangalani). Given an alpha value of 0.05, power of 0.80, 12 observations over 24 months, and an attrition rate of 20%, we estimated that the study needed 480 households and 600 children. An additional sentinel site, Loiyangalani, was added in the second year of data collection, and sample size increased to 600 households per site, allowing us to detect up to a 0.25 difference in WHZ across the four sites by the end of the study. Loiyangalani sentinel site includes smaller locations in two sub-locations, Loiyangalani and Moite, which are more than 100 km apart, in contrast to the closer proximity within other sentinel sites (Figure 2).

An initial training plus 11 refresher training courses were conducted during the study period, covering the bimonthly (seasonal) and annual questionnaire (Annex B)[7], and anthropometric measurements. The research team used digital data gathering tools and CommCare to maintain high data quality. Data collection commenced in September 2021 and ended in September 2023.

The frequent surveys represent a heavy time burden for participating communities and households. Thus, we designed a rapid short instrument for the longitudinal data collection that includes child and female caregiver anthropometry and prioritizes possible seasonal drivers. On the 6th and 12th round of data collection (September 2022 and 2023), we carried out an annual survey on variables that we hypothesize remain consistent throughout the year. We used nutritional indices (weight-for-height, weight-for-age, height-for-age (HAZ), unadjusted mid-upper arm circumference (MUAC) and MUAC-for-age) to construct anthropometric variables (z-scores) and indicators of wasting, stunting, and underweight.

We used remote sensing data to analyze environmental conditions: temperature, rainfall, and vegetation. Monthly averages for land surface temperature (LST), enhanced vegetation index (EVI), and rainfall were calculated for each ward for a near 24-year date range, February 26, 2000–April 1, 2024. The extended date range allowed us to look at climatic trends over the past versus the research period (September 2021–September 2023).

### 2.1.1 Quantitative statistical analysis and modelling

For all outcome measures, we ran mixed effects harmonic regression models. To incorporate seasonality and account for the observed non-even intervals in wasting, we included four harmonic terms with both 2 and 4π sine and cosine terms in the regression, in line with previous epidemiology research on seasonality. A day variable was generated for the calendar day of the survey date (1–365) to capture trends over time. Details of the general model specification and procedures followed are in Annex A. To best identify the drivers for the study overall as well as each sentinel site separately, we ran three different adjusted models:

- Model 1: Included seasonal variables and annual variables that were collected across both years
- Model 2: Included seasonal variables and annual variables that were collected in Year 2 (the more expanded variable list)
- Model 3: Only included seasonal variables that were collected across both of the two years (resulting in the largest sample size)

In this report we primarily focus on variables that were significant across all models within a site. However, some of the less-consistent findings are also noted throughout, with the caveat that their significant relationship was perhaps less robust. In addition, for the majority of the seasonality graphs we use the values predicted from these models as opposed to the raw data as it allows us to more clearly visualize the seasonal pattern. When that is the case, we describe the outcome in the figure as "predicted." Throughout the report, relationships are described as significant if the p-value is less than 0.05.

7 Annexes are contained in separate documents (see link)..

## 2.2 Qualitative methods

The design of the qualitative inquiry complemented the quantitative data analysis by allowing for deeper investigation of key themes, community perceptions, and changes over time. The focus on local perceptions of the drivers of acute malnutrition and their seasonality was complemented by developing an understanding of the changing nature and transformation of livelihood systems and institutions over time, and their role as both contributors to and mitigators of child malnutrition. This was achieved through various qualitative methods, including the development of community profiles and histories, as well as case studies. The study sought to understand the formal and informal institutions, processes, and systems (including relationships and power dynamics) that affect livelihood systems. Gender and age were considered throughout. Key themes were further informed by the findings from the longitudinal data.

The qualitative research team conducted a series of five field visits to the sentinel sites, starting with a scoping study (see Annex A). Qualitative methods involved sequencing different methods or techniques, combined with triangulating findings, as part of a process of iterative inquiry. In each sentinel site, the team conducted focus groups (FGs) and key informant interviews (KIIs). Focus groups were conducted separately with young and older women and men. Focus groups included various participatory techniques, including facilitated discussion, mapping, ranking, proportional piling, and the creation of timelines. Key informant interviews were held with local leaders, local traders, and health workers. Additionally, in all sites we conducted case study interviews with women. In Laisamis ward, the research team visited three separate *fora* (a satellite livestock camp) for interviews with women caregivers and herders. At the end of Year 1, we investigated the reasons for the above-average attrition rate in Laisamis site by conducting interviews with women who had been registered at the start of the study but subsequently never attended (missing households), and additionally women who had participated in all six rounds (full attendance households). Overall, we conducted: 44 FGs with women, 21 FGs with men, 12 KIIs, 8 case study interviews with women, and 12 individual interviews regarding households who had missed survey rounds (referred to as "missingness"). Observations and remarks during visits to markets, wells, or other rural locations were also recorded.

Training for the qualitative fieldwork included reviewing tools and best practices for managing focus group discussions, note-taking, asking open-ended questions, and probing. It also involved training and piloting participatory techniques as part of the scoping study, training in ethical research and informed consent, and training in the use of qualitative data analysis software.

During the fieldwork, researchers reviewed their notes and participated in daily team meetings to share observations, insights, and key findings. Transcribed field notes were uploaded for coding and further analysis in qualitative software (Dedoose version 9.2.012). We systematically organized and explored patterns within the data using predefined descriptors and coding, allowing us to triangulate the findings and explore patterns. We developed profiles of each study site based on the qualitative data and investigated specific topics arising from the quantitative data analysis.

# 3. Results: the Basic Drivers: Contextualizing Child Acute Malnutrition

This section reviews the basic drivers of child acute malnutrition in each of the four study sites to contextualize the problem of persistent global acute malnutrition. The review begins with the unique histories of each community, followed by an examination of their climate and environment, including seasonality and extreme variability, and the community's experience of shocks and disasters. This is followed by a review of systems and institutions that strengthen resilience and mitigate risks associated with extreme rainfall variability and other shocks.

## 3.1 Sentinel site histories and overview

Each of the four sentinel sites—Garbatulla, Ngaremara, Laisamis, and Loiyangalani—have unique origins and trajectories shaped by population movements, livelihood changes, politics, development, climate shocks, and conflict. We worked in multiple smaller locations in each of the sentinel sites, and each smaller location also has a unique context and history.

Most of the settlements within the sentinel sites became permanent locations within the past 40 to 70 years. Previously, the majority of the human population of Kenya's ASALs was engaged in nomadic transhumance with their livestock herds; very few people resided in permanent settlements. Many of the early inhabitants of the sentinel sites settled due to both pressures (such as from climate and conflict events) and opportunities (such as development schemes, the growth of market opportunities, and improved access to services). National policies that encouraged sedentarization of nomadic or seminomadic pastoralists contributed to the establishment of these permanent settlements (see Box 1). Settling in one location for all or part of the year brought a shift in patterns of livestock migration and also people's livelihood activities (see Section 3.4.2 and 3.4.5), which—across the sentinel

**Box 1. National policies on sedentarization in northern Kenya**

Both push and pull factors have contributed to sedentarization of pastoralists in northern Kenya. Government policies and interventions aimed at development and service provision have heavily influenced these patterns, as have colonial and postcolonial security measures, including pacification campaigns, disarmament, and livestock confiscations. Many of these security policies are designed to control pastoralists and have disrupted their mobility and led to forced settlement in designated areas.[8] Additionally, religious and humanitarian and development organizations established famine relief stations in the 1980s and 1990s, which prompted pastoralists to settle to access food, healthcare, education, and eventually markets.[9] These varied policies aimed to provide support, improve security, expand services, and integrate pastoralists into the national economic framework. While there have certainly been successes, in many instances the implementation of these policies created negative externalities that curtailed the mobility that underpins pastoral resilience while also at times exacerbating resource pressures, scarcity, and conflicts.

8 J. Markakis, "Pastoralism on the Margin" (London: Minority Rights Group International, London, 2004); G. Schlee, "Territorializing Ethnicity: The Imposition of a Model of Statehood on Pastoralists in Northern Kenya and Southern Ethiopia," *Ethnic and Racial Studies* 36, no. 5 (2011): 857–874.

9 E. Fratkin and E. A. Roth, As Pastoralists Settle: Social, Health, and Economic Consequences of the Pastoral Sedentarization in Marsabit District, Kenya, vol. 1 (Springer Science & Business Media, 2006).

sites—had previously been based upon nomadic pastoralism. For example, in all but Loiyangalani, over 90% of households reported that their grandparents' main livelihood was pastoralism (Figure 2).

The reasons for permanent settlement vary across the sentinel sites. For instance, early residents of Malkadakka in the mid-1970s were enticed to settle to participate in a development project for irrigated cultivation; they decreased reliance on livestock husbandry as part of their engagement in the scheme. In Loiyangalani, households or parts of households began to settle in Loiyangalani and Moite sub-locations in the 1980s and later to benefit from humanitarian assistance, to diversify into fishing as a response to livestock losses from drought and conflict, and to take advantage of opportunities in Loiyangalani town. A small number of Turkana households moved from Baragoi in Samburu County (not Turkana County) to settle in Ngaremara in the late 1950s in search of economic opportunities after losing their livestock. Some were able to find casual work for merchants, and a handful found unskilled wage labor jobs in the growing Isiolo town, though they discussed the experiences of discrimination they experienced as outsiders. Many more people moved to Ngaremara following serious droughts in the 1970s and 1980s. In Laisamis, permanent settlements started in response to the growth of services such as schools and health centers, as well as the markets and economic opportunities provided by Laisamis town. Early residents of these smaller locations were primarily women with children of school-going age. Today, the populations in the Laisamis locations remain the most mobile, with women, children, and men regularly moving to and from the *fora*[10], but with children of school-going age residing primarily in the villages to access schools.

Hence, there is a long history of pastoralism across all sites, which is evident in the lasting pastoralist institutions that continue to shape cultural and community identities, social roles, and values, including systems of social support and reciprocity. Decisions as to where and when herders move their livestock are influenced by well-defined norms and rules that allow pastoralists to adapt to spatial and temporal variations in climate and environmental resources, often in interaction with others (see Box 2). Additionally, there are often complex systems of customary governance related to pastoralist mobility involving management of environmental resources, conflict resolution mechanisms, and negotiations with other land users and state authorities. These pastoralist systems and institutions are evolving and continue to play a crucial role in the resilience and adaptation of pastoralist communities (see Section 3.3 and 3.41).

10 A "fora" refers to a satellite livestock camp and is discussed in more depth in later sections. Normally, entirely or mostly mobile herders rotate with livestock to take advantage of available resources. Local languages have different names for these livestock camps; we use the Kiswahili "fora" throughout this report as it is a term understood by all groups. Fora encampments are typically located away from the primary dwellings of a pastoralist community, ranging from a few kilometers to more distant locations that may span multiple administrative boundaries and counties. Fora settlements facilitate livestock mobility to take advantage of seasonal variations in vegetation and water availability and access to the rangelands' strategic dry season water and pasture resources, enabling pastoral households to sustain their livestock and livelihoods in dynamic and often variable rangeland environments.

### Box 2. Mobility and herd management strategies

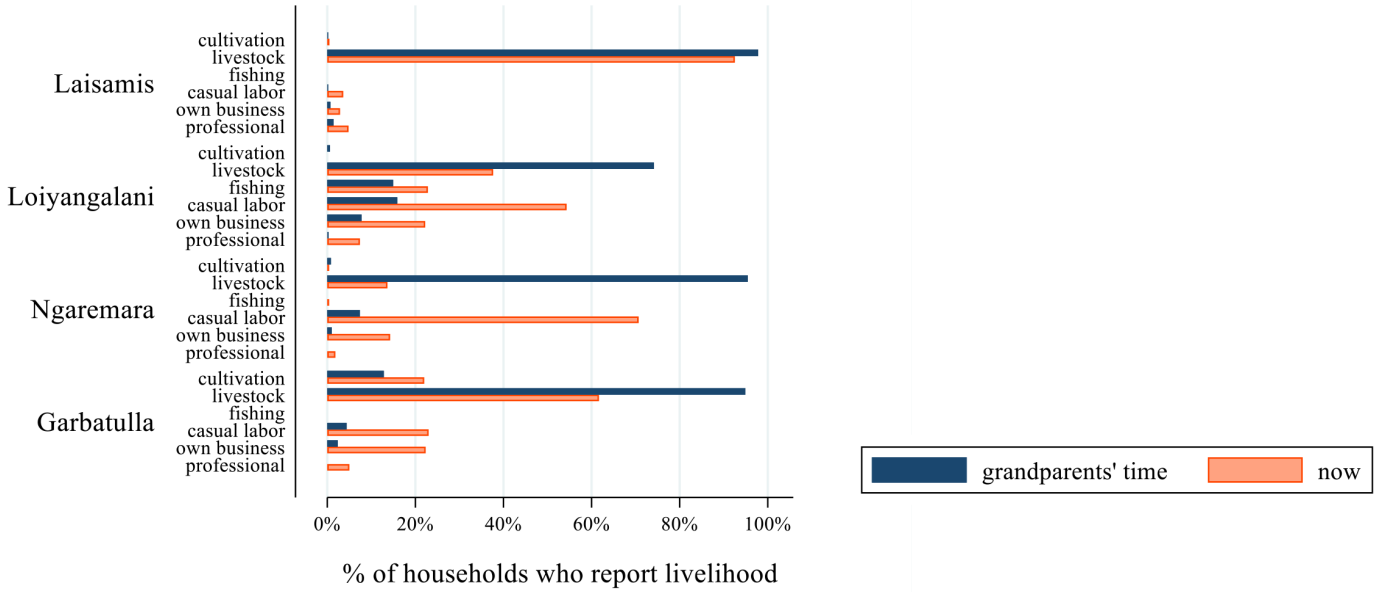
Mobility is a central tenet of pastoral systems. It is strategic and involves the planned and coordinated movement of herds within and across rangelands in response to spatial and temporal variations in rainfall and pasture, both between seasons and during drought years.[11] The system of mobility relies in large part upon the system of *fora*, which serve as temporary, seasonal locations for herds and community members with herding responsibilities. Distances to the *fora* vary based on pasture and water availability, local rules of use and access, and seasonality, with herds migrating farther during the dry season.

Strategic mobility of the pastoral groups in the sentinel sites for this study involves three distinct and sometimes overlapping patterns: i) small and circular movements around permanent villages, ii) circular movements within dry season reserves, and iii) long distance mobility.[12] The small and circular movements around permanent villages (type i) occur during the rainy seasons when water and pasture are plentiful. The proximity of the livestock allows household members to access milk and preserves dry season pastures. If rains are inadequate, most animals are kept in nearby *fora*, with a small number of milking herds remaining in the villages to ensure milk access. Groups in Garbatulla and Laisamis set special access rules for pastures within 10–20 km of settlements for the exclusive use of milk herds. Circular movements within dry season reserves (type ii) occur as pasture conditions change and the distance between water points and *fora* increases. Herders make careful use of available pasture and water resources, including sharing with other groups, splitting herds to take advantage of different conditions, and scouting routes and resources to plan the next movement. Long-distance mobility (type iii) occurs at the peak of the dry season and during drought conditions when pasture and water sources are scarce. At times, herds move across national and international borders, requiring careful coordination of resource access and communication on security.

11 M. Niamir-Fuller, ed., Managing Mobility in African Rangelands: The Legitimization of Transhumance (London: Intermediate Technology Publications Ltd., 1999).

12 E. Stites et. al., "Mobility Matters. The Benefits of Pastoralist Mobility for Nutrition in Marsabit and Isiolo Counties, Kenya" (USAID Nawiri Longitudinal Study Learning Brief No. 2, USAID Nawiri program, Catholic Relief Services, Feinstein International Center, Friedman School of Nutrition Science and Policy at Tufts University, Boston, MA, 2023).

**Figure 2. Main livelihood now versus grandparents' time by sentinel site (annual survey, September 2023)**

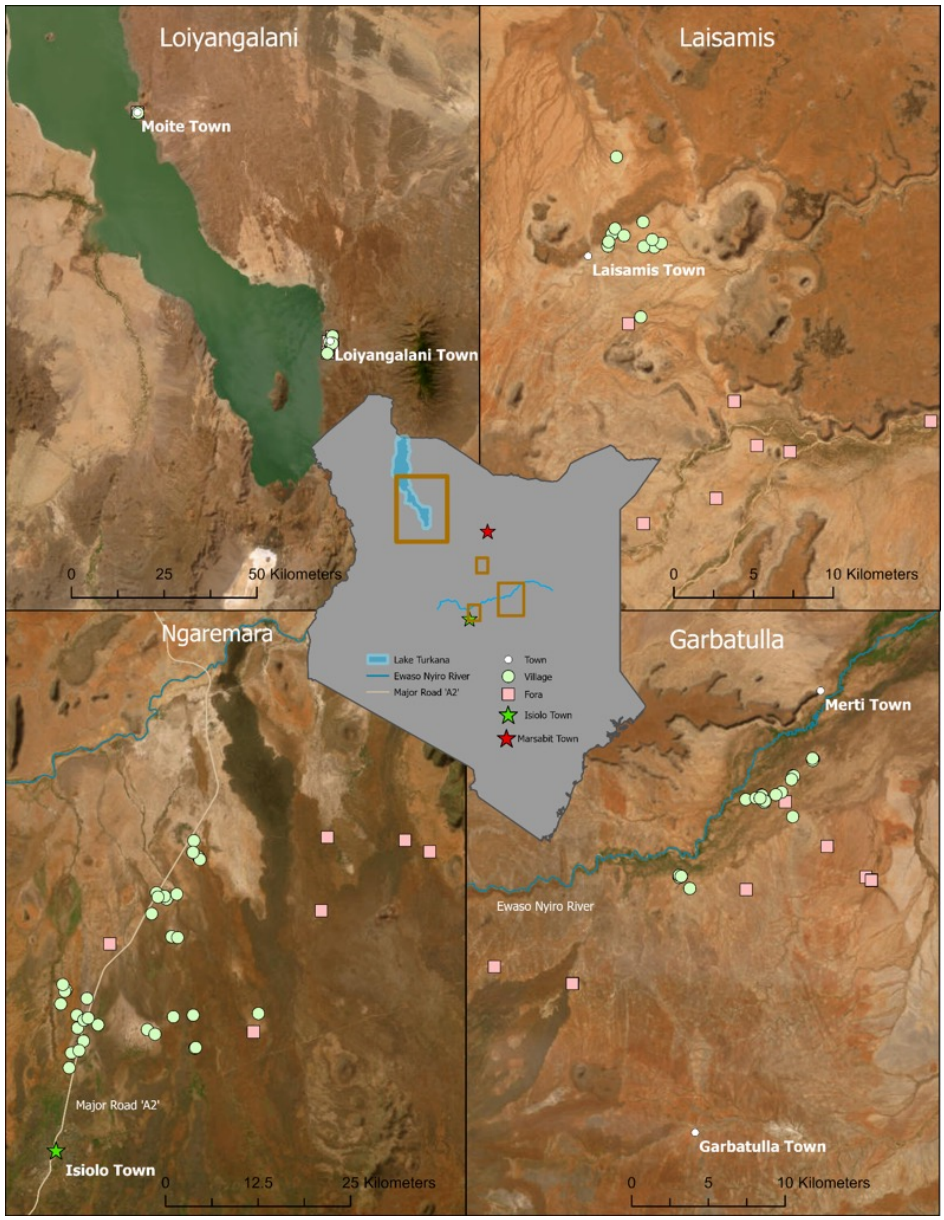



Across all the sentinel sites, the populations have ebbed and flowed in accordance with local shocks and opportunities. In Garbatulla, for instance, the collapse of the irrigation scheme in Malkadakka in the early 1980s led to a gradual shift back towards pastoralism, which would have been associated with increased movement to and from the settlement and *fora*. Some households have resumed irrigated cultivation over the past decade, while others remain more heavily invested in production of small ruminants and maintain strong ties with *fora* in the extended area. Similarly, the population of Kombola, a sub-location in Garbatulla, grew with the return of political refugees from Somalia in the late 1990s. Climate and drought shocks are the main drivers of population influxes in Loiyangalani site, with the smaller location of Moite, and some of the smaller locations around Loiyangalani town (such as Nawaitorong) expanding rapidly during the recent drought. People who lost all or most of their livestock settled in order to engage in fishing, seek emergency humanitarian relief, look for jobs in casual labor, or receive assistance from kin. Conflict in grazing areas and a subsequent exodus of residents also contributed to the expansion of both Moite and Loiyangalani smaller locations. Populations in Ngaremara have similarly expanded due to both opportunities and shocks. Some locations within Ngaremara, such as Kisile, were settled by people seeking more grazing land, while others—such as Attir and Zebra—were settled by people escaping conflict in grazing areas and after drought-induced livestock losses.

One of the starkest differences between the sites is the variations in access to markets and services. Ngaremara sentinel site is the closest to a sizeable town (Isiolo), and many of the smaller locations in Ngaremara abut the paved A2 highway, with various transportation options facilitating access to the town's busy commercial opportunities and public services (Figure 2). Residents in the Laisamis sentinel site locations can access Laisamis town and its two hospitals with relative ease, but commercial opportunities are fewer than in the Isiolo sentinel sites. The Garbatulla sentinel site locations are between approximately 30 km (Malkadakka) and 90 km (Kombola) from Garbatulla town on improved roads; residents of Garbatulla rely primarily upon local markets or cross the Waso Nyiro River to reach the smaller town of Merti. Loiyangalani ward is the most geographically dispersed of the sentinel sites, with major differences not only between the Moite and Loiyangalani sub-locations, but also among the smaller locations studied within Loiyangalani sub-location. The smaller location of Moite is extremely

remote and has few economic opportunities outside of fishing, and limited services and infrastructure. The smaller locations within Loiyangalani differ by ethnicity and livelihood activities, with some lying along the lake and benefitting from the fishing industry, while others are much more peri-urban in character. Loiyangalani town is approximately the same size as Laisamis town.

**Figure 3. Map showing smaller locations and *fora* across the four sentinel sites accessed by the quantitative team**




A common theme across all the sentinel sites is much greater livelihood diversification today compared to previous generations. Respondents described their grandparents as exclusively or almost exclusively dependent upon livestock and near-universal livestock ownership of multiple species across all households (Figure 2). Today, patterns of livestock ownership have shifted towards small ruminants, with high-value animals owned primarily by the better off (see Section 3.4.1). In some locations, especially Ngaremara and Garbatulla, diversified livelihood activities outside of pastoralism provide for a sizable percentage of many households' food and income. These shifts are due to both constraints

on pastoralism that have emerged over the past half century and the increased opportunities brought through economic growth, commodification, extension of infrastructure, and the reach of education to the dryland areas. For a more detailed discussion of diversification activities in the study sites, see Section 3.4.5.

Conflict and insecurity flare sporadically in pastoral areas across much of the Greater Horn and have influenced the settlement, populations, and livelihoods in each of the sentinel sites in this study, with differences by location and time period. Insecurity is most common when people are in the distant *fora* with their herds or when attempting to access resources for their animals. This means that the effects of conflict on pastoral livelihood activities are often the most visible, but in fact the direct and indirect impacts of conflict have an extended reach. In this study, these effects are visible in original and continuing patterns of settlement, in the access to services and markets, in transhumant routes, in decision-making about herd management, and in the nature and evolution of customary institutions. These and other aspects are discussed throughout this report.

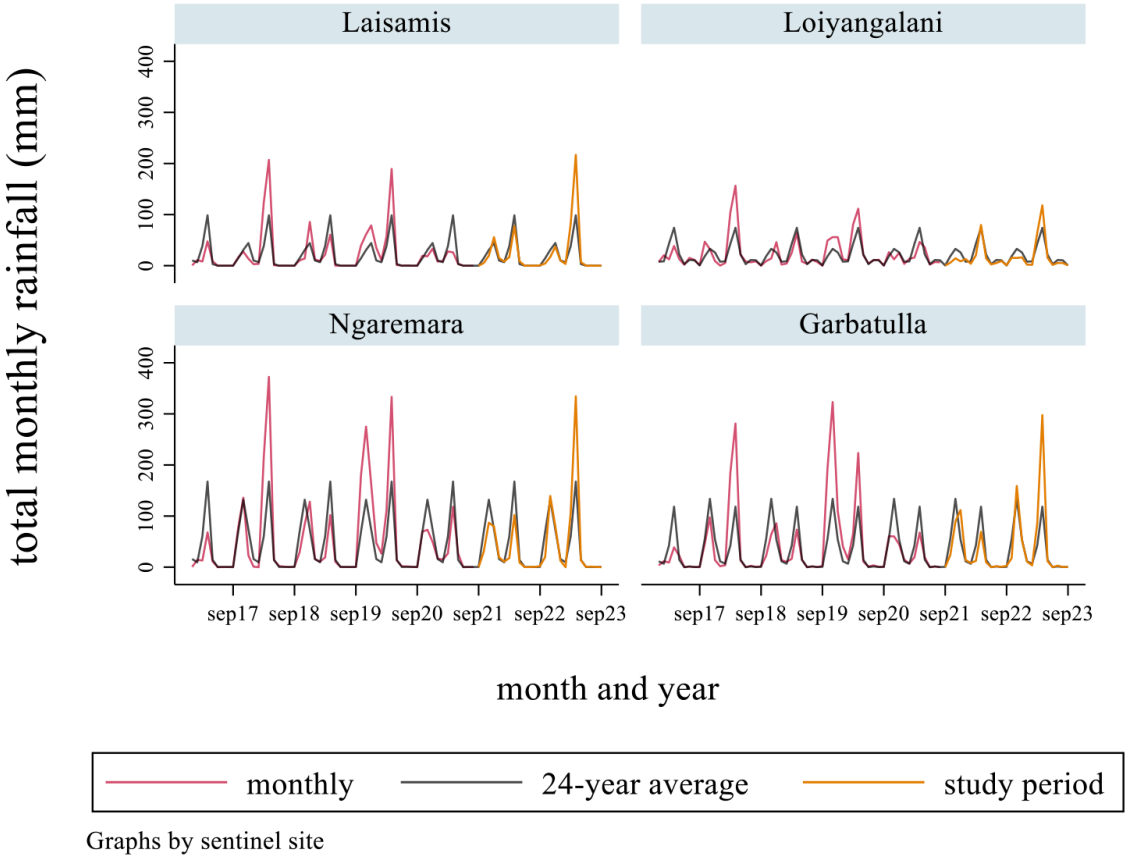
## 3.2 Climate, environment, and seasonality

This section presents the climatic conditions—precipitation, temperature, and vegetation—in the four sentinel sites during the two years of study. These patterns are compared with trends over the past 30 years, noting climate (droughts, floods) and other shocks. The climatic conditions vary significantly, despite their location within two neighboring counties. This variation affects access to environmental resources such as arable land and water resources like Lake Turkana and the Ewaso Nyero River. Proximity to urban centers, like Isiolo town and Loiyangalani town, is also a factor that influences resource availability and access.

### 3.2.1 Climate, environment, and seasonality in the sentinel sites

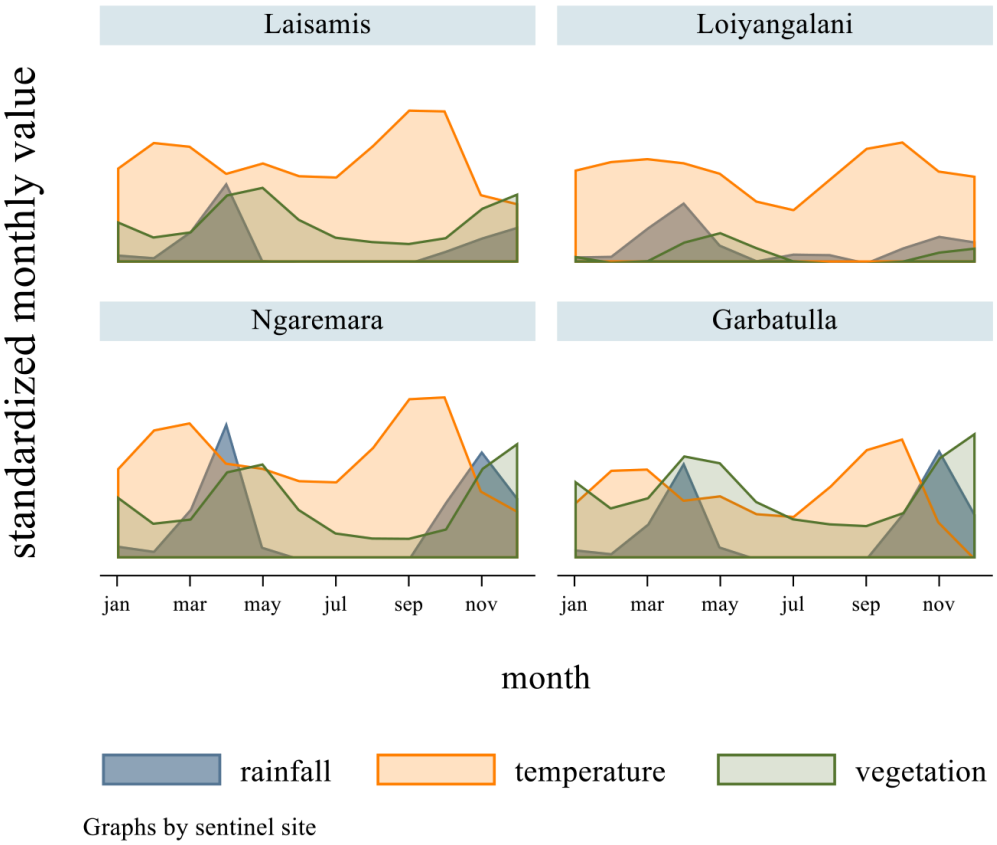
It is important to contextualize the two-year study period within longer-term trends. The first year of our study marked the second consecutive year of below-average rainfall, indicating an extended drought, while the second year experienced above-average rainfall (Figure 4). The data also show high rainfall variability, with 2017/2018, 2019/2020, and the study year 2022/2023 recording the highest rainfall. The annual variability is further reflected in the historical frequency of droughts and floods. From 2004 to 2023, Marsabit experienced only four years without reported disasters, while Isiolo had just two such years (Figure C1 in Annex C). Thus, a drought or flood occurs almost every year, sometimes within the same year (2011 and 2019 in Isiolo and 2008, 2011, and 2019 in Marsabit).

**Figure 4. Rainfall variability from September 2015–September 2023: monthly data versus 24-year average (2000–2024)**




Comparing across the four sentinel sites (Figure 5), we observe climatic differences. Loiyangalani is by far the driest site with the least amount of vegetation. Garbatulla, on the other hand, is the greenest throughout the year, with a slightly lower temperature than observed in Laisamis and Ngaremara. Laisamis and Loiyangalani, while still exhibiting two peaks of rainfall and vegetation, have lower total rainfall and a smaller November peak compared to the April peak, which is in contrast to the pattern in Garbatulla and Ngaremara, which have equal-sized peaks. However, overall, we do observe two peaks for rainfall (April and November), two peaks for temperature (February and September/ October), and two peaks for vegetation (May and December) in all of our sites.

**Figure 5. Standardized 24-year (2000–2024) average rainfall, temperature, and vegetation across the four sentinel sites**




*Note: standardized across wards: (value – mean(value))/standard deviation(value)) to allow us to visualize all the different climatic variables on one graph despite different units of analysis*

### Local perceptions of seasons and seasonality

Pastoralists divide the year into seasons governed by the rains and the availability of pasture and rainwater. The annual production cycle starts with the long rains in March, followed by a long dry season. Then come the short rains and a short dry season, though the short rains in recent years often fail, extending the long dry season. Thus, the June-to-September dry season is longer (4 to 6 months) and more consistently dry than the short dry season in January (1 to 2 months).

Respondents identified the transition period between seasons. For example, "*nait*" marks the end of the rains and early dry season when grasses turn yellow and begin to dry out. "*Gururam*" is the transition period from drought to rains in Malkadakka, characterized by stricter rules of use and access to water.

Annex D presents examples of seasonal calendars for some of the smaller locations in the four study sites. The seasonal calendars for Malkadakka and Ngaremara start in January, in line with the Gregorian calendar. In Malkadakka, the names of the seasons are direct translations from English; "*bonn haggaya*" means short drought, rather than distinct local names.

## 3.2.2 Access to environmental resources in the sentinel sites

Although the sentinel sites are located in two neighboring ASAL counties, they have remarkably different environmental resources (Figure 2). Garbatulla site locations (Malkadakka and Kombola) are situated close to the Ewaso Nyoro River, providing year-round, open-source water for household use and with adjacent cultivable land. Due to this proximity, Garbatulla sites have the highest

proportion of households reporting having access to land for cultivation (almost half), with 41% of households specifically saying that they have access to land near a riverbed.

Laisamis and Loiyangalani are the driest sentinel sites, and hence in both sites the proportion of households with access to land for cultivation is near zero. However, both sites have access to other environmental resources. The Loiyangalani site locations are located on Lake Turkana, which is an abundant aquatic resource. However, we observe large differences in water use access between Loiyangalani and Moite smaller locations (Figure 6). In Moite, the more rural of the two, only a small proportion of households report having access to a borehole or piped water, compared to over 90% of all households residing near Loiyangalani town.

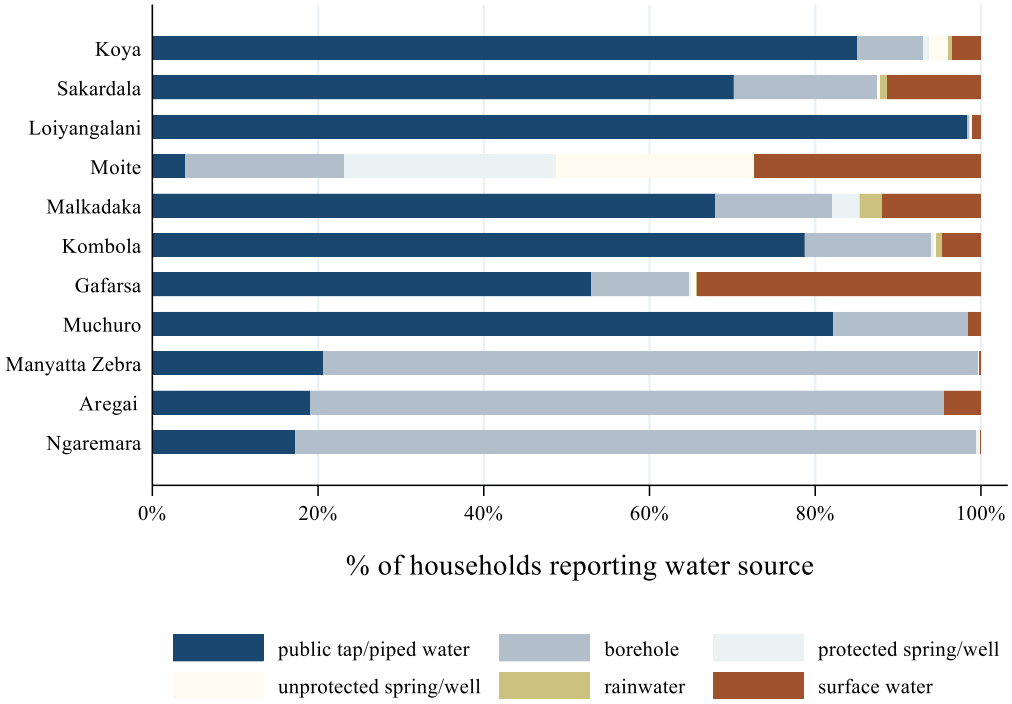
Laisamis, while being fairly dry and hot, on the other hand has seasonal rivers that provide closer dry season resources as can be seen through the distribution of *fora* locations of migrating households (Figure 2). Given that the rivers are not permanent, we only see a small spike in the use of open-source water in Laisamis during and immediately after peak rains (see Section 5.3). However, open-source water use significantly increased in Year 2, either as a result of more rain leading to more open-source water that was present for longer, or other options (like boreholes and tapped water) might have required maintenance post rains and hence were not available.

Ngaremara is situated along a main road (A2 Highway) with a dispersed settlement pattern, with some registered land parcels for cultivation close to the highway that are irrigated through public taps in their neighborhood, and also more distant farms adjacent to the Ewaso Nyoro River. A third of households in Garbatulla have access to land, yet only 15% report cultivation as part of their livelihood portfolio. There is also some access to pasture to the east of the settlements. On the left of the Ngaremara site, on the other hand, there are no *fora* locations due to the presence of conservation land that limits access to humans and livestock. In Ngaremara, given its proximity to Isiolo town, over 80% of households report using a borehole, with the least amount of open-source water use and open-source water seasonality.

Distance to a water source is directly related to the type of water source used. Households report walking farther for surface water and unprotected wells/springs (almost 3 km on average), compared to less than 1 km for public taps or boreholes. Thus, not only are households consuming less potable water, but it is more time-consuming to go to these sources, indicating that this decision is likely not a choice of convenience but rather the lack of better options.

We did find a significant relationship between reporting using open-source water and whether a child was acutely malnourished in Garbatulla only. On the other hand, in the smaller locations within Loiyangalani sub-location, consumption of piped water was associated with worse outcomes. The lack of a relationship across most sites and the negative relationship in Loiyangalani sub-location could be due to the presence of harmful minerals and fecal matter across different sources, including those assumed to be potable. While water quality surveillance data are limited, an analysis of 13 boreholes and one pond across the four sites in Isiolo and Marsabit identified the presence of arsenic, iron, fluoride, nitrate *E. coli*, total coliforms, and/or total dissolved solids at or above the World Health Organization (WHO) threshold in 6 of the boreholes. It is worth noting, however, that of the two Ngaremara boreholes tested, both met the WHO guidelines. Not surprisingly, the pond tested in Marsabit was highly contaminated in both total and fecal coliforms.

**Figure 6. Main source of water for human consumption by smaller location**




**In summary**, the ASAL context is characterized by significant climatic variability across both time and space, and this is evident in the four sentinel sites across two neighboring counties. While the seasonal patterns of rainfall, temperature, and vegetation are similar across all four sites, the amplitude varies quite dramatically. Loiyangalani is extremely dry and hot for most of the year, with very limited vegetation but access to Lake Turkana's aquatic resources. In contrast, Garbatulla is relatively greener year-round and is located on a permanent river. These environmental differences over a small geographic area highlight Kenya's high spatial variability, which includes seven climatic classifications.[13]

The differences in climate and access to environmental resources between these sites influence the available livelihood opportunities (see Section 3.4). Additionally, a range of pastoralist institutions mitigate the effects of extreme variability in rainfall and vegetation such as the strategic mobility of livestock herds and the customary systems that manage access to environmental resources (Section 3.3). Furthermore, climate and environment impact the seasonality of drivers, with almost every driver and outcome analyzed following a seasonal pattern that is somehow directly related to rainfall, temperature, and vegetation.

## 3.3 Systems and institutions for managing risks and ensuring resilience

The ASAL context is characterized by significant climatic variability across time and space, which is evident in the four sentinel sites across two neighboring counties (see Section 3.2). Pastoralist groups use a range of institutions to mitigate this variability and adapt to social, economic, and political changes in the study sites. Pastoral institutions and social organizations facilitate resource sharing, risk spreading, and the voluntary redistribution of livestock, food, and childcare responsibilities. However, sociopolitical and environmental changes

13 The seven climatic classifications include: arid, humid, one unimodal wet season, one bimodal wet season, one multimodal wet season, two unimodal wet seasons, two wet seasons with one being unimodal and the other being bimodal, as well as areas defined as having more than two wet seasons. S. M. Herrmann and K. I. Mohr, "A Continental-Scale Classification of Rainfall Seasonality Regimes in Africa Based on Gridded Precipitation and Land Surface Temperature Products," Journal of Applied Meteorology and Climatology 50, no. 12 (2011): 2504–2513.

in these sentinel sites, along with substantial recent herd losses, have severely affected the viability and effectiveness of these systems. Despite these significant transformations, the adaptation of pastoralist institutions underscores the continued importance of pastoralism, showcasing its resilience and adaptability in addressing contemporary challenges. This section explores the pragmatic application of essential pastoralist institutions that help manage risks and build resilience in our sentinel sites, their transformations over time, and their impact on the nutrition of pastoralists in the four sentinel sites.

In Isiolo and Marsabit Counties, pastoralist groups rely on customary institutions and a range of well-established social norms, practices, and conventions to use variable resources profitably and sustainably in the ASAL rangelands. These factors shape the lives and livelihoods of the study communities, ultimately influencing the drivers of malnutrition and child wasting.

Pastoralists respond to and adapt to the spatial and temporal variability that characterizes their environment (see Box 2 and Section 3.4.2) in an adaptive manner. Customary institutions for environmental resource governance and social organization play a key role in maintaining resilience in the face of uncertainty. These institutions are underpinned by trust, social support, and reciprocity.[14] These mechanisms allow environmental resource access and sharing, risk spreading, and voluntary redistribution of resources such as livestock, food, and childcare responsibilities.

These customary institutions enable pastoralists to respond rapidly to changing conditions using a well-developed, practical repertoire of responses. Some of the essential pastoralist institutions that help manage risks and build resilience in the highly variable rangeland environment include the strategic mobility of livestock complemented by indigenous knowledge and adaptive herder skills and practices, customary institutions for governing environmental resources, and informal social support networks for social safety nets and wealth distribution.

### 3.3.1 Strategic mobility for reducing risk and increasing resilience

Strategic mobility is the seasonal movements of herders and their livestock from one location to another, driven by the necessity to access water and pasture resources in the variable rangelands. Strategic mobility is a foundational element in pastoralist production and environmental resource governance in our sentinel sites, playing a crucial role in reducing risk and enhancing the resilience of pastoralism. Strategic mobility, rooted in traditional practices and adaptive strategies, is essential for managing the environmental variability and socioeconomic challenges characteristic of Isiolo and Marsabit Counties. Flexibility and adaptability are key features of the institution of strategic mobility, enabling herders to continuously adapt their mobility patterns in response to changing environmental and socioeconomic conditions (see Box 2). This adaptability is crucial for coping with the uncertainties of environmental variability, exploiting new opportunities, and responding to emerging threats, reducing their vulnerability, and increasing their resilience.

Strategic mobility is deeply embedded in the traditional practices and indigenous knowledge of the pastoral groups in our sentinel sites. Pastoralists have developed intricate mobility patterns based on traditional knowledge passed down through generations, allowing them to efficiently utilize the temporal and spatial variability of rangeland resources such as water and pasture. Understanding seasonal variations, water sources, and pasture conditions is crucial for making informed decisions about when and where to move their herds. A member of the Council of Elders explains, "Herders navigate vast terrains, showcasing a deep understanding of the geographic and ecological nuances of the landscapes they traverse." An elder from the Waso Boran in Garbatulla explains that Boran herders rely on "the wealth of knowledge possessed by herders and passed down from one generation to another." Decisions based on indigenous knowledge are critical for reducing the risks associated with drought and resource scarcity, ensuring the efficient use of resources, and sustaining pastoralist livelihoods.

14 G. Oba, Pastoralist Resilience to Environmental Collapse in East Africa since 1500 (Palgrave Macmillan, Cham, 2024).

The institution of strategic mobility is supported by strong social structures and governance systems within pastoralist communities. Customary institutions, councils of elders, and community leadership play a vital role in regulating mobility. Customary institutions, such as the Boran Dedha and Ilturiya Council of Elders, manage strategic mobility by establishing and enforcing pasture and water use rules. They create guidelines dictating when and where herders can move their livestock, ensuring sustainable resource use and preventing overexploitation.

Strategic mobility remains crucial for pastoral livelihoods in our sentinel sites, supporting economic and nutritional needs. However, long-term changes with food security and nutrition implications are emerging (see Section 3.3.4).

## 3.3.2 Customary institutions for governing environmental resources

Pastoralist customary institutions, rooted in deep cultural practices and norms, play a crucial role in resource management, with leadership often passed down through generations. These institutions, led by respected male elders, adapt governance practices to address environmental and social changes, ensuring sustainable resource use and pastoralist livelihoods. Additionally, formal government institutions collaborate with these customary systems to enforce regulations and resolve conflicts, exemplifying adaptive governance in managing rangeland resources and mitigating drought impacts.

Customary institutions of environmental resource governance, such as the Dedha Council among the Boran and the Council of Elders among the Rendille, are vital for the productivity and resilience of pastoralism, especially during droughts and other risks. These traditional systems establish and enforce rules for accessing and using drought reserves and dry season water sources, ensuring their preservation and careful use during times of scarcity. By regulating resource use, these institutions prevent overexploitation, promote equitable distribution, and facilitate cooperation and conflict resolution, enhancing the resilience and sustainability of pastoral livelihoods and their rangeland ecosystems.

Pastoralists use resource management practices to capitalize on the seasonal variability of rangeland resources, enhancing livestock productivity while simultaneously responding to risk and uncertainty in the rangelands. Self-organization, the creation of dry season reserves, and enforcement of access and usage rules allow pastoralists to adapt to scarcity, uncertainty, and change. In particular, pastoralist groups in Isiolo and Marsabit Counties manage access to water between seasons and during drought years. Seasonal rains are critical for feeding the seasonal rivers, earth pans, boreholes, and wells that pastoralists rely on in rangelands near settlements and in distant pastures. Water sources and rules of access and use vary by location and from year to year.

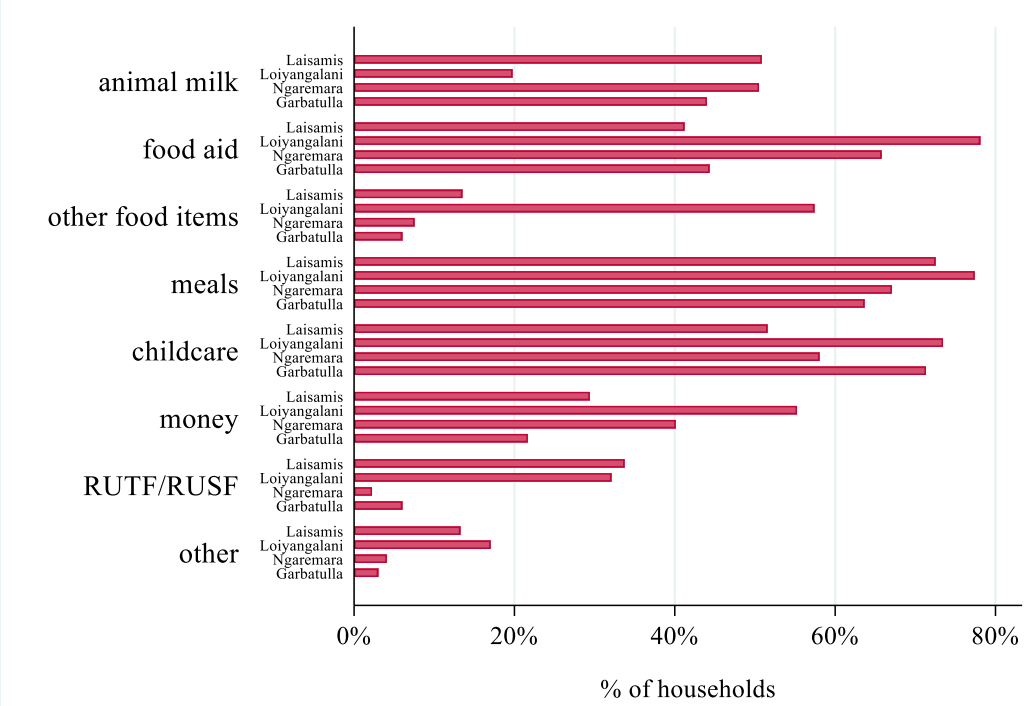
Alongside the management of water resources, pastoralists must consider access to adequate pasture, especially during dry seasons. These considerations can be seen in how groups classify and manage different pasture zones, especially in preserving areas during the rainy season. During the dry season, pasture must be used strategically and in collaboration with other groups to prevent its depletion. Thurusi borehole in Laisamis, for example, is known for its abundant water supply during dry seasons and is used strategically by the Rendille (Ilturiya) and Samburu pastoralists as a critical drought reserve. To ensure adequacy during the dry or drought periods, male elders restrict access (including for local herds) from the beginning of rains to the start of the next dry season.

The beginning of the reserve period is marked by prayer rituals by the Council of Elders, marking the beginning of grazing restrictions until such a time the Ilturiya Council of Elders determine a drought; only then will the reserve be open for use again. The local Ilturiya Council of Elders has developed institutions to manage drought reserves. These institutions are based on inclusionary principles favoring negotiation, complementary and reciprocal decision-making, and governance linked to willingness to follow rules and cooperate around shared resource management. A crucial role of the Council of Elders is to institute and enforce rules on access and use and determine and enforce fines and sanctions for violating the regulations of drought reserves. Apart from instituting and enforcing strict sanctions, such as livestock fines, the enforcement of the rules of access and use of drought reserves often happens in cooperation with formal government institutions, represented by the Chief and County Commissioner, who enforce compliance through stricter sanctions such as arrest and arraignment of violators in a Court of Law.

### 3.3.3 Informal social support networks for social safety nets and wealth redistribution

Pastoral institutions include a distributive and collective approach rooted in informal social support networks and relationships structured by obligations through sharing (food and non-food items, childcare, and herd management responsibilities), gifts, and loans. These social support networks often serve the joint purpose of resource management and social security during a crisis. Households in the four sentinel sites rely on flexible, cooperative interactions that include sharing herding and livestock watering responsibilities, scouting for pasture, and security management. Informal social support networks cater to specific needs, with the greatest support usually going to the most vulnerable. In the study sites, households in the poorer wealth groups received support in the form of food and sometimes cash from relatives, neighbors, and other community members. Sharing occurred between settled and *fora* locations as well as within villages. Figure 7 below shows the extent to which respondents in the quantitative survey reported sharing (receiving) food, cash, and childcare. The three most commonly shared resources were meals, childcare, and food aid. Animal milk was most often shared in Laisamis and Ngaremara, while food aid, other food items, meals, childcare, and money were most shared in Loiyangalani. The sharing of ready-to-use therapeutic food (RUTF) and ready-to-use supplementary food (RUSF) was highest in the two sites with the highest prevalence of acute malnutrition: Loiyangalani and Laisamis.

**Figure 7. Sharing of resources by type of resource and ward (round 12, September 2023))**




The practice and reliance on social support networks differ across our sentinel sites. Reciprocity is assumed but not required in a transaction, and many respondents discussed the role of differences in wealth and assets in determining the terms of an exchange. All respondents reported some form of sharing with kin and close family members. The Ilturiya of Laisamis reported the most complex and extensive transfers to kin and non-kin relationships, including of livestock, and the expectations of reciprocity in these exchanges.

The sharing of resources can function in a protective manner. We found that in Loiyangalani in particular, the more resources a household reported that

other members of the community shared with them, the less likely the child was wasted (See Table C1 in Annex C). Breaking it down further, we can see that in Loiyangalani (less so in all other sites), the protective aspect of social capital is incredibly important: an odds ratio (OR) below 1 shows a protective correlation (Table 2). Sharing of animal milk, food aid, meals, money, or "other" were all significantly correlated (in the crude model) with an almost 50% reduction in the odds that a child is wasted.

**Table 2. Odds Ratio (OR) on wasting related to sharing of resources in Loiyangalani (round 12)**

| Item Shared | Odds Ratio | P-value | 95% Confidence Interval | |
|---|---|---|---|---|
| animal milk | 0.51 | **0.01** | 0.30 | 0.86 |
| food aid | 0.59 | **0.01** | 0.40 | 0.88 |
| other food items | 0.79 | 0.20 | 0.55 | 1.14 |
| meals | 0.47 | **0.00** | 0.31 | 0.70 |
| childcare | 0.75 | 0.14 | 0.50 | 1.10 |
| money | 0.68 | **0.03** | 0.47 | 0.97 |
| RUTF/RUSF/Fortified Blended Foods | 1.89 | **0.00** | 1.31 | 2.72 |
| other | 0.54 | **0.02** | 0.32 | 0.92 |

Despite the importance of social safety networks in pastoral systems, livestock losses, protracted and compounded shocks, and livelihood transformation have undermined these systems in some of our sentinel sites. We observed the adoption of high-risk coping strategies in Loiyangalani, where the social networks appeared to be the weakest, least developed, or most frayed. However, many forms of social support have evolved with the changes to the pastoral livelihood system. Two of these are childcare and the sharing of milk: these were evident in all of the sentinel sites and are discussed below.

The sharing of childcare is an important component of the informal social support network. Across the four sites, between 52% (Laisamis) and 72% (Garbatulla and Loiyangalani) reported sharing childcare. Childcare responsibilities are almost exclusively borne by women in pastoral contexts, and a mother who needs to leave her children for an extended period of time must find an alternate female caretaker. Drought conditions during the study reduced the availability of animal products within the home as well as income sources from livestock products. Filling this dietary and income gap at the household level fell primarily to women, who took on various and multiple additional livelihood activities to provide for their households (see Section 3.4.5). Women are often unable to take all children under age 5 with them when they engage in these activities, due to distance, insecurity, heat, and other factors. Children are left with mothers-in-law/grandmothers, female neighbors, or older (usually female) siblings. The time spent by children with these secondary caregivers is seasonal in many locations, often increasing during the dry season when resources (such as water and wild foods) are often located farther from the homestead and when women are more engaged in casual labor. While the provision of childcare by grandmothers and others is a long-standing practice in the ASALs (and most

other societies), women's daily activities away from the home have increased and intensified due to both the drought and the evolution of pastoral systems. These changes mean that women's economic and subsistence contributions are essential components of basic household needs. At the same time, the greater work burden for women means that children are spending more time with secondary caregivers. Children—sometimes including breastfeeding infants—go for up to 12 hours without food in the absence of their mother.

An excerpt from a women's focus group discussion in Moite (smaller location in Loiyangalani sentinel site) in May 2023 illustrates both the system when a woman must be away from her child and the seasonality of milk availability: "In the rainy season where there is milk, the mother will put some in a calabash and instruct the sibling to feed the infant regularly, but during drought there is no milk, and they can stay the whole day without until the mother comes home." Thus, this form of social support allows women to engage in activities to provide for their families but may have negative impacts on child nutrition when a mother does not have adequate food on hand to leave with her child's caregiver. For example, while most of the children were brought in by their mothers for the bimonthly anthropometric weighing, approximately 4% (which is over 100 children in our sample) in round 12 were brought in by someone other than their mother. This proportion was highest in Loiyangalani. If a child was brought by someone other than their mother, the child had almost twice the odds of being wasted compared to a child brought in by their mother (25% vs. 14% wasted).

Milk sharing is deeply rooted in cultural norms and informal institutions that support those in need. Milk is central to the diet of many pastoral households and underpins child nutrition (see Section 3.4.3). Milk also carries significant social value and plays a crucial role in establishing and nurturing relationships, often involving sharing in times of need or gifting at significant events like circumcision, marriages, or births. Poorer households often reciprocate milk sharing by assisting in herding, childcare, and other tasks.

Historically, milk sharing involved lending a lactating animal, which the receiving party kept for its milk production period. This practice, common among kin and sometimes unrelated households, is still prevalent among the Ilturiya in Laisamis but less so among the Turkana in the smaller location of Moite, attributed to herd losses and increased commercialization.

Our research indicates a decline in milk sharing across all the pastoral groups in Isiolo and Marsabit, especially during droughts and in response to herd losses. This decrease is mainly due to livestock losses, reduced milk yield, and shorter periods of milk availability during prolonged droughts. In Garbatulla, women's groups purchase milk from *fora* settlements and sell it in urban markets, using the proceeds to buy food, which potentially limits milk availability for sharing. In Ngaremara, there are fewer livestock-owning households, with generally smaller herd sizes compared to the other study sites (see Section 3.4.1). Nevertheless, by September 2024, the annual survey found similar rates of milk sharing and receiving in Ngaremara and Laisamis (though less so in Garbatulla, possibly related to the increased sale of milk there) indicating the continuing importance of this social norm and ongoing need among the poor. In contrast, during the drought, households who could afford it bought milk from the market as there was none to share (according to the Focus Groups (FGs).

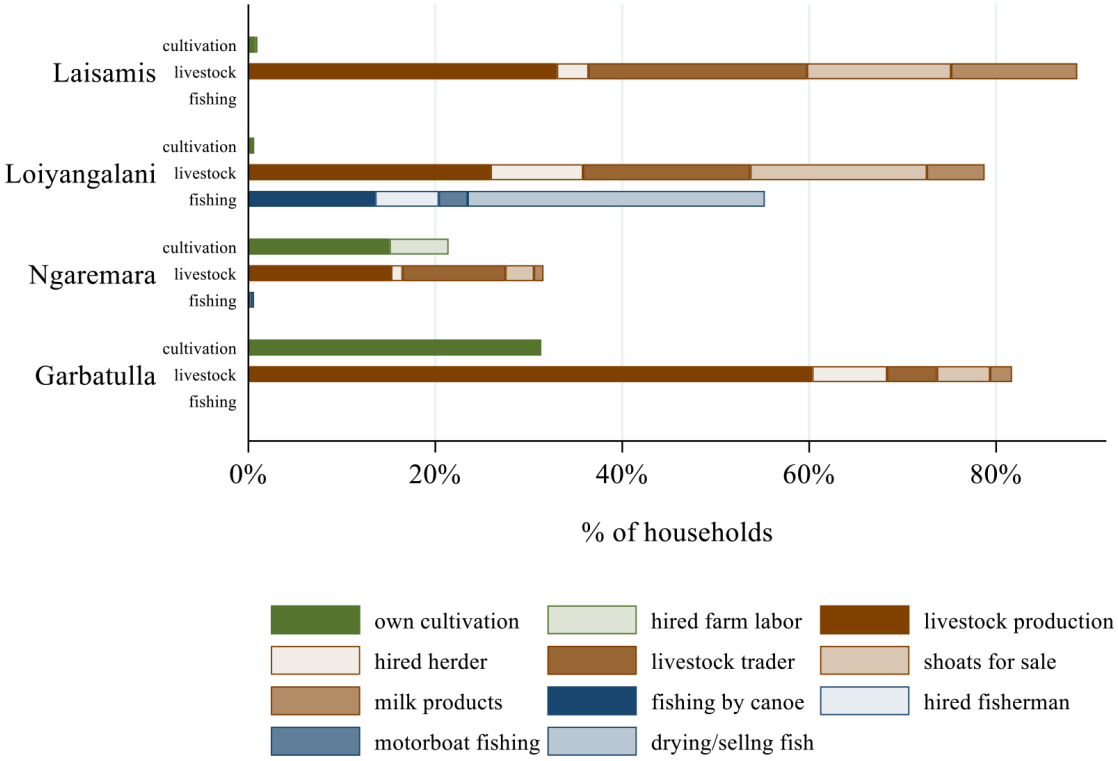
**In summary**, the systems and institutions for managing risks and ensuring resilience among pastoral groups in our sentinel sites have transformed significantly. Our findings indicate that livestock mobility remains the key risk management strategy. However, increasing drought frequency, combined with broader political and economic changes such as sedentarization, rangeland fragmentation, and the establishment of formal government institutions, has constrained the mobility of people and livestock, altering traditional mobility practices.

Additionally, institutions related to sharing livestock, food, and production responsibilities have experienced noticeable changes and, in some cases, complete erosion. These constraints highlight the need to support pastoralist systems and institutions in managing risks and ensuring resilience, while also promoting positive diversification. .

## 3.4 Livelihood systems, gender, and diversification

Environmental resources underpin primary production and livelihood specialization, with pastoralism predominating (Figure 8). Combining pastoralism with farming (Garbatulla) or fishing (Loiyangalani) broadens access to resources compared to pastoralism alone but depends on access to cultivable land and water resources (Lake Turkana or the Ewaso Nyero River) as well as relevant skills and experience. Aside from livestock activities, households engage in farming in Garbatulla and fishing in Loiyangalani. In Ngaremara, a fifth of households engage in cultivation or farm labor (Figure 8).

**Figure 8. Primary production activities practiced in the sentinel sites (multiple responses possible, annual survey September 2023)**




In the regression analysis, we found a protective element of livestock keeping with respect to casual labor in Laisamis. If a household reported that their main source of income is casual labor as opposed to livestock keeping, a child had two times higher odds of being wasted. However, this relationship was only found in Laisamis. In Ngaremara, on the other hand, where there are significant constraints to practicing livestock keeping, the opposite relationship was found, with children of households who practice livestock keeping having significantly greater odds of being wasted compared to households whose main source of livelihood was casual labor or their own business. In addition, fishing, as opposed to livestock keeping, was also associated with lower odds of a child being wasted in Loiyangalani, likely highlighting that that sentinel site is associated more with drop-out pastoralists than those being able to keep a large and healthy herd. Thus, as described above, having a proper enabling environment for pastoralism allows pastoral livelihoods to have a positive impact or relationship with child nutrition.

### 3.4.1 Pastoralism: a vital livelihood system

Herd composition, including goats, sheep, cattle, and camels, varies significantly by site. Influencing factors include environmental conditions, cultural preferences, pasture and water access, and threats like drought, disease, conflict, and insecurity. Camels are favored for their high economic value, drought resistance, and status, while sheep and goats are valued for their rapid economic returns, fast reproduction, and disease resistance. Cattle are prized for cultural reasons. Donkeys, an important means of transport, are common among livestock and farming households, but declining in Ngaremara, possibly as the use of *boda boda* (motorbikes) is increasing.

The annual survey results (September 2023) confirmed that most households owned livestock, except possibly in Ngaremara. In Laisamis, over 90% owned goats or sheep, and more than half owned cattle or camels (Table 3), highlighting livestock's overarching importance. Garbatulla also had high ownership of sheep and goats, indicating their economic importance. In Loiyangalani, ownership of sheep and goats was lower due to herders moving to the lakeside during different droughts to seek assistance and fishing opportunities. This is further evidenced in Table 4 below, with fisher-pastoralists owning by far the least amount of livestock out of any of the reported main livelihoods. While a high proportion of households own livestock, it is important to also consider the size and distribution of these herds to fully understand their community-wide importance.

**Table 3. Household ownership of livestock by species (2023 annual survey)**

| | *Percent of households who own this animal* | | | | |
|---|---|---|---|---|---|
| | **cattle** | **camel** | **sheep** | **goat** | **TLU[i] (median)** |
| Laisamis | 57% | 63% | 90% | 92% | 5.00 |
| Loiyangalani | 3% | 10% | 46% | 69% | 0.96 |
| Ngaremara | 8% | 0% | 49% | 57% | 0.70 |
| Garbatulla | 13% | 2% | 78% | 78% | 2.02 |

i. The Tropical Livestock Unit (TLU) was calculated using the following coefficients: sheep 0.1, goats 0.1, milking and non-milking cattle and camels 1 .

Table 3 shows the median household Tropical Livestock Units (TLU) for each site, ranging from 0.7 TLU in Ngaremara to 5.0 TLU in Laisamis. These values are insufficient for basic subsistence and reflect the heavy livestock losses from drought, disease, raiding, and the 2023 rains. Caution is also advised when interpreting TLU figures, considering the sensitivity of disclosing personal assets and the likelihood of underestimation if, for example, humanitarian or other support may be at risk.

Note that even better-off households employed by the government or in the private sector place significant value on livestock, as shown in Table 4. Their livestock ownership closely aligns with that of households whose primary sources of income or food relate to livestock activities.

**Table 4. Individual livestock ownership and Tropical Livestock Units (TLU) by livelihood (annual survey 2022 and 2023)**

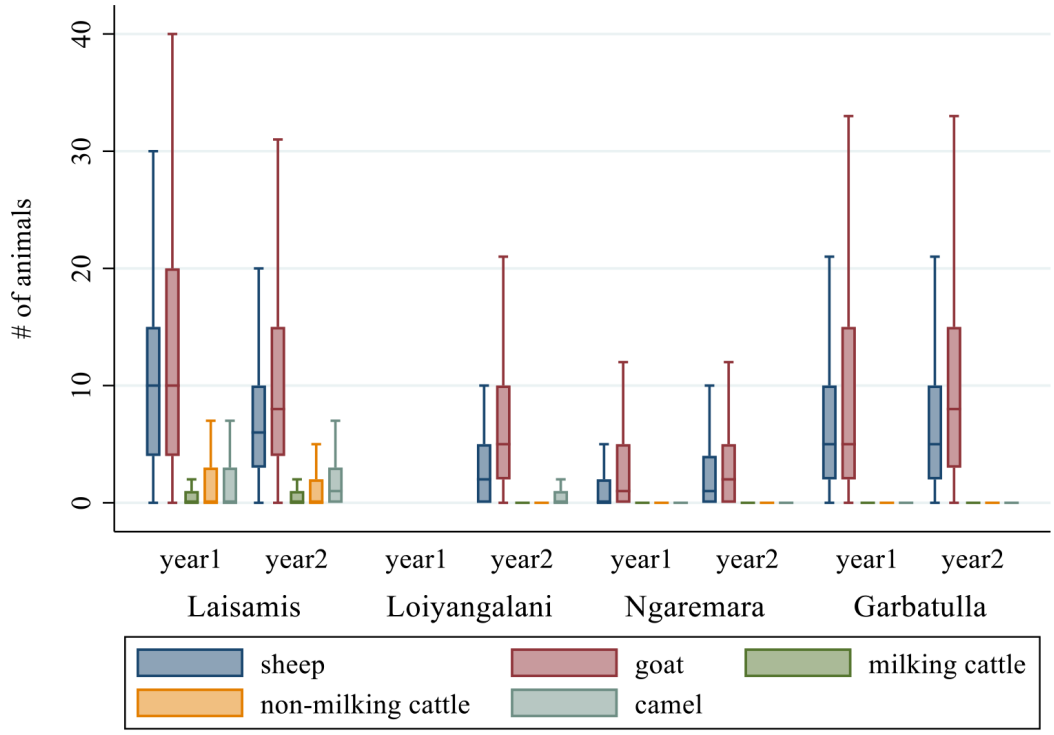
| livelihood activity | donkey | beehive | chicken | sheep | goat | milking cow | non-milking cow | camel | TLU |
|---|---|---|---|---|---|---|---|---|---|
| own cultivation | 0.86 | 0.00 | 1.61 | 5.25 | 7.50 | 1.25 | 0.25 | 1.21 | 4.01 |
| livestock | 1.14 | 0.02 | 0.83 | 10.19 | 12.39 | 0.67 | 1.26 | 2.29 | 6.49 |
| own fishing | 0.42 | 0.00 | 1.27 | 2.41 | 7.78 | 0.00 | 0.03 | 0.82 | 1.88 |
| casual labor | 0.24 | 0.03 | 1.59 | 3.34 | 4.47 | 0.14 | 0.18 | 0.12 | 1.24 |
| own business | 0.51 | 0.02 | 1.92 | 5.52 | 8.61 | 0.23 | 0.36 | 0.43 | 2.46 |
| government/ private | 0.39 | 0.04 | 1.39 | 8.13 | 9.83 | 1.17 | 1.00 | 2.06 | 6.03 |
| none | 0.75 | 0.00 | 1.49 | 8.69 | 10.50 | 0.44 | 0.95 | 1.03 | 4.34 |
| other | 0.20 | 0.15 | 1.58 | 3.29 | 5.66 | 0.10 | 0.51 | 0.07 | 1.59 |
| total | 0.62 | 0.03 | 1.41 | 6.54 | 8.52 | 0.37 | 0.67 | 0.95 | 3.51 |

*Note: Green highlights represent which livelihoods have above-average (from our sample) livestock ownership. Black outline shows the livelihood with the greatest ownership.*

Livestock are mostly distributed in small herds of less than 20 animals (Figure 9). A few households have larger herds, but these represent a relatively small proportion of the total livestock, suggesting there is low inequality in ownership in the study sites (or that the sample missed wealthy households). Although within some sentinel sites FGs reported differences in livestock ownership between smaller locations, for instance in Garbatulla sentinel site, about a quarter of households in Kombola own goats, whereas in Malkadakka almost all households do.

In Laisamis, sheep and goat holdings dropped in Year 2 compared to Year 1, while camel numbers slightly increased, likely due to drought losses of shoats and camels' drought resistance. In Garbatulla and Ngaremara, goat ownership increased between Year 1 and Year 2, possibly due to better rainfall and vegetation in Isiolo County compared to Marsabit County. Figure 8 does not capture livestock losses prior to the study. Groups in Moite (smaller location) explained that livestock holdings have significantly declined over the past 30 to 40 years, with losses mainly due to drought, disease, and raids by other tribes.

**Figure 9. Distribution of livestock by species by herd size**



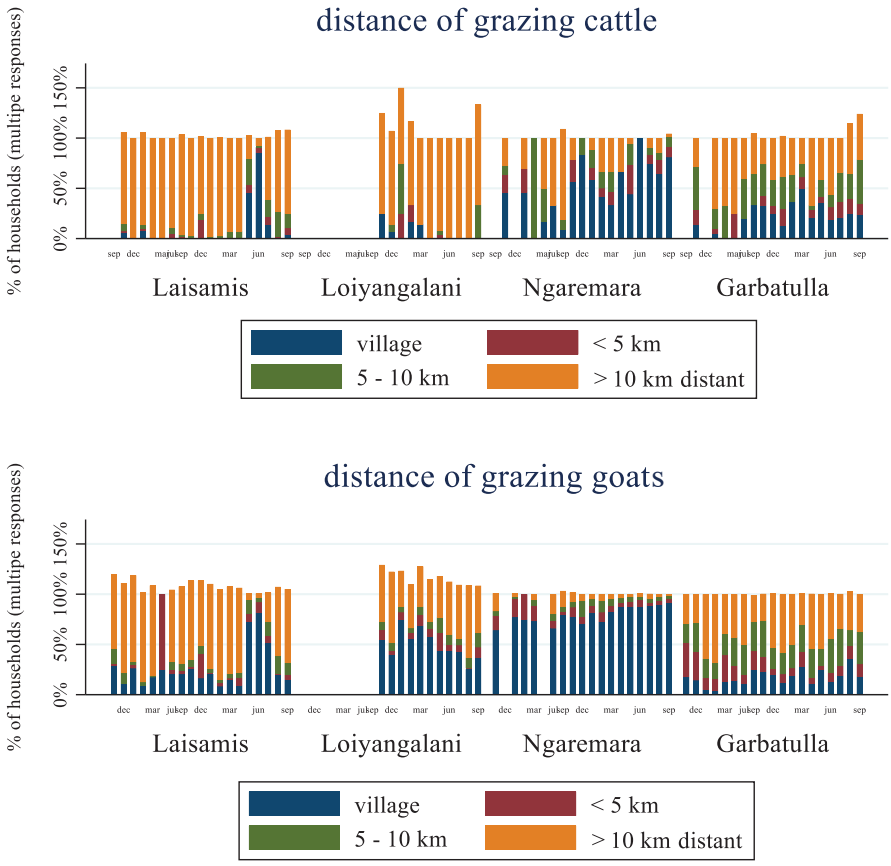

Note: excludes outside values defined as < = or > = 1.5 times the interquartile range

FGs confirmed differences in livestock ownership between the better-off and the poor, and among smaller locations. In the smaller locations of Loiyangalani sentinel site, many poorer groups and recent arrivals owned only 1 or 2 weakened goats, while the better-off, longer-term residents typically had 10 to 15 camels, over 100 shoats, and 2 donkeys, but no cattle due to losses from drought and raids. One respondent noted that drought and other shocks have had an equalizing effect, as everyone has experienced loss of livestock. However, extensive losses impact the poor more severely, as rebuilding herds is extremely difficult when starting with only one or two animals. These losses also undermine social support networks, as customary institutions rely heavily on livestock as a medium of sharing and exchange.

## 3.4.2 Mobility patterns, herd location, and conflict

The strategic mobility of livestock ensures year-round access to adequate water and pasture for livestock. Typically, in a year of adequate rains herds spend the dry season in more-distant grazing reserves, returning to the local village *fora* once they are sufficiently green with the start of the rains. This seasonal long-distance travel mobility of herds between dry season reserves and the village rainy season *fora* differs from the small circular movements within dry season movements and movements around permanent villages. In the dry season reserves, herds rotate between satellite *fora* within the same area, depending on pasture and water resources, dung accumulation, security concerns, or sporadic rainfall. Herds move around permanent villages during the rainy season when water and pasture around the settlements is abundant, which conserves pastures in the dry season reserves. This pattern is most evident with cattle in Laisamis (Figure 10), where they are reported to be present in the village only from May to August (depending on the year). This period coincides with the highest vegetation and pasture availability (see Section 3.2).

**Figure 10. Distance of cattle and goats from the village by month of data collection**

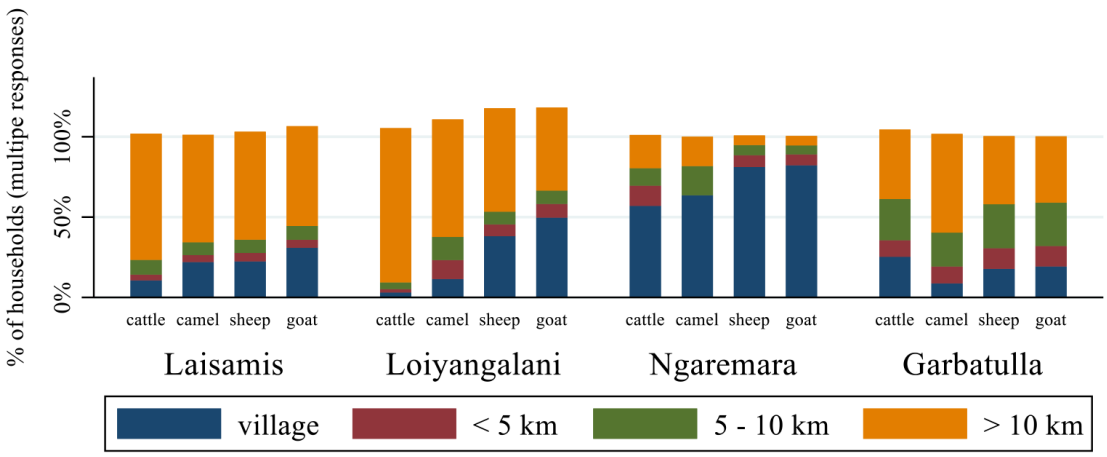



However, mobility patterns often change due to environmental conditions, physical barriers, insecurity, or social reasons. In 2021 and 2022, poor rainy seasons forced herds to travel increasing distances in search of adequate pasture, sometimes crossing county boundaries. This is again apparent in Figure 10 in Laisamis when comparing May/June at the start of the study (2022) when there were no reported cattle in the village, and goats were mostly reported to only stay nearby for a month, compared to the multiple months observed in Year 2 of the study (2023). This led to extended separations between livestock herds and their settled communities, lasting up to two years.

Some pastoralists do not have a permanent settlement and move with their animals year-round. Women informants in Moite (Loiyangalani sentinel site) described living year-round in the *fora* until livestock losses forced them to seek assistance. For permanent residents of Loiyangalani sentinel site, their herds return in the rainy season to nearby *fora*, and herders spend substantial periods in the settlements.

During the dry season in October 2023, Laisamis, followed by Loiyangalani, had the highest proportion of herds in distant *fora* that are more than 10 km from the settlement (Figure 11). In Garbatulla, herds are kept at varying distances, with about half in the dry season *fora* within 10 km of Malkadakka (Garbatula sentinel site), for example. This proximity makes them more accessible for wives and children to visit. Fewer households in Ngaremara sentinel site own animals, and most of these keep their shoats in the villages, unsupervised by day—"self-grazing"—and returning at night to the house, attracted by the prospect of household scraps.

**Figure 11. Distance of livestock herds (by species) from the village**




Insecurity plays a central role in determining the location and mobility patterns of herds. For example, Ngaremara is situated between Samburu and Boran territories, and Ngaremara herders face limited options for moving with livestock due to the presence of game reserves on two sides (Buffalo Springs and Shaba National Reserves), the Ewaso Nyiro River to the north, and Isiolo town to the south. As a result, insecurity in accessing rangeland for herders from Ngaremara is a recurring problem. Conflict also impacts non-livestock activities in Ngaremara, with both male and female focus group respondents reporting that children do not attend school and people do not engage in casual labor or trade in Isiolo town when there is tension or conflict with neighboring groups. Insecurity continued in Ngaremara during the research study period, with the populations of six villages displaced to more central locations due to conflict with the Samburu. These examples illustrate the ways in which conflict and insecurity affect a broad range of people's daily livelihood activities, with potentially important implications on health and nutrition outcomes.

Importantly, however, levels of insecurity and conflict are neither constant nor consistent and shift based on local conditions, movements, and alliances. These shifts have important implications for herd mobility and resource access. For instance, Boran/Sakuye herders from Garbatulla regularly access the Belgesh grazing area on the border of Isiolo and Garissa. At times, they experience conflict with Somali herders from Garissa. This conflict can drive human and livestock populations from the Belgesh *fora*, but at other times, the different groups share resources without confrontation. Some respondents in Kombola (a smaller location in Garbatulla) also reported conflict between herders and farmers, with associated negative impacts on livelihood activities for both groups. Respondents in Laisamis reported fewer experiences of conflict than in the other sentinel sites; when conflict did occur, it was most common in more-distant grazing areas, such as near Kom and Merti in Isiolo, as this is where the greatest mixing of different groups took place.

### 3.4.3 Managing availability of and access to milk

Multiple factors influence the availability of and access to fresh milk, including fecundity, timing of conception, birth interval, lactation duration, animal nutrition, and livestock mobility patterns. Herders manage these different factors to smooth the availability of milk and protect the health of the mother and offspring.

Different livestock species have varying reproductive cycles. Goats may have two cycles per year, camels have a gestation period of one year with 24-month calving intervals, and cows and sheep generally have one cycle per year. The 24-month calving interval for camels means they lactate for at least 12 months, whereas the lactation period for small ruminants is much shorter. Animal nutrition also affects lactation,

with milk yields peaking during the rainy season and declining as animals transition from a diet of green to dried grass. As one woman noted in Laisamis, "Today there is no milk, because there is no grass."

Herders time births to coincide with the rains to ensure adequate pasture for lactating mothers and weaned offspring. By spacing the different breeding cycles of mixed herds, herders can spread lactation and the availability of milk more evenly throughout the year, and thereby reduce the seasonality of milk availability. However, the shift in herd composition over the past two decades, away from camels and especially cattle, has resulted in an increased proportion of goats and sheep—making it more difficult to achieve year-round milk production and causing greater seasonality in the availability of fresh milk.

Seasonal access by women and children to fresh milk depends on the proximity of women and children to milking animals. These patterns have changed with increased sedentarization. In nondrought years, herds graze near settlements during the rainy season, and milk is both abundant and accessible. As the herds move away, sometimes before the end of the rains to preserve pasture, access to milk declines for humans living in settlements. In Ngaremara in May 2022, just after the fourth poor rainy season, a women's FG explained there was some fresh milk available, mostly cow's milk, because their animals are kept "here at home." By May 2023, in Ngaremara, women were getting milk from their livestock following the good rains in March/April. In contrast, in Laisamis in May 2023, women reported that "town goats don't produce milk," in contrast to goats in the *fora*.

By May 2023, most Laisamis herds had been in remote *fora* for over two years as a result of the prolonged drought. Herds from Garbatulla and Ngaremara were also in drought *fora* that were up to 60 km from the settlements. By September 2023, 95% of households with milking cattle had sent them to distant *fora* in hopes of accessing pasture and ensuring survival; this is a reversal of the usual practice of keeping milking animals near the village at this time of year. Women were feeding the few animals remaining near the villages with food scraps and wild foods or by sharing their daily meal. Importantly, these practices illustrate that even by September 2023— five months after the first good rains April, when the drought was technically over—pastoralism was still far from recovery.

Herders generally restrict breeding in extended droughts in order to protect the health of the mothers and offspring. The repeated failure of the rainy seasons during the three-year drought meant that herders could not adequately plan breeding cycles. Rains returned in March/April of 2023, but few births occurred as the previous breeding cycle had been missed and animals were very weak. Women were still reporting near-zero milk output in Laisamis and Loiyangalani in May 2023, and in Kalama *fora* women reported only a half cup to two cups per milking camel (compared to one liter per milking camel in a nondrought dry season). It took time for animals to recover their condition, with goat births postponed until November/December 2023 and the first camel calves not expected until June 2024

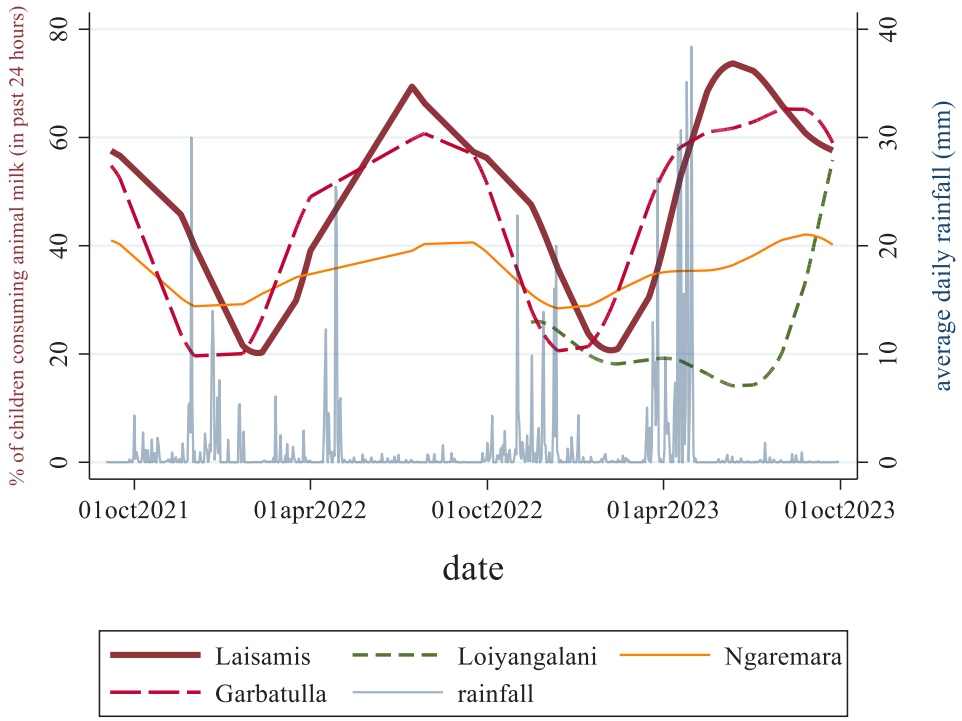
The results from the quantitative survey illustrate the highly seasonal nature of children's milk consumption (Figure 12). The July/August peak in milk consumption follows a sequence of rains, growth of pasture, and the return of lactating animals to the village (see Figure 9 above). As one woman reported in May 2022 in Laisamis, following a generally poor long rains season, the goats were producing milk about three to four weeks after the rains had started. By September, fewer animals are present in the community, leading to decreased milk consumption, which is lowest in February/March before animals start to return. However, based on the survey data, during the two-year study period milk consumption never dips below 20% of children reporting consuming milk in the past 24 hours, although this doesn't take the *quantity* of milk being consumed into account. An exception is Loiyangalani, where 15% of children report milk consumption in the past 24 hours. Overall, the proportion of children consuming milk is much higher in Laisamis and Garbatulla compared to Ngaremara and Loiyangalani.

While "consumption of milk" in the past 24 hours might not tell us much about quantity, we know that when these animals are present in the community, both the quantity and frequency of milk consumption increases. In Laisamis, we find that having camels in the village was associated with significantly lower odds (50%) that a child was wasted. Similarly, in Ngaremara, if a household reported that their cows were in the village, the child had an almost 90% lower odds of being wasted.

Qualitative interviews confirmed milk purchases are contributing to this consumption figure. In Laisamis

and Loiyangalani, if women have money (from selling a goat or sheep, or from selling firewood or casual labor), they buy small packets of UHT milk or powdered milk, while women in Kombola (Garbatulla sentinel site) reported buying fresh camel's milk. Both groups prioritize what little milk they have for their youngest children.

**Figure 12. Seasonal patterns of animal milk consumption by sentinel site**



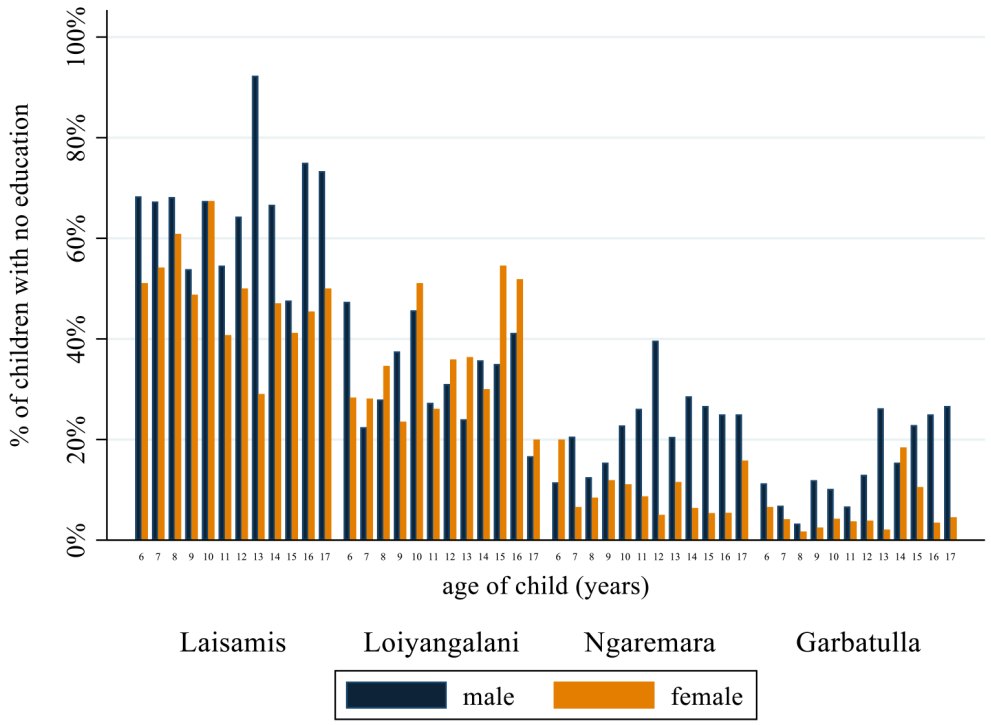

## 3.4.4 Relationships between *fora* and settlements

Close ties exist between villages and *fora*, as pastoralist families are often split between the two. This pattern is most prevalent in Laisamis and Loiyangalani but is also seen in Garbatulla and Ngaremara (3.9%, 2.5%, 1.8%, and 0.8% respectively of children measured in the *fora*[15] ). While men and male youth primarily go to the *fora* as herders, women either live there supporting and working with their husbands or make frequent short visits. Depending on the distance, women usually walk or go by donkey. Wives in the *fora* bring their youngest children (under 2 or 3 years), while older children stay in the village with grandmothers or co-wives. Women staying long term in the *fora* often bring all their children with them, especially in Loiyangalani and Laisamis. Quantitative data show children aged 4 and above are over half as likely to be in the *fora*. This relationship is only significant in Laisamis and Garbatulla.

School-aged children help with herding during holidays, but not all children attend school, as parents may choose some to become herders. The Laisamis sentinel site has the highest proportion of children with no education, and the largest proportion of pastoralist households (Figure 13). Additionally, boys are significantly less likely than girls to have any education in all sites except Loiyangalani, possibly due to their greater involvement in herding. Grandmothers and girlfriends occasionally visit, but women from households without livestock do not. Thus, in all sites, the social structure of community and family life spans both multiple *fora* and village, with childcare involving multiple caregivers in different locations.

15 These percentages are not representative as enumerators were only able to follow up on children in the *fora* if they were able to reach it during the day of data collection. Thus, children in farther *fora* would be counted as missing and not included in the data.

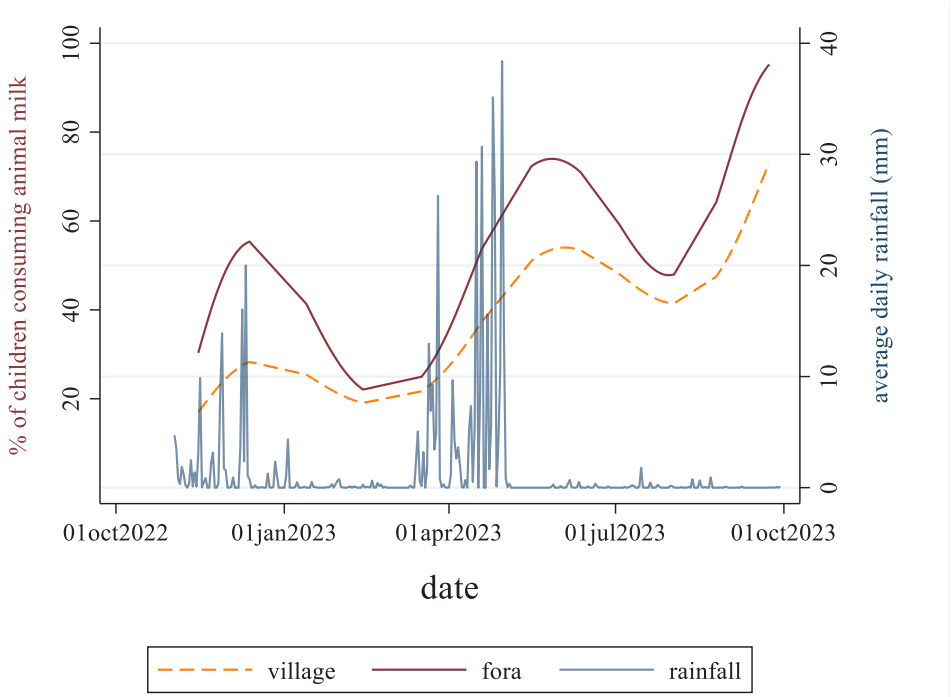
**Figure 13. Proportion of children with no schooling by age, sex, and sentinel site (annual survey, September 2023)**




In previous generations, many more families stayed in the *fora* year-round. This is now less common, especially in Garbatulla, partly due to a preference for children to attend school (Figure 13). The increased investment in education in Garbatulla is evident from the lower proportion of younger children without education compared to older children (ages 3–5 years).Education and health services and nongovernmental organization (NGO) programs also affect these movements of women and children. In Loiyangalani, many women returned to villages from the *fora* when Nawiri started, hoping to be registered for assistance. Similarly, in Laisamis, at least one woman walked for 3–4 days to have her children measured for this study. Others leave their documents with neighbors when going to the *fora* to avoid missing relief registration.

Many women prefer life in the *fora* during years with good rains because of the better environment. A new *fora* is often pristine, ungrazed, and unspoiled by livestock waste. Preferences vary depending on *fora* conditions, for example, water and pasture conditions, local relationships, and security. However, there are risks in the *fora* environment. Households in the *fora* are over four times more likely to use surface water for consumption than in the village (33.2% versus 7.4%). We found no relationship between surface water consumption and worse nutrition outcomes (see Section 5.3).

**Figure 14. Consumption of animal milk seasonality for children in the *fora* versus children in the settlement**




The major benefit of being in the *fora* is access to milk even in the dry season if camels are present. Children in the *fora* consistently consume significantly more animal milk (Figure 14). This greater milk access, along with other environmental differences noted by respondents, may explain why regression analysis shows the *fora* is protective, though only in Laisamis (see Annex C1 and Section 6.3.2). In the Laisamis sentinel site, the wasting prevalence for children in the *fora* is almost half that of children in the village (13% vs. 20%).

However, during prolonged droughts, there is more frequent moving of herds and people to new encampments, and only very small amounts of camel's milk are available. Each move involves decamping, traveling, and setting up new enclosures for the livestock. Food must be brought from the village or purchased nearby, with the diet mainly consisting of maize porridge. Threats of wild animal attacks at night, bandits, and conflict with other groups are constant.

These dynamics may explain some of the differences in child age and nutritional status. Children ages 6–24 months show lower rates of wasting than those ages 24–59 months. Women in the *fora* are likely to have their youngest children with them, benefiting from breastfeeding, better access to animal milk, and less exposure to pathogens. Older children are more likely to remain in settlements with other caregivers. We return to the discussion of differences by age in Section 4.3.

### 3.4.5 Livelihood diversification by site and gender

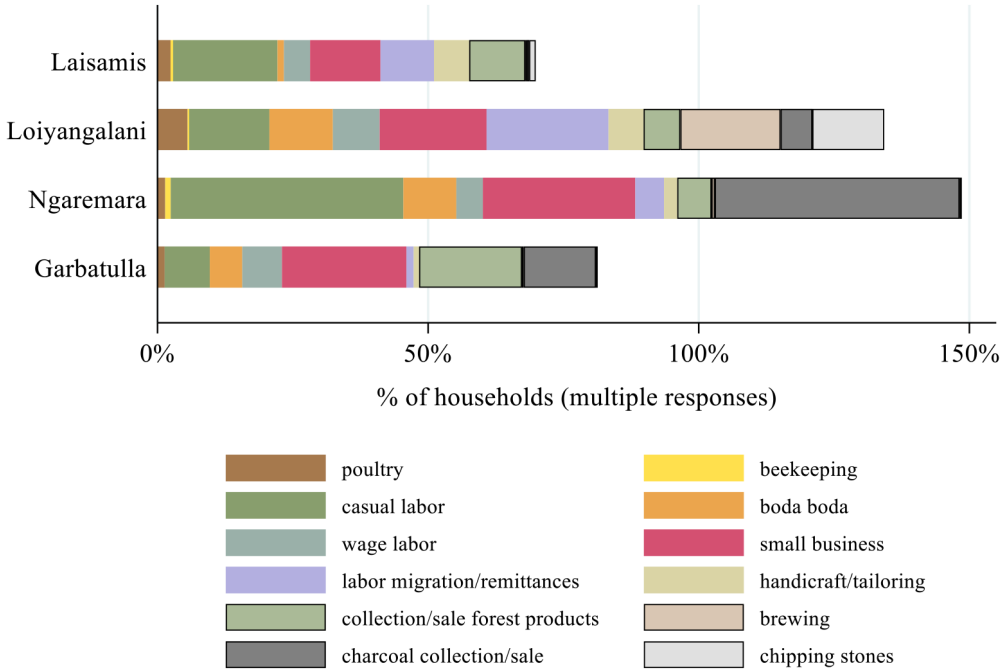
Livestock and pastoralism remain the bedrock of most livelihoods even as the system of pastoral production is evolving. One significant change is the increasing diversification of economic activities and income streams. This diversification varies within households, leading to shifts in economic responsibilities based on age and gender. For some households and communities, diversification can enhance economic returns and buffer seasonal fluctuations and potential downturns in pastoralist productivity. However, for the very poor and those in marginal pastoral production, diversification usually serves as a coping mechanism or crisis strategy to meet immediate needs.

Distinguishing between survival coping strategies and strategic and adaptive livelihood diversification

is crucial. While the former often involves personal risks, long working hours, and yields meager economic returns, the latter offers more consistent and lucrative outcomes. Pursuing livelihood diversification requires capitalizing on opportunities, which differ based on wealth, gender, and location.

Local opportunities, skills, resources, and markets shape the extent and nature of diversification, leading to clear differences by location. Figure 15 illustrates the extent of diversification into livelihood activities beyond livestock, farming, and fishing. Many successful activities are linked to pastoralism. For example, *boda boda* motorbikes play an important role in facilitating village-*fora* linkages, providing multipurpose transport services of money, goods, people, and information as well as operation over longer distances to *fora* in remote locations with poor road networks. By extension, *boda boda* support pastoralism.

**Figure 15. Livelihood diversification activities in the sentinel sites (multiple responses possible, annual survey, September 2023)**




Note: Black outline indicates maladaptive or nonsustainable strategies.

In Garbatulla sentinel site, farming is more common in the smaller location of Kombola than in Malkadakka, involving both men and women. However, there are several constraints to agricultural activity in Malkadakka, including limited irrigation, land, and resources, crop damage by elephants, inadequate extension services, limited market access, and conflict with local herders. Aside from farming, around 50% of households engage in small business activities, including *boda boda* motorbike transport services, kiosks, petty trade, food/tea stalls, and tailoring. For poorer households, charcoal making and casual labor are vital for both women and men, although men are more likely to profit from selling charcoal in bulk while women sell outside their homes. Women collect and sell firewood collection and undertake domestic labor, while men work as hired farm laborers. Despite challenges such as market access and transport constraints, the range of small business income-earning activities reflects an adaptability, albeit with gender disparities in labor and income distribution.

In Loiyangalani, a shift towards diversified livelihoods stems from drought and conflict-affected pastoralists coming to the lakeside settlements in search of relief and alternative sources of food and income. Fishing

as a livelihood can expand or contract as needed. In 2022 and 2023, there were numerous Turkana men fishing from hand-built canoes or working as hired fishermen on motorized fishing boats. Women's work in the fishing sector includes mending nets, drying fish, and local resale. One pastoralist woman had a business renting out fishing nets. As fishing can be quite lucrative, it attracts young men not able to swim, and there are risks posed by unstable canoes, illegal fishing in restricted areas, and the threat of crocodiles and poisonous snakes. Despite the potential returns from fishing, most young Turkana fishermen expressed a commitment to pastoralism and wish to rebuild their herds.

A range of coping mechanisms are mainly undertaken by women, involving high risks and low returns. Survey findings indicate about one-fifth of women respondents engaged in either brewing, chipping stones, or collecting and selling forest products. Brewing is legally prohibited, which might lead to underreporting in the survey. Breaking and chipping stones by hand for construction is labor-intensive, and injuries are common. Women make day-long trips to collect firewood in distant locations, where there is a risk of harassment and gender-based violence. Charcoal burning is less common than firewood collection as there is a group that specifically does this. While insecurity curtails collection of bush resources temporarily, these activities quickly resume given the lack of alternatives. There is some domestic work in the hotels and houses in Loiyangalani town. These examples illustrate the risks women undertake to support their families and the precarity of their livelihoods.

In Laisamis, livelihood diversification is low compared to other sites, with fewer households engaged in a more limited range of activities. The most common diversification strategies, aside from livestock-related activities, are *boda boda* motorbike transport services, casual labor (such as domestic work and water carrying), and small businesses (such as petty trade, kiosks, food/tea stalls, or other ventures). However, several activities are practiced by fewer than 1% of households, including farming, brewing, charcoal, stone chipping, beekeeping, construction, tailoring, tea or food stalls, and selling wild food. The viability of farming activities is hindered by lack of farming skills and experience, lack of cultivable land, and low, unpredictable rainfall. Poorer households undertake sand harvesting, fence construction, and firewood collection in the dry season, and are compensated either monetarily or in kind, reflecting a long-standing tradition of social support through work. The number of households engaging in these marginal activities expands when drought is prolonged. Charcoal burning is uncommon in Laisamis, as this is practiced primarily by "blacksmiths." There are instances of women running successful small businesses, such as goat trading, retailing household goods, and cereal trade.

In Ngaremara, livelihood strategies differ from other sites, as the main activities are not livestock related. Poorer households engage in a mix of subsistence and marginal, low-paid, and risky endeavors. Farming is subsistence-based, with occasional agricultural work on nearby irrigated farms. The availability of casual labor, undertaken by 55% of households, varies seasonally. Charcoal production and selling is also common; it is practiced by 48% of households. While crucial for immediate cash needs and a stepping stone for rebuilding herds, charcoal making has a severe environmental impact and involves long absences from home for women. The third-most common form of diversification is small business (38%). Petty trade and small businesses, mainly run by women, involve selling vegetable produce and other food items, often bought from wholesalers and sold locally for small profits. Women sometimes start their businesses using loans from savings groups. Mpesa agents are a growing sector due in part to cash transfers by aid organizations. Transport services, especially *boda boda* (motorbike taxis), have expanded, providing transport for goods and people, and sometimes facilitating activities like charcoal transport. *Boda boda* businesses are mainly operated by young men, who either rent or buy motorbikes on credit. Better-off households often hold salaried jobs such as soldiers, teachers, or government staff. Middle wealth groups may own some livestock and supplement their income with small businesses such as the sale of second-hand clothes, charcoal, or livestock drugs.

**In summary**, the lasting prevention of child acute malnutrition requires understanding and then addressing its basic drivers. In this section, we explored the history, origins, climate, environmental resources, and seasonality of these diverse communities. The region's three-year drought has caused livestock losses and severe food insecurity. Nevertheless, formal and customary governance

institutions have mitigated some of the worst effects by regulating access to permanent water resources and drought reserves. These efforts, along with herder skills and cooperative relationships between producers, underpin the resilience of the pastoralist system at such times. Pastoralist social support has also played an important role, aiding in the redistribution of food and resources, including relief.

Despite challenges, pastoralism remains the predominant livelihood system. Most households own livestock, even after losses to drought, disease, and raids. Seasonal livestock mobility ensures year-round access to water and pasture, but the extended drought has forced herds to travel farther, causing prolonged separations from their villages. Families are often split between the rangeland *fora* and permanent settlements. Besides male herders, some women and younger children stay in the *fora*, while school-age children remain in settlements. Milk access varies seasonally and is influenced by proximity to milking animals and herder management of reproduction, livestock mobility, and animal nutrition.

Pastoralism is increasingly supplemented with diverse economic activities, such as farming in Garbatulla and fishing in Loiyangalani sites. Diversification opportunities vary by site and gender. While diversification can enhance economic stability for some, for poorer households diversification is often a crisis strategy with low returns and high risks, primarily involving women. Households continue to adapt, balancing pastoralism with diversified livelihood activities to support food security and improve resilience. The implications of these findings for addressing child malnutrition are discussed in Section 6.3. In the next section we learn about the trends in child and maternal malnutrition over the two study years, and the immediate and underlying drivers related to this.

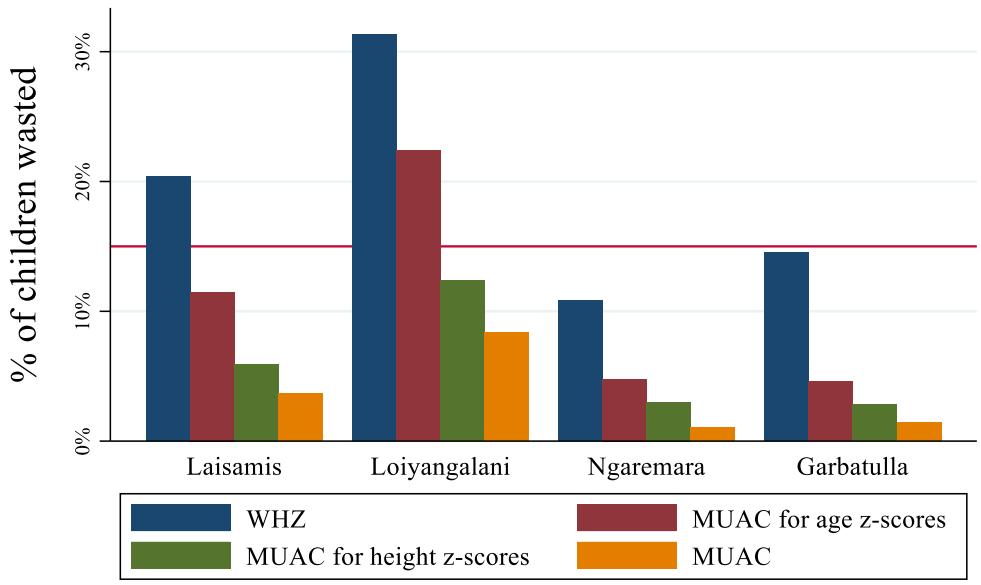
# 4. Results: Nutritional Outcomes by Seasonality, Sex, and Age

In this section, we explore the main outcome indicator as identified in the Adapted Malnutrition Causal Framework: nutritional status (see Figure 1 of the child and female caretaker. We primarily focus on child wasting, describing how it varies by site, across the two years of the research, the seasonal pattern, as well as variation by age and sex.

## 4.1 What is the prevalence of wasting by site?

Putting the sites in order, Loiyangalani has the highest prevalence of child wasting, followed by Laisamis, Garbatulla, and Ngaremara. Ngaremara ranks the lowest across all different measures of wasting: WHZ, MUAC for age z-scores, MUAC for height z-scores, and the MUAC cut-off of 125 mm. Overall, without adjustments for any covariates, there is a significant difference in wasting across all sites when using WHZ. If using MUAC, overall or adjusted for height or age, the difference between Ngaremara and Garbatulla is no longer significant (Figure 16).

**Figure 16. Different measures of wasting by sentinel site**

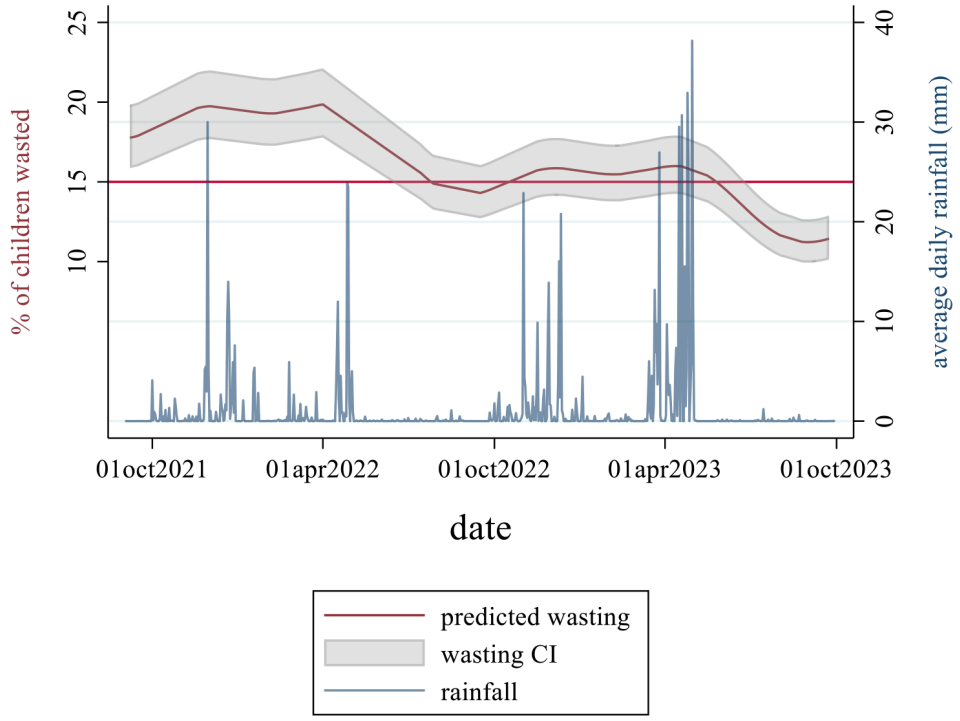



All the different measures of child wasting are significantly correlated in the same direction (Table C2 in Annex C). WHZ is most strongly correlated with MUAC for height and, only to a slightly lower degree, MUAC for age, but the relationship with unadjusted MUAC is fairly small. The significant but weaker relationship between MUAC unadjusted for age or height with WHZ is likely because, without the adjustment, MUAC tends to select for younger children, whereas in our sample (as described below) older children (ages 3–5 years) are more likely to be wasted. Given some of the important distinctions by sex and age and greater sensitivity to seasonality, we will be using WHZ for the remainder of the report.

## 4.2 What is the prevalence of wasting over time and by season?

Using the harmonic regression model and controlling for sex and age (in months), wasting significantly decreased over the two years of the study in Laisamis and Ngaremara; there was no reduction over time in Garbatulla. Loiyangalani is not included in this analysis as we only have one year of data. However, in the adjusted regression (Annex C: Table C1), the improvement across the two years is only significant in Laisamis. In the three sites for which we have two years of data, the average wasting prevalence in Year 1 was 17.9% (95% Confidence Interval: 16.6–19.3) and in Year 2 was 14.3% (CI: 13.6–14.9).

**Figure 17. The prevalence of predicted wasting over time and by season combined for Laisamis, Garbatulla, and Ngaremara**

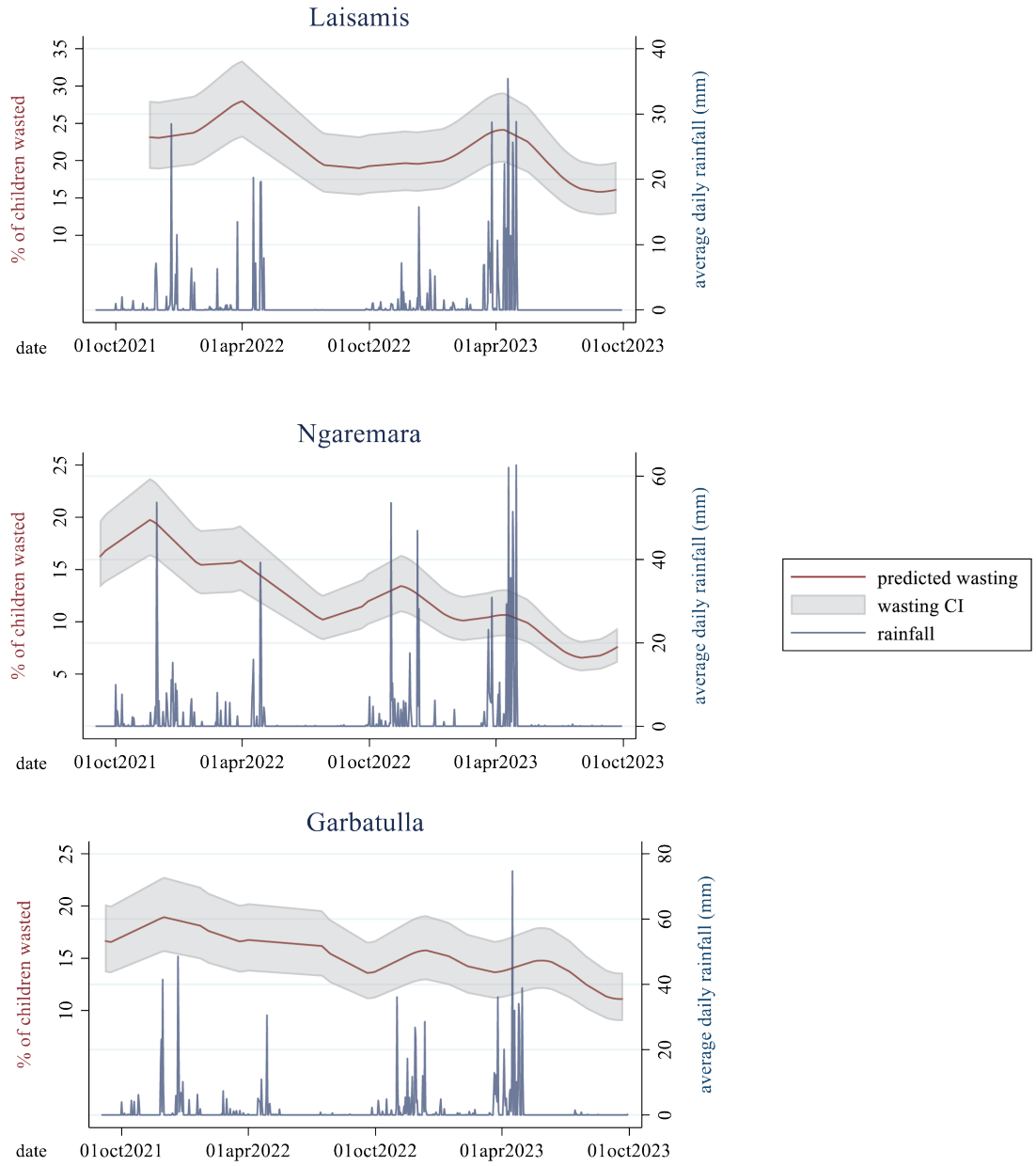



All four sites exhibited significant seasonality. Using the seasonal analysis (Figure 17) for the three sites for which we collected data across the two years, the reduction in wasting over time is clear. Wasting peaks during each of the two rainy seasons (November/December and April/May), with the lowest wasting prevalence in the middle of the long dry season (August/September). Raw prevalence data by month is in Annex C: Figure C2.

We also wanted to compare seasonal versus annual variability in wasting. The predicted wasting prevalence from December 2021 (20%) to December 2022 (16%) is a four-percentage point difference (the same is true comparing April 2021 and April 2022); however, if we compare December 2021 versus August 2022 (14%) (the highest and lowest point from Year 1) the difference is six percentage points, though that does drop to just four percentage points when comparing the two time periods in 2022. In other words, seasonal variability is greater or equal to annual variability in our sample.

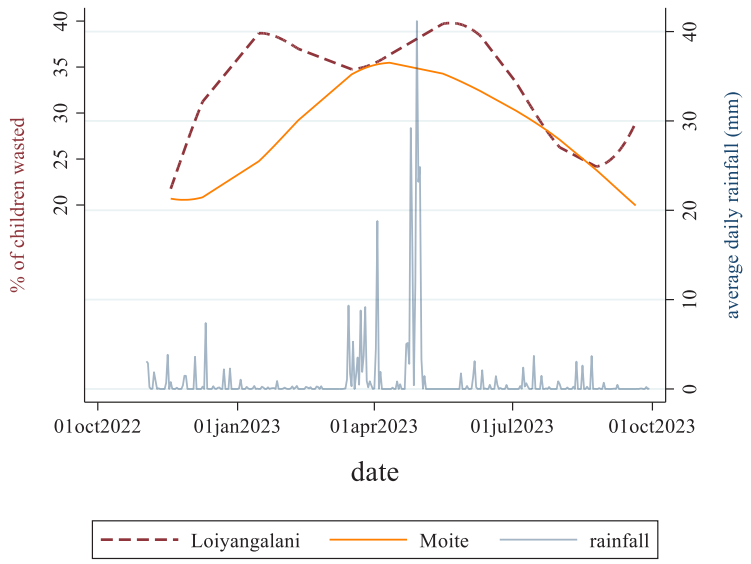
We also looked at how the seasonal pattern of wasting (using WHZ) might vary by sentinel site using the harmonic mixed effects regression. In the three sites with two years of data, we observe a similar seasonal pattern, with some differences in the timing of the main peak of wasting (Figure 18). For the sample as a whole, we see even-sized and significant peaks in November/December and April/May. However, the sentinel site-disaggregated data show that the timing of these peaks varies. In Laisamis, there is only one significant peak of wasting in April/May, corresponding to the local rainfall pattern, which shows a much larger April/May peak compared to November/December. Two significant peaks are also observed in Ngaremara, but the November/December peak is consistently greater than the April/May one. In Garbatulla, we observe the least amount of seasonal variability in wasting, with only one significant peak occurring in November.

**Figure 18. Seasonal patterns of predicted child wasting in Laisamis, Ngaremara, and Garbatulla sentinel sites**




The qualitative data show that the smaller location of Moite, and the smaller locations within Loiyangalani sub-location that together make up Loiyangalani sentinel site, are two very different populations (with respect to the peri-urban nature, access to resources, history of displacement, etc.). Thus, we also ran the seasonality analysis separately for the sub-locations of Moite and Loiyangalani. The seasonal pattern in the smaller locations of Loiyangalani sub-location actually looks different from all the other three sentinel sites and from the smaller location of Moite in the Loiyangalani sentinel site (Figure 19). In Loiyangalani (sub-location), there are two almost even-sized peaks in acute malnutrition in February and June (a few months after the peaks in the other three sites and Moite). These peaks correspond with the temperature peaks, with the lowest prevalence of acute malnutrition occurring in September (one month after the lowest point for the other two sites and the Moite sub-location).

**Figure 19. Seasonality of predicted wasting in Loiyangalani and Moite sub-locations within the Loiyangalani sentinel site**




*Note: CIs were very large for the graph given a higher standard error of the constant and so were removed from the visualization for easier interpretation.*

The regression results between the climatic indicators and wasting for each sentinel site further supports the seasonal patterns observed in the harmonic regression. Overall, the higher the rainfall, the greater the odds that a child is wasted ($p = 0.002$); however, this relationship was only significant in Ngaremara ($p = 0.001$) and approached significance in Laisamis ($p = 0.066$). When we run the analysis on temperature, it is only significant in Loiyangalani ($p < 0.001$) and corresponds to the completely opposite seasonal wasting pattern in that site (and specifically Loiyangalani sub-location). The relationship with vegetation is the most pronounced, with higher vegetation significantly increasing the odds that a child is wasted ($p < 0.001$). The relationship with vegetation was significant in Laisamis ($p < 0.001$) and Loiyangalani ($p < 0.001$), approached significance in Ngaremara ($p = 0.09$), and was insignificant in Garbatulla. As described in Figure 4, Section 3.2, vegetation tends to lag behind rainfall by a few weeks, which is likely why we are seeing this relationship in the data. The lack of a relationship in Garbatulla between wasting and any of the climate variables further supports the assertion above that Garbatulla exhibits the least amount of seasonal variability (during this study) in nutrition outcomes

## 4.3 What is the prevalence of wasting by age and sex?

In contrast to the general literature on wasting, older children (ages 3–5 years) in our sample, across all four sites (Table 5), are significantly more likely to be wasted. In the regression analysis, this association is highly robust and significant in all sites in both the crude and adjusted model. For every additional month in age, the (adjusted) odds that a child is wasted increases by 6% overall. The exact relationship with age in each sentinel site ranges between a 4% increase for every additional month in Loiyangalani to a 10% increase for every additional month in Garbatulla.

These findings on the association between child wasting and age are contrary to the expected age distribution, with the highest risk occurring between 6 months and 2 years of age. This typical pattern, combined with evidence that the majority of deaths among children under 5 years occur before 2 years of age, accounts for the focus of child health and nutrition interventions on the first 1,000 days from conception until 2 years of age. Given the difference between our findings and the literature, we wanted to confirm that this relationship was not a function of different body shape and growth patterns in the

northern Kenya population as compared to the populations used to construct the WHZ reference data. To do this, we used the Cormic Index, which is the ratio of sitting height to standing height as a comparable measure of body shape.[16] The higher the ratio, the longer the torso (with respect to the legs) and the smaller the ratio, the longer the legs (with respect to the torso). For our sample, even when adjusting age-specific wasting prevalence by the Cormic Index from other populations (agrarian Amhara population, white and Black children in the US), the higher vulnerability of older children to wasting remains. Put another way, the wasting seen in ages 3–5 years among the sample is not due to specific body shapes or growth patterns.

**Table 5. Wasting prevalence (using weight-for-height z-score (WHZ)) by site and age group**

| Age category | Laisamis | Loiyangalani | Ngaremara | Garbatulla | Total |
|---|---|---|---|---|---|
| 6–11 months | 10% | 24% | 6% | 5% | 11% |
| 12–23 months | 17% | 30% | 8% | 8% | 15% |
| 24–35 months | 17% | 31% | 7% | 11% | 16% |
| 36–47 months | 25% | 32% | 12% | 18% | 21% |
| 48–59 months | 28% | 35% | 18% | 24% | 26% |
| **Total** | **20%** | **31%** | **11%** | **15%** | **19%** |

The qualitative data point to multiple possible explanations for the differences in wasting by age; some of these have been mentioned earlier, such as the greater likelihood that a younger child accompanies his or her mother to the *fora* (and thus has access to breastmilk and animal milk) while the slightly older children are more likely to remain with secondary caregivers in the village. In addition, the youngest children receive prioritization for milk within a household, which means that in times of shortage (such as a drought), slightly older children may receive no milk at all. For those who can afford it, purchased milk follows the same distribution pattern by age as animal milk. The increase in women's livelihood activities and workload contributes to more time away from the home and hence more time for the child with secondary caregivers. In Ngaremara, women cited care by the grandmother as one of the main factors associated with child acute malnutrition. Often a mother has insufficient food to leave with the caregiver, and thus the children spend the day without eating. The youngest children, who can—at times—be carried by the mother while she pursues these activities and receive breastmilk are likely to have lower rates of wasting as a result.

We also find distinctions by sex, with boys generally more vulnerable than girls (Table 6). However, this relationship only holds in three of our four sentinel sites, with sex not having a significant association with wasting in Ngaremara. In the adjusted regression analysis, being female decreases the odds that a child is wasted by 35% on average across the sites. However, when just looking at Garbatulla, Loiyangalani, and Laisamis, being female reduced the odds by 50–60%.

16 P. Salama et al., "Malnutrition, Measles, Mortality, and the Humanitarian Response during a Famine in Ethiopia," JAMA 286 (2001): 563571.

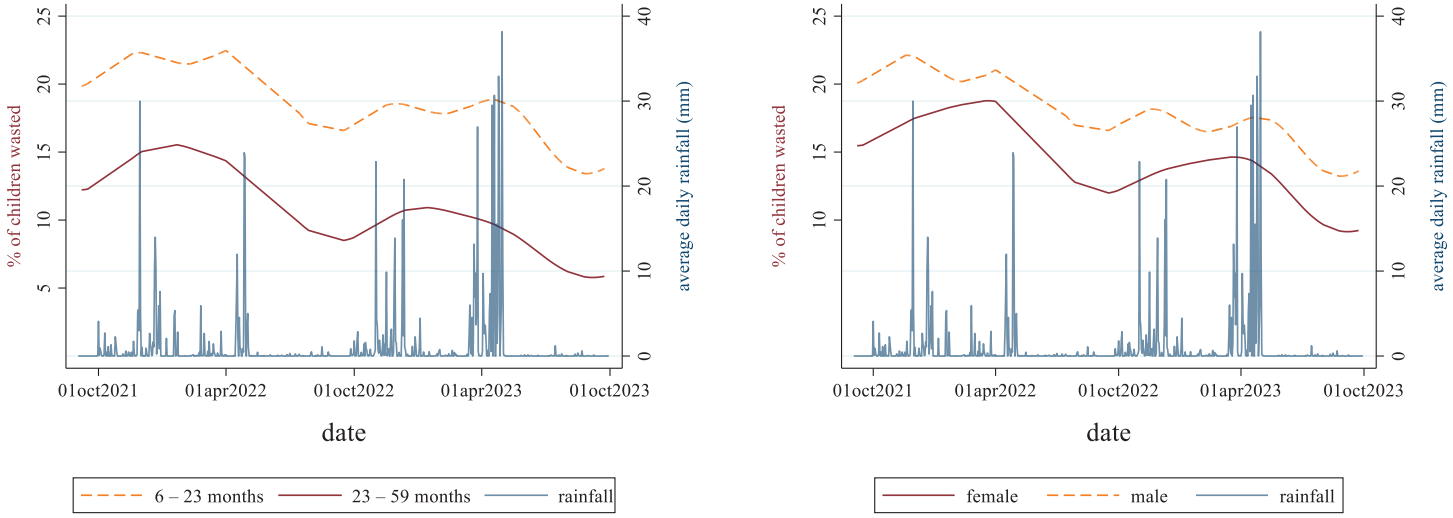
**Table 6. Wasting by sentinel site and sex**

| Sex | Laisamis | Loiyangalani | Ngaremara | Garbatulla | Total |
|---|---|---|---|---|---|
| male | 24% | 34% | 11% | 16% | 21% |
| female | 17% | 28% | 10% | 13% | 16% |
| **Total** | **20%** | **31%** | **11%** | **15%** | **19%** |

The significantly higher prevalence of wasting in children over 24 months (compared to those 6–23 months) and in boys (compared to girls) persists across the two years of study and different seasons (Figure 20). Additionally, there is greater variability (more peaks and valleys for older children and boys than for younger children and girls) in the seasonal pattern of wasting for older children and boys.

Increased variability (fluctuations) in nutritional status means that these children are either less resilient to the different shocks or exposures, resulting in immediate weight loss or gain, or that they experience more shocks and have greater exposure to different drivers of wasting. Either way, in this instance, greater variability and higher prevalence go hand in hand.

**Figure 20. Seasonality of predicted child wasting by sex (male vs. female) and age category (< 24 months vs. 24–59 months)**




## 4.4 What is the prevalence of stunting and underweight?

The data indicate that across the two years there was an increase in stunting (HAZ < −2 standard deviations). The increase across time is significant for the sample as a whole, but, when broken up by sentinel site, this holds true only for Laisamis (Table 7). There was no significant change over the two years in the odds that a child is underweight. Garbatulla and Ngaremara are fairly comparable in their stunting and underweight prevalence. Loiyangalani has by far the highest stunting and underweight prevalence in the sample.

**Table 7. Stunting and underweight by sentinel site and year**

| | Year 1 | | Year 2 | | Total | |
|---|---|---|---|---|---|---|
| | stunting | under-weight | stunting | under-weight | stunting | under-weight |
| Laisamis | 23% | 34% | 32% | 36% | 30% | 36% |
| Loiyangalani | - | - | 35% | 48% | 35% | 48% |
| Ngaremara | 14% | 17% | 16% | 16% | 15% | 17% |
| Garbatulla | 14% | 17% | 14% | 17% | 14% | 17% |
| **Total** | **17%** | **22%** | **24%** | **30%** | **23%** | **28%** |

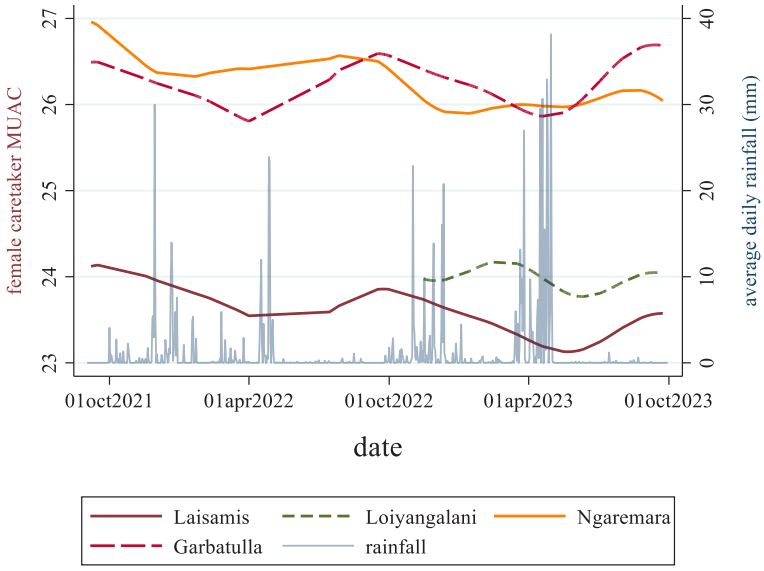
As with wasting, boys are significantly more likely than girls to be stunted and underweight. For the sample as a whole and in each sentinel site independently, younger children are significantly more likely to be stunted, particularly children 1–3 years of age (approximately 30% stunted in round 12), which corresponds to being born during the drought. The higher risk of younger children becoming stunted might partially explain the lower rate of wasting among younger children. In our sample, almost half (43%) of children under 2 who are wasted are also stunted; for children over 2 that relationship is weaker, with only 27% stunted, and more similar to the proportion of stunted children who are not wasted (20%). Meaning that almost half of children under 2 who are wasted are also stunted, thus likely increasing their weight-to-height ratio. When comparing round 2 data and round 12 data for the three sentinel sites, it is for this age group that an increase in stunting prevalence is observed. In all sites, except Ngaremara, older children are significantly more likely to be underweight.

## 4.5 What is the seasonality of female caretaker status?

Along with age, the MUAC of the female caretaker (the person who took the child to be weighed) was consistently and significantly associated with child wasting across the study as a whole and in each sentinel site. The higher the female caretaker's MUAC, the lower the odds that a child was wasted.

Female caretaker MUAC was highest (i.e., best nutrition) in Ngaremara and Garbatulla, with the lowest MUAC in Loiyangalani followed by Laisamis (Figure 21). Thus, MUAC follows a somewhat similar pattern as child wasting, with worse outcomes in the two Marsabit sites and better outcomes in the two Isiolo sites. A significant seasonal pattern was observed in all sites, but just like with wasting, the pattern was different across sites. Female caretaker MUAC behaved in a similar seasonal pattern in Laisamis and Garbatulla, with the lowest MUAC observed during the height of the April/May rainy season, which corresponds to the seasonal peak of wasting in Laisamis (though not in Garbatulla). Loiyangalani has a similar dip in May/June (slightly later than the other two sites) and corresponds to the peak of wasting in that site. However, female caretaker MUAC was at its highest around September/October in the four sites, which is right before the second peak in child wasting and therefore is slightly contradictory. On the other hand, in Ngaremara, we do see that the lowest female caretaker MUAC is found in November/December, corresponding to the significant wasting peak there. Thus, there is some alignment on the primary peak between child wasting and female caretaker MUAC for each site (corresponding to the regression analysis), but not on the secondary peak.

**Figure 21. Predicted female caretaker MUAC over time by sentinel site**




**In summary**, the data highlight the persistence of GAM in this context. The prevalence of GAM was above the emergency threshold for the first year, on average, across all the sites. And despite an improvement in rainfall and vegetation in Year 2 of the study corresponding with an above-average year (see Section 3.2), the prevalence of GAM continued to remain above the emergency threshold for six months out of the year. Once adjusting for all covariates, a significant improvement in wasting was only observed in Laisamis, which had the highest prevalence to start with. Thus, not only does the region experience persistent GAM, but recovery (in terms of reduced wasting) does not appear to be immediate and thus is not fully observed in the two-year study, despite the obvious improvement in climatic conditions. We also find that stunting has increased significantly over time for the sample as a whole, particularly in Laisamis.

Across the study, Loiyangalani consistently had the worst wasting prevalence, followed by Laisamis, Garbatulla, and Ngaremara. The same site-specific trend was observed with stunting and underweight, but with no difference between Garbatulla and Ngaremara.

All four sites showed significant seasonality, but to varying degrees. For the sample as a whole, wasting peaks during the rainy seasons (November/December and April/May) and is lowest during the long dry season (August/September). However, once we break this up by site, there is only one significant peak in Laisamis (April/May) and one significant peak in Garbatulla (November/December), with both of the other two sites identifying two significant peaks. But the nuance continues. Once we disaggregate Loiyangalani into the two sub-locations, we find that in Moite there is one peak in April (similar to Laisamis), while in Loiyangalani there are two peaks in November and June (more in line with Ngaremara). In line with the harmonic regression, we find that higher rainfall (on the day of child measurement) was associated with higher odds of wasting in Ngaremara; higher vegetation was associated with higher odds of wasting in Laisamis and Loiyangalani; and higher temperature was associated with higher odds of wasting in Loiyangalani only. Seasonal variability was equal to or greater than annual variability.

Age was the most consistent and robust predictor of child wasting across all sites. Older children (ages 3–5) are significantly more likely to be wasted compared to younger children (6–23 months), and boys are more likely to be wasted than girls (except in Ngaremara). Greater seasonal variability was observed for both of these groups, linking greater variability and higher overall prevalence.

In the next section, we further unpack the immediate and underlying drivers that could be related to both the observed seasonal pattern and the differences by site.

# 5. Results: Immediate and Underlying Drivers

In this section we explore the immediate and underlying drivers as identified in the conceptual framework: disease and diet (immediate drivers) and food security, care, and health (underlying drivers) (see Figure 1). We specifically highlight variables that were either significant in the regression analysis (see Annex C: Table C1) or identified as critical in the qualitative work with respect to acute malnutrition. In addition to presenting how these variables are associated with acute malnutrition, we also independently look at their seasonal patterns. We present summary statistics for program indicators in Table C3, Annex 3. However, it is important to note these were not found to be significant drivers of child acute malnutrition in the regression analysis.

## 5.1 Morbidity

### 5.1.1 Relationship between morbidity and wasting

Childhood illness was one of the most consistently significant variables associated with acute malnutrition in the regression analysis (crude and adjusted). Children who had had diarrhea in the past two weeks had 2.2–3.3 times significantly greater odds of being acutely malnourished compared to children who had not had diarrhea in the past two weeks across the four sentinel sites. Besides diarrhea, malaria (not confirmed) and fever were also significantly associated with wasting in Laisamis and Loiyangalani. In both contexts, children who either had malaria (not confirmed) or fever in the past two weeks had 1.4–2.1 times greater odds of being wasted. Respiratory illness was associated with wasting in Garbatulla only, where a child who had respiratory illness in the past two weeks was almost twice as likely to have been wasted.

### 5.1.2 Morbidity by site, over time, and across seasons

Children are the most likely (and significantly so) to be reported sick in Ngaremara and the least likely in Laisamis (Table 8). The most commonly reported illness is respiratory infection, with almost half of all child observations reporting positive for respiratory illness across the two years of data collection. Respiratory illness was more (significantly) common in the two Isiolo sites (Ngaremara and Garbatulla), which have comparatively higher rainfall and vegetation (albeit still low) when compared to the Marsabit sites (Laisamis and Loiyangalani). Malaria (reported, not confirmed) on the other hand is the highest (significantly so) in Garbatulla. Diarrhea was highest in Loiyangalani and lowest in Laisamis. Fever, a frequent symptom of most illnesses, was highest in Garbatulla (likely related to malaria) and Loiyangalani.

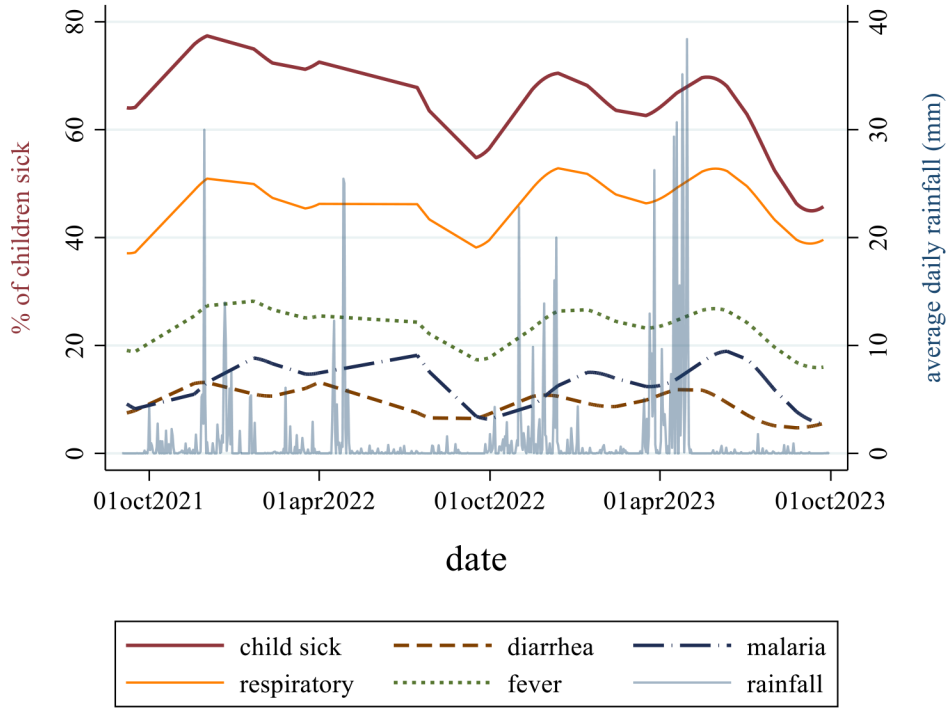
While diarrhea was consistently and strongly associated with wasting in the regression analysis, it is worth noting that the prevalence of diarrhea is lower than the prevalence of wasting across all sites. Only 16% of children who were wasted also reported diarrhea, meaning the majority of wasting cases do not also include diarrhea as a symptom.

**Table 8. Morbidity (overall illness, respiratory illness, fever, malaria (not confirmed), and diarrhea) by sentinel site (across the entire study)**

| | Sick in the past two weeks | Respiratory illness | Fever | Malaria | Diarrhea |
|---|---|---|---|---|---|
| Laisamis | 56% | 40% | 23% | 10% | 6% |
| Loiyangalani | 64% | 40% | 28% | 9% | 18% |
| Ngaremara | 73% | 51% | 13% | 5% | 13% |
| Garbatulla | 61% | 50% | 35% | 24% | 8% |

Significant seasonality is observed with all four types of illnesses. Specifically, we see that diarrhea tends to peak at the height of rainfall (Figure 22), while malaria (not confirmed), respiratory illness, and fever peak right after the height of rainfall. Importantly, the seasonal trend in diarrhea frequently goes in the opposite direction of the other three diseases: as diarrhea increases, reporting of malaria (not confirmed), respiratory illness, and fever falls. Thus, different illnesses contribute to (or are a symptom of) acute malnutrition at different times of year. Diarrhea

**Figure 22. Predicted illness, respiratory illness, fever, malaria (not confirmed), diarrhea, and rainfall for Laisamis, Ngaremara, and Garbatulla combined**



# 5.2 Diet

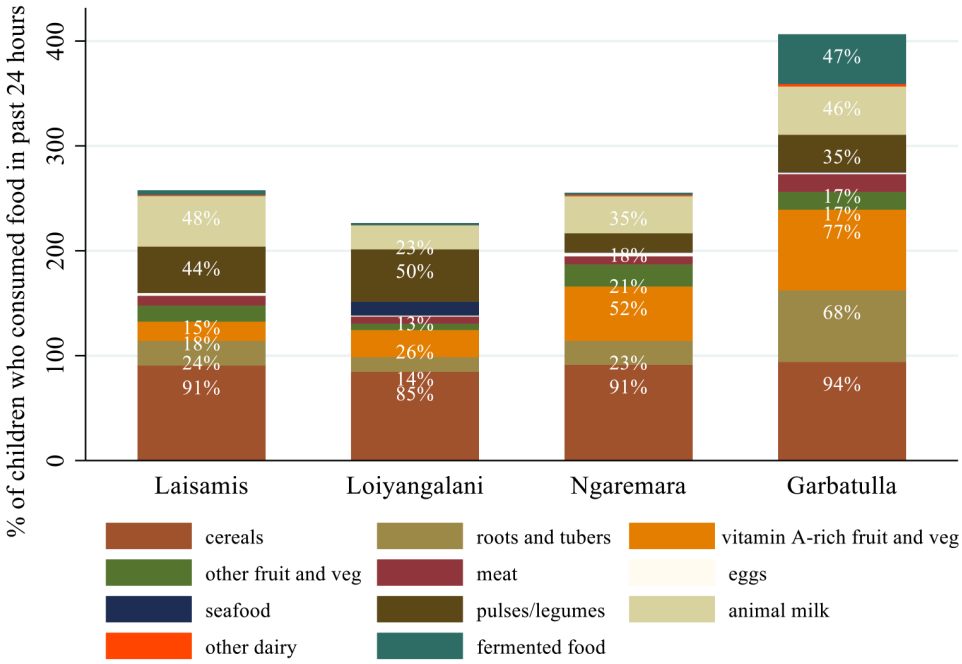
## 5.2.1 Relationship between diet and wasting

A child's diet composition (in the past 24 hours), along with morbidity, was also one of the most consistent variables associated with acute malnutrition. However, precisely which component of the diet was associated with acute malnutrition varied by site. Children consuming cereal (in the crude and adjusted regression model) in the past 24 hours had 55% and 70% lower odds of being wasted in Loiyangalani and Ngaremara respectively. Consumption of vitamin A-rich fruits was associated with 40% and 45% lower odds of being acutely malnourished in Ngaremara and Garbatulla respectively. In addition, children who consumed meat in the past 24 hours in Garbatulla had 55% lower odds of being acutely malnourished while those consuming roots and tubers had 66% greater odds of being acutely malnourished.

### Dietary profile by site

As is apparent in Figure 23, children in Garbatulla consume the most varied diet, in terms of cereals, roots and tubers, fruits and vegetables, meat, animal milk, and fermented foods. Fewer than one percent of children consumed fish in Garbatulla, despite proximity to the Ewaso Nyero river. Children in Loiyangalani eat the least varied diet, mostly composed of cereals, and pulses and legumes. Garbatulla particularly stands out in terms of the variability of the diet, with almost 50% of children consuming fermented foods and almost 80% consuming vitamin A-rich fruits and vegetables. Animal milk consumption is highest for children in Laisamis and Garbatulla.

**Figure 23. Dietary profile (in the past 24 hours) of children by sentinel site (averaged across data collection)**




Note: Multiple responses possible; if < 10% percentage not reported

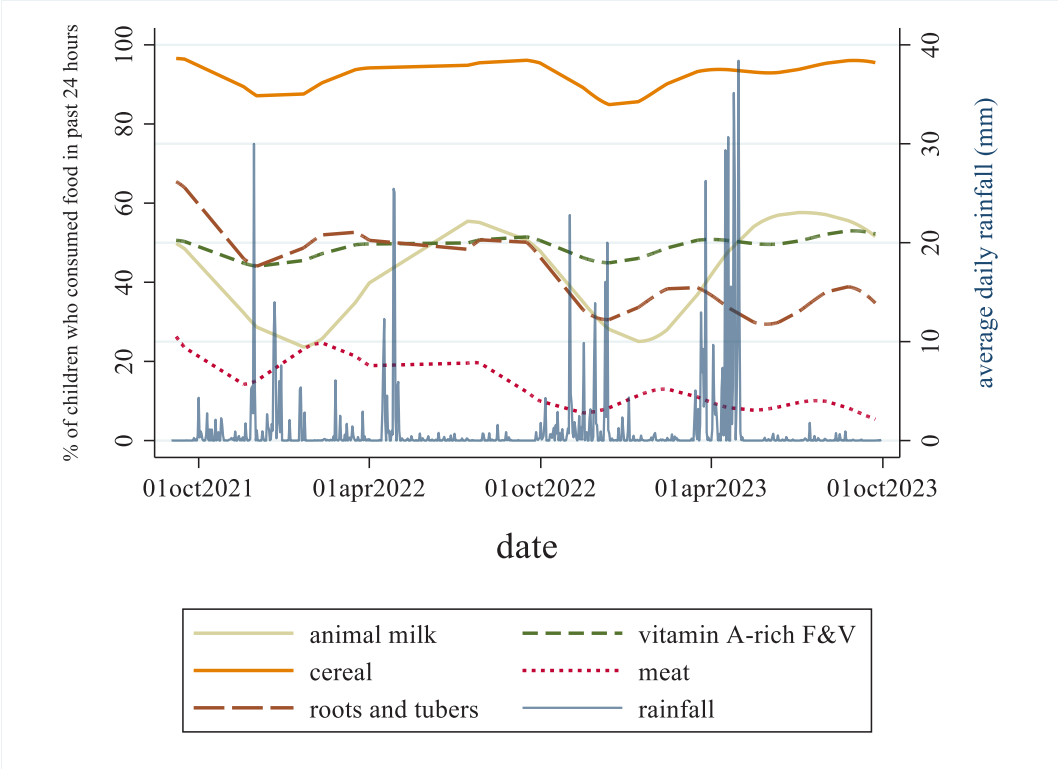
An important indicator of dietary quality for children between the ages of 6 and 23 months is minimum dietary diversity (MDD). MDD meets the necessary threshold if a child is consuming at least five different food groups and is consuming breastmilk at least twice a day for 6–8-month-old children and at least three times a day for children 9 to 23 months. Performance on this indicator was extremely poor,

with only 5% of children meeting this requirement. The proportion was highest (by far) in Garbatulla at 13%, followed by Loiyangalani at 4%, Laisamis at 3%, and Ngaremara at 1%. However, there was no significant relationship between MDD and child wasting overall or in any of the individual sentinel sites.

### Seasonality of key food categories

We examined seasonal patterns for several food categories that were either identified as significantly associated with acute malnutrition in the regression analysis or as critical in the qualitative work (Figure 24). Animal milk consumption shows the greatest seasonal variability, going from as low as 20% of children consuming animal milk at the end of the long rains/short dry season (February/March), to over 50% of children consuming animal milk in the middle of the long dry season (July/August). The greatest seasonal variability in animal milk consumption is in Laisamis and Garbatulla, the two sites with the greatest animal ownership (Table 3). Animal milk consumption is much more consistent across all seasons in Ngaremara, with about 20–40% of children consuming animal milk at any one time.

**Figure 24. Predicted seasonal patterns of cereal, roots and tuber, vitamin A-rich fruit and vegetables (F&V), and animal milk**




In the focus group discussions, women respondents preferred cow's and camel's milk for feeding young children as a drink or by adding it to ugali (maize porridge) or tea, although camel's milk was unavailable in Malkadakka or the Ngaremara sites. Camel's milk is highly valued in Laisamis and Loiyangalani, often described as nutritious and having "medicinal qualities." Milk from goats and sheep is widely used to prepare tea everywhere. Both fresh and fermented milk are consumed, and sometimes cow's milk is used for making ghee, as reported in Laisamis.

On average across the four sites, while cereal and fruit and vegetable consumption remains relatively steady, a dip does occur every year at the height of the short rainy season (December/January). However, there are large differences by site in consumption of fruits and vegetables with much smaller differences by site in cereal. For example, over three-quarters of all children consumed fruits and vegetables in Garbatulla (79%) versus 18% in Laisamis, with Loyangalani having slightly higher consumption than Laisamis (26%) and Ngaremara having slightly lower consumption than Garbatulla (52%). The significance

of these variables in Ngaremara and Garbatulla also corresponds to the fact that the main acute malnutrition peak in these two sentinel sites occurs in November/December (as opposed to April/May). While not perfectly aligned, both cereal consumption and child nutrition in these two locations follow a similar trend during the rainy season: overall decline.

Meat and root/tuber consumption follow the same seasonal pattern as each other, with two dips, one in December/January (just like cereals, fruits, and vegetables) and a second dip in April/May. Consumption of meat and roots/tubers all significantly declined across the two years. However, the two categories of food have very different relationships with wasting in Garbatulla, with meat consumption serving as protective of nutritional status during these peak periods while root/tuber consumption is associated with a higher risk of being malnourished. Interestingly, meat consumption increases both when milk consumption is lowest and highest.

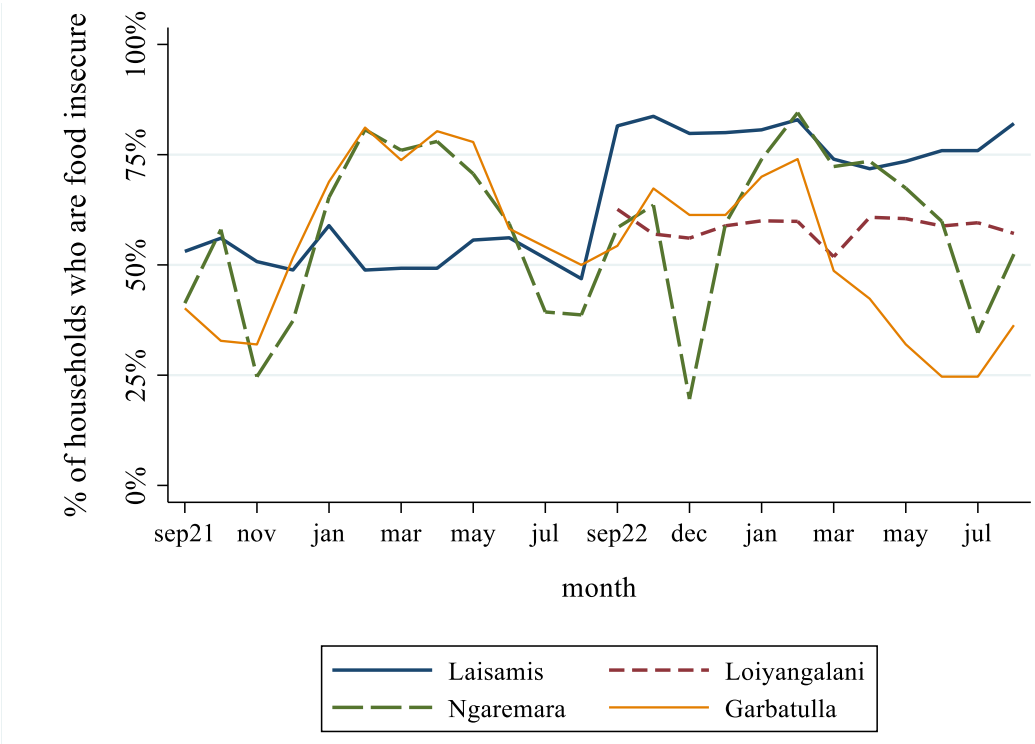
## 5.3 Food security, the care environment, and health

Extremely few underlying drivers were identified as significant in the quantitative analysis, nor were they as robust across different adjusted regression models (only seasonal, seasonal with annual variables, and Year 2 data analysis only) as age, diarrhea, and female caretaker MUAC.

### 5.3.1 Food insecurity

Food insecurity, as measured by the Household Food Insecurity Access Scale (HFIAS), is associated with an increased risk of acute malnutrition in Garbatulla only. Despite the limited significance of HFIAS in the regression analysis, when breaking it up by its four categories (food secure, moderately food insecure, mildly food insecure, and severely food insecure), throughout the study the proportion of households severely food insecure never dipped below 84% and was 91% by the end of the study.

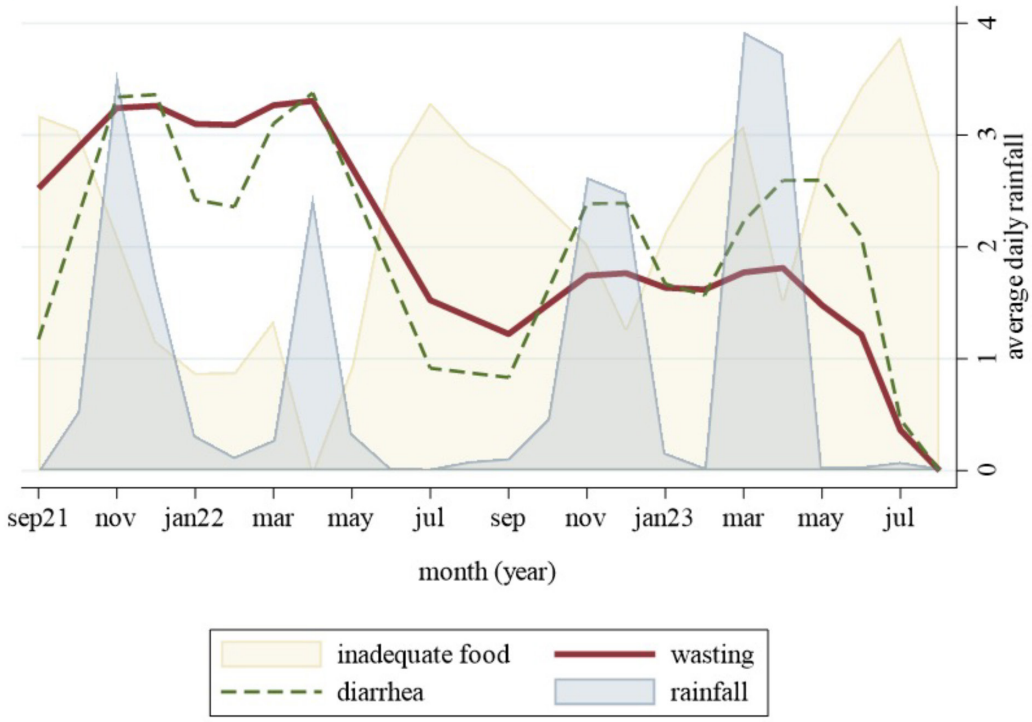
**Figure 25. Inadequate food security by ward and month using Months of Adequate Household Food Provisioning (MAHFP) (retrospectively collected in round 6 and 12)**




Using MAHFP as a measure of food insecurity as described by households at both the annual surveys, we were better able to look at seasonality and trends over time (Figure 25). In Laisamis, we see a

huge increase in food insecurity between the two years with some, but limited, seasonality (which is the opposite of the trend with wasting over time). Seasonality is much more apparent in the two Isiolo sites. Food insecurity is highest January through May in Year 1, which encompasses both the short dry and short rainy season (which was poorer than average) and January through March in Year 2, indicating a clear improvement in food security with the nonfailed short rains in the second year of the study. Particularly in Ngaremara, very sharp improvements are observed in November (Year 1) and December (Year 2) corresponding to the height of the rainy season, and again in July (Year 1 and Year 2) corresponding to the middle of the long dry season. The relationship between wasting and food insecurity is thus likely to be stronger around March/April, but not apparent during the November/December peak (Figure 26).

**Figure 26. Standardized and predicted diarrhea, food insecurity, wasting, with raw rainfall**




*Note: standardized across wards: (value – mean(value))/standard deviation(value) to allow us to visualize all the different climatic variables on one graph despite different units of analysis*

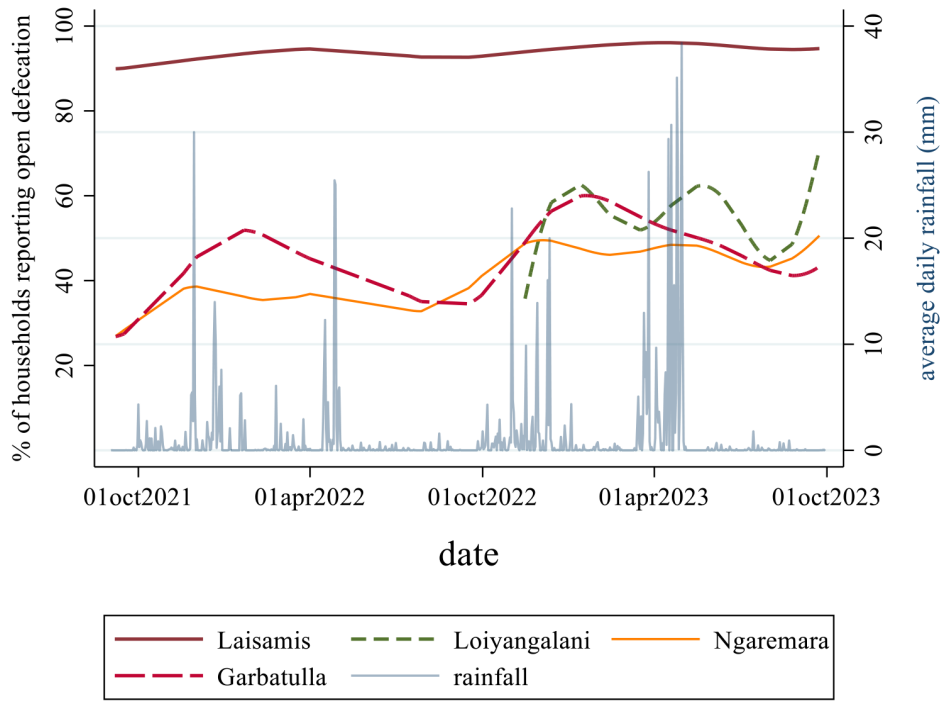
## 5.3.2 Care environment

Open defecation was associated with a 43% significant increase in the odds that a child was acutely malnourished in the Loiyangalani sentinel site compared to households who reported that they did not openly defecate. When disaggregating this further by the two sub-locations in Loiyangalani, we find that open defecation matters more (i.e., is significant) in the much more peri-urban area of Loiyangalani as opposed to the more rural Moite sub-location. While the relationship is not significant in Ngaremara, it is closest to approaching significance ($p < 0.2$) compared to the other sites, likely indicating that the issue of open defecation is more of a concern for denser peri-urban as opposed to rural locations.

In addition, we find open defecation has significantly increased across the two years, and the variable behaves very seasonally and differently across the four sites (Figure 27). In Laisamis, almost all households reported consistent open defecation, and hence we see no seasonal trend. In Garbatulla, open defecation shows a seasonal peak, but only during the short dry season. Peak open defecation

in Ngaremara occurs during each rainy season, while peak open defecation in Loiyangalani occurs right at the end of the rainy season/start of dry season, corresponding to the seasonal trend of acute malnutrition.

**Figure 27. Predicted seasonal patterns of open defecation by sentinel site**

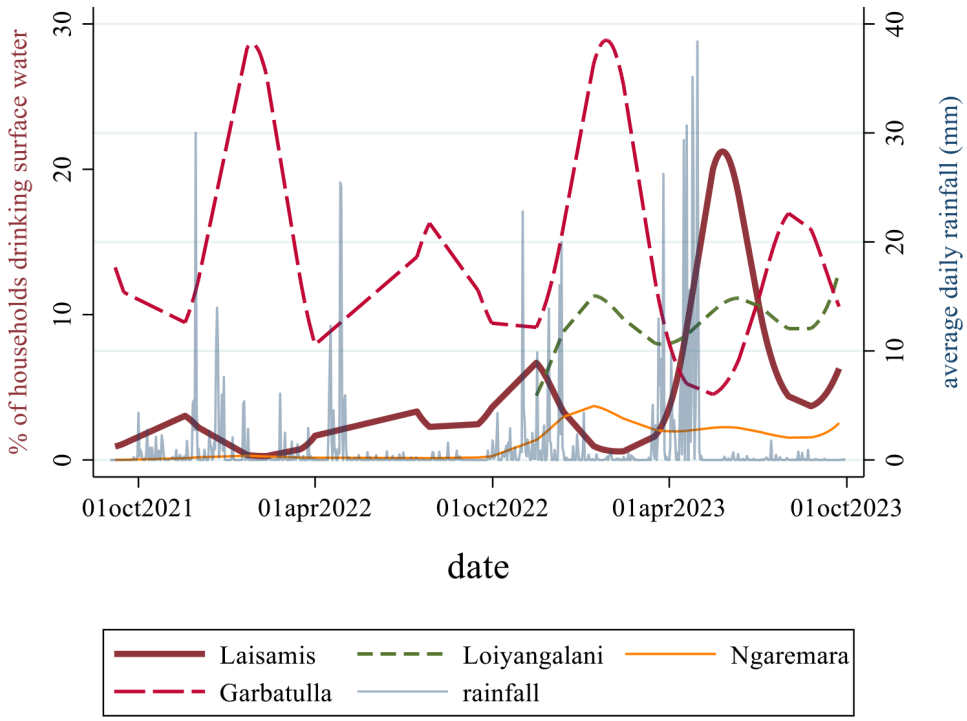



Besides open defecation, the other water, sanitation and hygiene (WASH)-related variable that we found significant was access to a formal or protected water source[17] in Garbatulla only. Garbatulla is where we have the highest proportion of households reporting consuming open source/surface water (meaning from a pond, river, or temporary available surface water), likely due to the proximity to the all-year-long available Ewaso River as well as (and related) greater practice of cultivation along that river (see Section 3.2). Children in households in Garbatulla who consumed water from a formal source or a water source with some protection were about 50% less likely to be wasted. We also find this relationship in the smaller locations within Loiyangalani sub-location, but in the opposite direction. Given that the majority of households consume piped water in the smaller locations within Loiyangalani sub-location, this finding calls into question the quality of that water and needs to be further investigated.

Open-source water consumption follows a clear seasonal pattern overall, but one that varies across sites. The seasonal pattern is most pronounced in Garbatulla, but is similar in Ngaremara and Loiyangalani, with open-source water use increasing during the dry season. On the other hand, in Laisamis, open-source water use correlates directly with rainfall, with greater reporting of open-source water use during the height of the rainy season (Figure 28). In Garbatulla, where open-source water use was correlated with higher odds of wasting, up to 30% of all households report open-source water use during the short dry season (February), which could be linked to their visits to dry season *fora* or other dry season activities that make them reliant on open-source water

17 For this analysis we used a binary water variable; formal or protected and informal or unprotected. The formal category included borehole, protected spring, public tap or piped water, bottled water, and protected well. While the unprotected or informal source included: unprotected spring, rainwater harvesting, rainwater, river/lake/surface water, and unprotected well.

**Figure 28. Predicted seasonality of open-source water consumption across the sentinel sites with respect to overall rainfall**




There is also evidence that children have better outcomes if the primary caretaker is the mother. Children had 90% fewer odds that they were wasted in Garbatulla if the mother brought in the child for weighing.

### 5.3.3 Health

We looked at a host of different health variables, including vaccinations, deworming, vitamin A, distance to a health center, and whether a child slept under a mosquito net. While many of these variables did come out as having a p-value < 0.2 in the crude analysis and hence were included in the adjusted models, only sleeping under a mosquito net was significant, with $p < 0.05$ in the final adjusted models. Children in Laisamis who were reported to sleep under a mosquito net had 40% lower odds of being wasted. While this relationship was not significant in the other locations, we do see that it applies to the data overall, with children having a 40% lower odds of being wasted if they sleep under a mosquito net.

**In summary**, across the quantitative analysis of the immediate and underlying drivers, morbidity, diet, and—to a much less robust degree—open defecation and sleeping under a mosquito net are significantly associated with acute malnutrition. However, other than with diarrhea, we observe differences in these relationships across the four sentinel sites. In Laisamis and Loiyangalani, disease seems to be the dominant driver, with fever, malaria (not confirmed), and diarrhea consistently associated with worse outcomes. In addition, in Loiyangalani (specifically the peri-urban sub-location) open defecation is also predictive of wasting, further supporting the disease-wasting link in these two contexts. In Garbatulla, the relationship between diet and food insecurity and wasting is most consistent. Children who eat meat and/or fruits and vegetables or come from food-secure households (using HFIAS) are less likely to be wasted in Garbatulla. At the same time, consumption of tubers and roots was associated with higher wasting and is likely a food-related coping strategy where households eat cheaper but less preferred and nutritious foods as they are unable to afford or obtain healthier foods. Overall, given the limited relationship with food security and food security seasonality, we hypothesize that addressing food insecurity during the short dry season is when it is likely to be most effective for also addressing malnutrition. Of the health-related variables, only sleeping under a

mosquito net in Laisamis came out as significantly associated with wasting. Finally, we find that almost every driver has a seasonal element to it and that the seasonal pattern is not always consistent across the sentinel sites.

# 6 Discussion

This study has confirmed the ongoing high rates of child GAM and provides an in-depth look and visual summary of the underlying factors driving persistent acute child malnutrition in Isiolo and Marsabit Counties. These data and associated analysis point to a range of challenges for stakeholders in addressing some of the systemic issues that contribute to acute malnutrition. At the same time, the data also illustrate key sources of resilience and adaptation within pastoral systems. These sources of resiliency and internal support (in addition to external interventions) helped to prevent the most recent drought from being much *worse* than it was in terms of impact upon humans. This discussion section presents the most important storylines and takeaway messages from the results presented above and highlights critical areas of strength and resilience within the pastoral system and priority areas for learning. The implications for action (policies, programs, and practices) are considered under the conclusions.

## 6.1 Child global acute malnutrition: stubborn and resistant to change

### 6.1.1 Persistent GAM (PGAM)

Across the two years of the study, on average, wasting prevalence varied from a minimum of 15% (September 2023) and a maximum of 21% (November 2022), with an overall average of 18.6% (95% CI: 18.0–19.1%). Thus, despite context-specific seasonal reductions in wasting prevalence (which we discuss below), the selected sites in Marsabit and Isiolo show a stubborn persistence in GAM prevalence that surpasses and hovers at the 15% emergency threshold. While an above-emergency level of GAM was expected in the first year of the study given that it encompassed the second year of drought, the perseverance of GAM in the second year of the study when the rains returned (and were above the 20-year average) highlights the severity of the problem and that recovery (as discussed further below) is not an immediate process. In the adjusted regression, a significant reduction ($p < 0.01$) in GAM across the study was only observed in the Laisamis sentinel site, and even so it only went from an average of 23% in the first year of the study to 20% in the second year. These findings correspond to the initial hotspot analysis that was used to select the sites for the study. From 2010–2020, surveys[18] reported "critical" GAM rates (from 15 to 29.9%) in six out of 14 Standardized Monitoring and Assessment of Relief and Transitions(SMART) surveys in Marsabit, and four out of 11 surveys in Isiolo.[19]

Despite this alarming assessment of PGAM in the four sentinel sites, a review of the within-year or seasonal variability in wasting shows that achieving a prevalence below the emergency threshold and even below the "serious" level (10–14.9% GAM) is possible. For example, in Ngaremara, we go from a high of 18.1% (November/December 2021) to a low of 6.1% (August 2023), and in Garbatulla, the prevalence drops to 10.8% in August 2023 from a high of 18.3% (March 2022). However, in both Marsabit sites, wasting prevalence never goes below 15%. While these figures are still a long way from achieving the Sustainable Development Goals (SDGs) to reduce the proportion of wasting to < 5% by 2025 and < 3% by 2030,[20] the lower prevalence of wasting in August

18 Standardized Monitoring and Assessment of Relief and Transitions (SMART) surveys

19 S. Ocholo, " Malnutrition Hotspot Mapping Analysis for the Nawiri Project in Isiolo County" (Nawiri Program, Nairobi, 2021); S. Ocholo, "Malnutrition Hotspot Mapping Analysis for the Nawiri Project in Marsabit County"(Nawiri Program, Nairobi, 2021).

20 World Health Organization (WHO), "Global Action Plan on Child Wasting. A Framework for Action to Accelerate Progress on Preventing and Managing Child Wasting and Achievement of the Sustainable Development Goals" (WHO, Geneva, 2020).

2023 in Ngaremara shows that it is possible to meet the SDG goals, even in these hotspots.

### 6.1.2 Seasonality of wasting

In general, we find that seasonal variability in our sentinel sites is as big or greater than annual variability. On average, there is a six versus four percentage point difference between peak and nonpeak timing when comparing those peaks across the two years respectively. The similar or greater seasonal as compared to annual variability is even more striking considering we are comparing two very different years from a climate perspective (second year of drought versus return of above-average rainfall).

When we map the seasonal patterns onto the calendar months and with respect to climate, we can identify two general peaks in wasting. For the combined sample of Laisamis, Ngaremara, and Garbatulla (sites for which we have two years of data), wasting peaks during each of the two rainy seasons (November/December and April/May), with the lowest wasting prevalence in the middle of the long dry season (August/September). There is a small dip between the November/December and April/May peaks (i.e., short dry season). While on the one hand this dip is less than one percentage point, on the other hand it does indicate that there is a mediating factor between the two rainy seasons that not only keeps the prevalence of wasting from increasing during the short dry season, but also, on average, slightly reduces the prevalence of wasted children.

The Loiyangalani site is a bit different due to both having only one year of data and being made up of smaller locations within two sub-locations that are quite different from each other: peri-urban Loiyangalani town and rural Moite. In the smaller locations within Loiyangalani sub-location, there are two almost even-sized peaks in acute malnutrition in February and June. These peaks correspond and are significantly correlated with the temperature peaks, with the lowest prevalence of acute malnutrition occurring in September. Moite, on the other hand, more closely resembles the other sites, with peak acute malnutrition occurring in the middle of the April/May rainy season, with the lowest prevalence in September.

The presence of two peaks in the three sentinel sites and the differences between them and the Loiyangalani sentinel site also tells a story of spatial variability. While we do observe a similar pattern in the three sites for which we have two years of data, which of the two peaks is greater is different across the three sentinel sites. In Laisamis, there is only one significant peak of wasting in April/May, corresponding to the local rainfall pattern, which shows a much larger April/May peak compared to November/December. Two significant peaks are observed in Ngaremara, but the November/December peak is consistently greater than the April/May one. In Garbatulla, we observe the least amount of seasonal variability in wasting, with only one significant peak occurring in November. While we cannot claim that the primary peak in each site will always occur at this time, it does indicate that there is a difference across the sites in terms of drivers and protective factors.

The seasonal pattern identified in our study confirms but also contradicts aspects of previous nutrition studies that consider seasonality. Three[21] qualitative participatory studies identified the end of the two dry seasons (September/October and February/March)—right as rainfall commences—as peak timing of acute malnutrition. This description fits our Loiyangalani site (one of the locations for the participatory epidemiology work referenced above), but not any of the other sites completely. While February/March (the middle of the short dry season) does correspond well enough with our study as it lies right between the two peaks, with only a small dip, our regression and climate analysis consistently shows that the middle of the long dry season is the time for the lowest prevalence of wasting, with higher rainfall and vegetation associated with *higher* (not lower) odds of wasting. However, another seasonality study in Turkana found that WHZ actually increases

21 Food and Agriculture Organization (FAO), UNICEF, and Washington State University, "Marsabit County, Kenya Seasonality of Malnutrition: Community Knowledge on Patterns and Causes of Undernutrition in Children and Women in Laisamis" (FAO, Rome, 2020); K. Manners, M. Calo, I. Awino, and J. Korir, "Undernutrition Risk Factors and Their Interplay with Nutrition Outcomes: Nutrition Causal Analysis Pilot in Kenya," Field Exchange 49 (2015); J. Burns, A. Catley, and H. Mahmoud, "Using Participatory Epidemiology to Investigate the Causes and Seasonality of Acute Malnutrition in Marsabit and Isiolo Counties, Northern Kenya: Methods and Experiences" (Feinstein International Center, Friedman School of Nutrition Science and Policy at Tufts University Nawiri project, 2021).

during the dry season[22] (more in line with our findings) while MUAC declines (a point we discuss in the methods Section 2). When plotting wasting as defined by WHZ, the authors show two peaks, a large one in November and another in July, both associated with the rainfall peaks in Turkana. This finding corresponds to our research and most closely aligns to the panel nature of our longitudinal study, by following the same children with eight rounds of data collection within 12 months.

What is particularly interesting and valuable about seasonality research is that identification of peak timing of malnutrition can point to evidence of drivers. The studies that identify the dry season as the most vulnerable time for malnutrition link wasting with food insecurity and poor consumption, with a strong focus on milk, while the Turkana study makes the conclusion that "the results indicate that food availability is not likely to be the sole determinant of nutritional status and that infection may be an important contributor to the high levels of nutritional and immunological stress among nomadic Turkana children" (pg. 1). What we believe our research and previous research is showing is that wasting is multicausal, and that the drivers might not be the same across the seasons, but also vary given the context of the site. Below we dive into some of the significant relationships observed in the regression analysis between the immediate and underlying drivers and wasting. First, we present the consistent findings around what characteristics (as opposed to drivers) were associated with a wasted child.

### 6.1.3 Consistent characteristics of a wasted child

A consistent finding both across the study and within each sentinel site is that children 3–5 years of age have much higher odds of being wasted than younger children. The finding that children 3 to 5 years of age are more malnourished is unexpected and noteworthy because global trends indicate that WHZ declines from birth and reaches its nadir at around 12 months before slowly improving thereafter; this is consistent with an improved immune system among older children that diminishes the impact of infection on the child's weight.[23]

In Kenya, the literature is actually not in agreement about what age group is the most at risk for wasting, with some studies finding no difference,[24] others identifying children around 2–3 years as being at greatest nutritional risk (with one of those studies using Kenya Demographic and Health Survey (KDHS) data),[25] and one study finding that younger children had better WHZ scores.[26] Previous KDHS data showed that children under 24 months of age suffered higher wasting rates compared to the older cohort. However, the most recent KDHS from 2022 similarly shows a reversal of the expected relationship between age and wasting for the whole of Kenya (though not as stark as in our sample), with 5.2% of children 24–59 months acutely malnourished compared to 4.3% of children 23 months and under. The recent KDHS data further confirm the jump in acute malnutrition happens at around 3 years of age, thus primarily affecting children 36–59 years of age, just like in our longitudinal study.

Previous research in Sudan has shown that in conditions of severe food insecurity or famine,

22 B. Shell-Duncan, "Impact of Seasonal Variation in Food Availability and Disease Stress on the Health Status of Nomadic Turkana Children: A Longitudinal Analysis of Morbidity, Immunity, and Nutritional Status," American Journal of Human Biology 7 (1995): 339–355

23 R. E. Black et al., "Maternal and Child Undernutrition and Overweight in Low-Income and Middle-Income Countries," Lancet 382, no. 9890 (2013): 427–451; C. G. Victora et al., "Worldwide Timing of Growth Faltering: Revisiting Implications for Interventions," Pediatrics 125, no. 3 (2010): e473–480.

24 Shell-Duncan, "Impact of Seasonal Variation"; B. Shell-Duncan and J. W. Wood, "The Evaluation of Delayed-Type Hypersensitivity Responsiveness and Nutritional Status as Predictors of Gastro-Intestinal and Acute Respiratory Infection: A Prospective Field Study among Traditional Nomadic Kenyan Children," Journal of Tropical Pediatrics 43 (1997): 25–32.

25 A. Adeladza, "The Influence of Socio-Economic and Nutritional Characteristics on Child Growth in Kwale District of Kenya," African Journal of Food, Agriculture, Nutrition and Development 9, no. 7 (2010); P. K. Masibo and D. Makoka, "Trends and Determinants of Undernutrition among Young Kenyan Children: Kenya Demographic and Health Survey; 1993, 1998, 2003 and 2008-2009," Public Health Nutrition 15, no. 9 (2012): 1715–1727.

26 J. Brainard, "Nutritional Status and Morbidity on an Irrigation Project in Turkana District, Kenya," American Journal of Human Biology 2 (1990): 153–163.

the proportional increase in acute malnutrition and mortality tends to be greater among children 2+ years of age.[27] The authors of these studies hypothesize that this might be because acute food crises usually have a community-wide effect, and that in famines the highest excess mortality is among children over the age of 2 years and adults. In contrast, morbidity and mortality rates (and thus disease-related drivers) are generally higher among infants and younger children compared to children who are no longer complementary breastfeeding (2–5 years). However, a recent paper found that where mortality rates are elevated there is a proportional increase in deaths among older children and a decline in younger children.[28] This age-related trend is attributed to the accumulation of exposures to shocks with age, similar to findings that show that stunting is a result of the accumulation of multiple previous wasting episodes.[29] Thus, the finding that older children are at a greater risk of wasting could be an indication of the accumulation of stresses that this age cohort faced in the three to five years prior to the study.

The finding around sex is also generally consistent across the study sites (except for Ngaremara), with boys being at a greater risk of wasting, stunting, underweight, and higher mortality. The significantly higher prevalence of wasting among boys is not surprising in the ASALs. A Nawiri desk study on drivers of wasting identified boys as having significantly worse nutrition outcomes compared to girls. A recent meta-analysis found that boys had higher odds of being wasted, stunted, and/or underweight compared to girls, and this difference was stronger in Africa than in South Asia.[30] Thus, what is almost more interesting is why we *do not* see the standard distinction by sex in Ngaremara and see a smaller (but still significant) difference by sex in Garbatulla as compared to Laisamis and Loiyangalani. If the sex difference were purely physiological, we would expect the difference in wasting by sex to exist across all sentinel sites. A related finding comes from a recent narrative review of sex differences in undernutrition that found that sex differences tended to be much higher in more food-insecure contexts and where there are higher prevalences of undernutrition.[31] The association between sex differences, food insecurity, and overall burden of undernutrition corresponds to the differences observed across the four sites in our study in regard to dietary diversity and wasting prevalence, with Laisamis and Loiyangalani reporting the lowest dietary diversity, the highest wasting prevalence, and also the highest differences in acute malnutrition by sex for children under 5 years of age.

For both age and sex, we find that the more vulnerable category (boys and children over the age of 2) also show the greatest variability in their wasting prevalence across the two-year study. This increased variability (or fluctuations) points to the lower resilience of these children to different shocks or exposures. Similar to the differences in age, this also could be related to the accumulation of shocks on these children, affecting their immune systems or nutrition absorption. While the exact mechanism is not clear, the evidence does point to the link between greater variability and higher wasting prevalence.

The final variable that was consistently associated with higher odds that a child was wasted across all four sentinel sites was the nutritional status of the female caretaker as measured by adult MUAC. The higher the female caretaker's MUAC, the lower the odds that a child was wasted. By-site comparisons further show that where child wasting is highest are the same sites where female caretaker MUAC is lowest. While adult MUAC and child wasting do not necessarily follow the same seasonal trend, likely indicating somewhat different drivers and overall resilience to shocks, the consistency of the

27 H. Young and S. Jaspers, "Nutrition, Disease, and Death in Times of Famine," Disasters 19, no. 2 (1995): 94–109; H. Young and S. Jaspars, "The Meaning and Measurement of Acute Malnutrition: A Primer for Decision-Makers" (Humanitarian Practice Network Paper No. 56, Humanitarian Practice Network, Overseas Development Institute, London, 2006).

28 O. Karlsson, R. Kim, A. Hasman, and S. V. Subramanian, "Age Distribution of All-Cause Mortality among Children Younger Than 5 Years in Low- and Middle-Income Countries," JAMA Network Open 5, no. 5 (2022): e2212692, doi:10.1001/jamanetworkopen.2022.12692.

29 S. M. Schoenbuchner et al., "The Relationship between Wasting and Stunting: A Retrospective Cohort Analysis of Longitudinal Data in Gambian Children from 1976 to 2016," American Journal of Clinical Nutrition 110, no. 2 (2019): 498–507, doi: 10.1093/ajcn/nqy326.

30 S. Thurstans et al., "Boys Are More Likely to Be Undernourished than Girls: A Systematic Review and Meta-Analysis of Sex Differences in Undernutrition," BMJ Global Health 5, no. 12 (2020).

31 S. Thurstans et al., "Understanding Sex Differences in Childhood Undernutrition: A Narrative Review" (Emergency Nutrition Network, 2022), www.ennonline.net/understanding-sex-differences-childhood-undernutrition-narrative-review

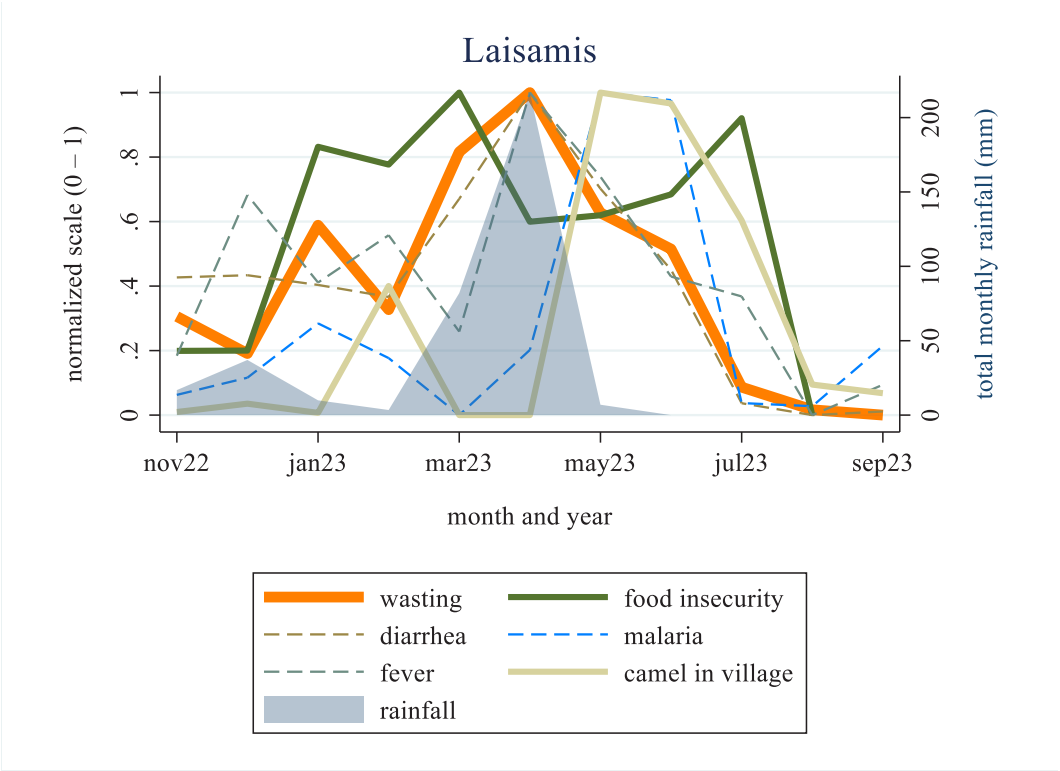
relationship points to the fact that child wasting is usually an indicator of greater vulnerability of the entire household, particularly the female caretakers.

## 6.2 Pulling it all together: a synthesis of the immediate and underlying drivers

While we saw consistent relationships across some of the characteristics of a wasted child, the only driver that was correlated with wasting across all four sites was diarrhea. And while morbidity is an important contributor to wasting, it is difficult to parse out the directionality: does the child have diarrhea because their system is weakened by acute malnutrition or vice versa? Furthermore, while this relationship was highly and consistently significant, the actual overlap between children who are both wasted and have diarrhea is extremely small (16%), demonstrating that most episodes of wasting did not also include symptoms of diarrhea.

For the remaining drivers, the regression analysis showed a much more inconsistent picture, with each sentinel site having its own unique set of drivers.

**Figure 29. Seasonality of all significant immediate and underlying drivers of wasting, wasting, and food insecurity in Laisamis (using raw data from the second year of the study)**



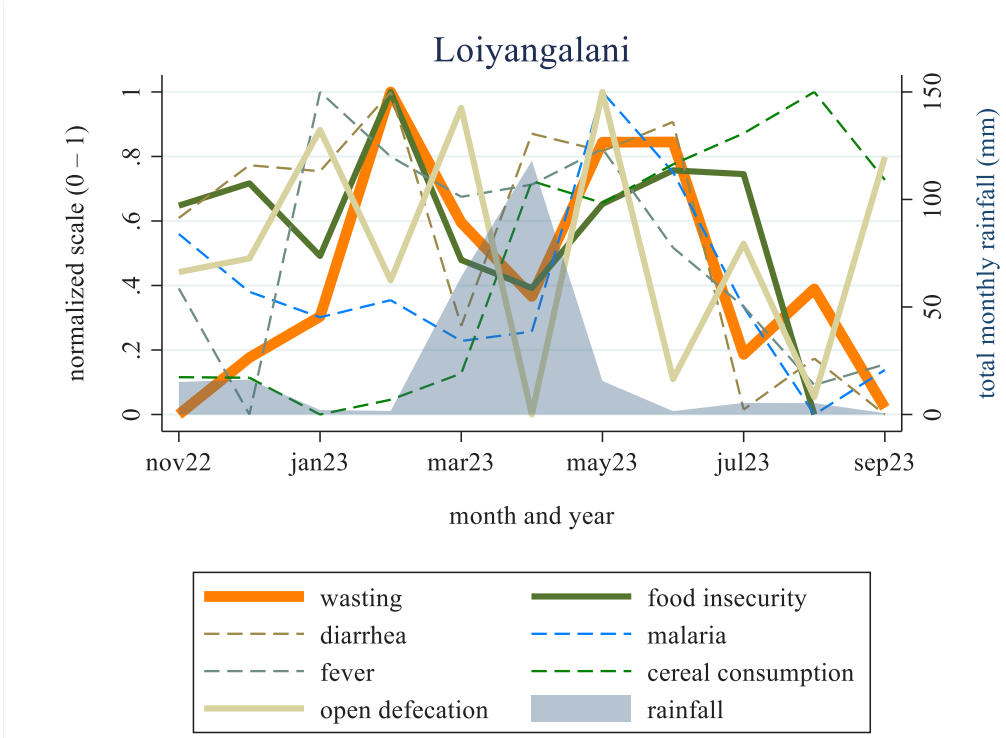

*Note: All variables, other than rainfall, were normalized, whereby you subtract the minimum value from each data point and then divide it by the range. This way, all the variables will have a range from 0–1, allowing them to be presented in the same figure.*

### 6.2.1 Laisamis

In Laisamis, significant *seasonal* drivers of child wasting included fever, malaria (not confirmed), diarrhea in the past two weeks, and the absence of household camels in the village. Plotting all of these drivers in one visualization (using the raw data) and including MAHFP to represent food insecurity, it becomes more apparent when each of these drivers might be more relevant for wasting (Figure 29). We find that malaria (not confirmed) is likely an important contributor to wasting after both rainy seasons when pools of stagnant water are likely to be present. This likely explains why children who sleep under a mosquito net in Laisamis have significantly lower odds of being wasted. The relationship between

malaria (not confirmed) and wasting is not as strong as the relationship between diarrhea and wasting (50% greater odds versus three times the risk), but still remains a robust predictor of wasting in Laisamis. Fever and diarrhea consistently follow the same seasonal pattern as wasting, indicating that when these rates increase, we can presume that wasting is increasing as well. An important mediating factor that likely contributes to the small dip in wasting in the short dry season and the huge dip in wasting in the long dry season is that these dips directly correspond to the presence of cattle in the village, which are an excellent source of highly nutritious milk for these children. The figure also shows why August/September is the period of lowest wasting, as it corresponds to lower food insecurity, follows the presence of camel milk (when camels are in the village), and has the lowest prevalence of malaria (not confirmed), fever, and diarrhea.

**Figure 30. Seasonality of all significant immediate and underlying drivers of wasting, wasting, and food insecurity in Loiyangalani (using raw data from the second year of the study)**




*Note: All variables, other than rainfall, were normalized, whereby you subtract the minimum value from each data point and then divide it by the range. This way, all the variables will have a range from 0–1, allowing them to be presented in the same figure.*

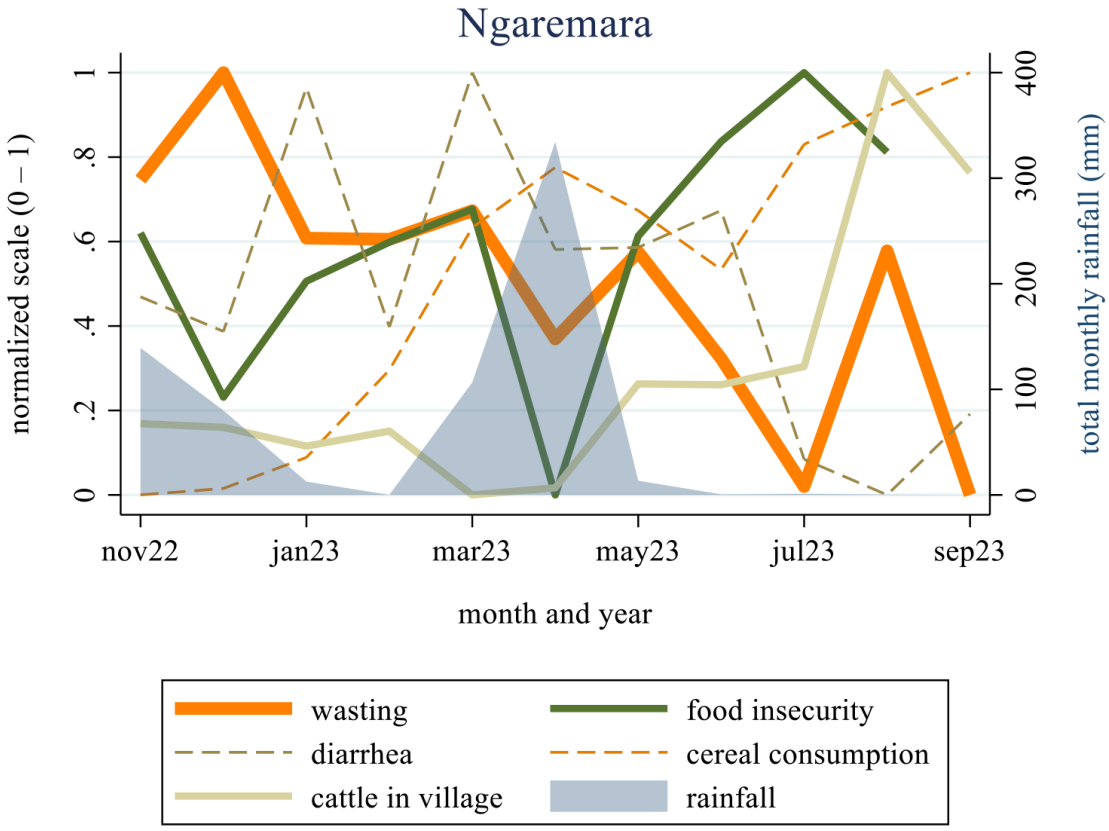
## 6.2.2 Loiyangalani

In Loiyangalani, the significant *seasonal* drivers of child wasting included fever, malaria (not confirmed), diarrhea in the past two weeks, open defecation, and no consumption of cereals in the past 24 hours. Malaria (not confirmed), fever, and diarrhea consistently follow the same seasonal pattern and are a significant predictor of wasting. Similar to what we find across all sites, the August/September period (middle of the dry season) is a time when wasting is at its lowest, as are all the significant seasonal predictors. Cereal consumption and food insecurity in general follow a similar pattern to wasting and are particularly problematic during the short dry season and the start of the long dry seasons, while open defecation is a problem at the end of both of the rainy seasons. The increase in cereal consumption specifically could be associated with the food aid ration provided in this highly drought-affected site. Though it is good to point out that cereal consumption, while seasonal, never went below 90%, so the large spikes observed in Figure 30 are partially a product of normalizing the data (to fit it all on one figure).

### 6.2.3 Ngaremara

In Ngaremara, the significant *seasonal* drivers of child wasting included diarrhea in the past two weeks, no consumption of cereals in the past 24 hours, and absence of cattle in the village (Figure 31). As with all four sites, diarrhea and wasting generally behave similarly across seasons. Cereal consumption and the presence of cattle in the village all point to the availability of critical macronutrients for a child's diet and clearly show their seasonal presence is critical for child nutrition. Just like with the other sites, these drivers are least prevalent in the middle of the long dry season (August/September), corresponding to the lowest seasonal prevalence of wasting. However, it's important to note that, compared to all the other sites, many more individual caretaker and household characteristics were associated with wasting in either direction in Ngaremara: if a female caretaker had a disability there was a four to five times increase in the odds that a child was wasted; if a female caretaker was married in a polygamous household the child had 70% lower odds in being wasted; and practicing almost any livelihood other than livestock also resulted in significantly lower odds of a child being wasted. Thus, in Ngaremara, more so than in any other site, individual caretaker and household characteristics are good predictors of the odds that a child is wasted; this is likely due to the decline in social capital in more peri-urban communities.

**Figure 31. Seasonality of all significant immediate and underlying drivers of wasting, wasting, and food insecurity in in Ngaremara (using raw data from the second year of the study)**



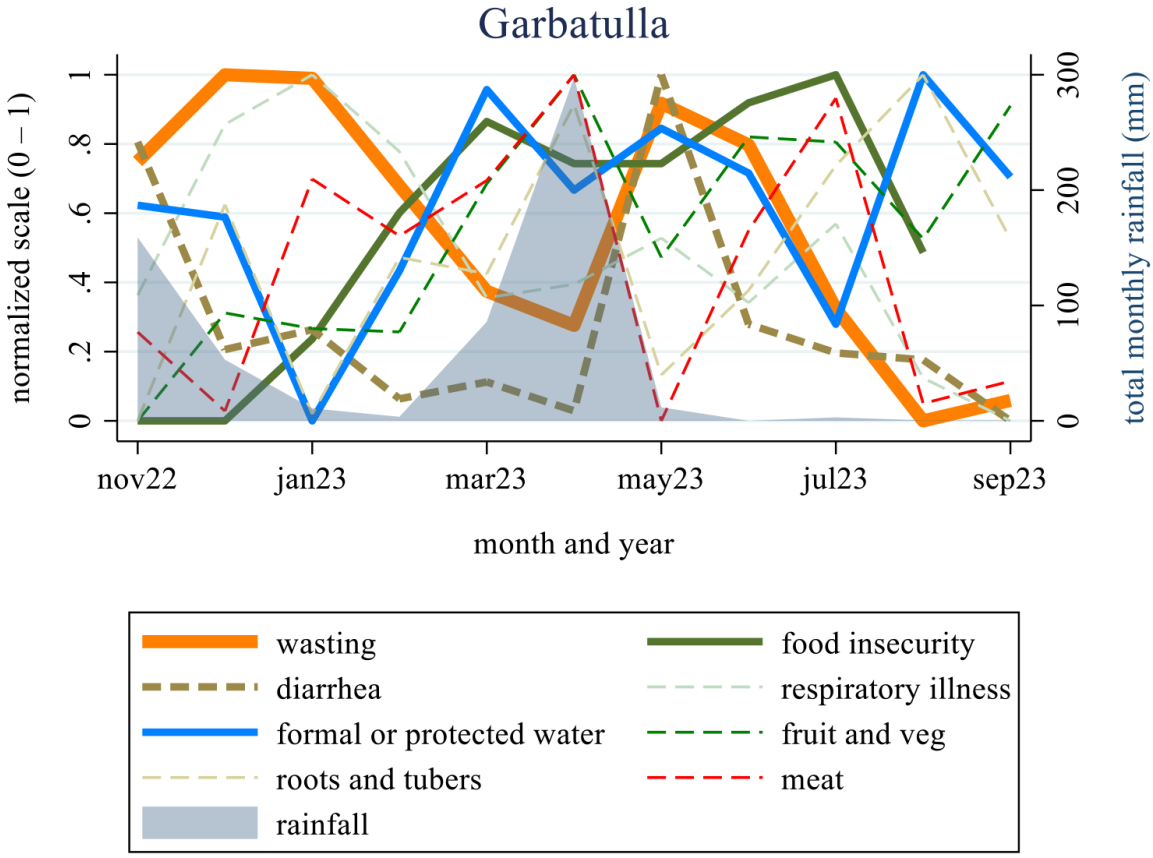

*Note: All variables, other than rainfall, were normalized, whereby were you subtract the minimum value from each data point and then divide it by the range. This way, all the variables will have a range from 0–1, allowing them to be presented in the same figure.*

### 6.2.4 Garbatulla

In Garbatulla, the significant *seasonal* drivers of child wasting included diarrhea in the past two weeks, respiratory illness in the past two weeks, use of an informal water source, not consuming fruits and vegetables, not consuming meat, consuming roots

and tubers, and household food insecurity (Figure 32). Roots and tubers are likely a cheaper substitute for grains and are consumed mainly by the poor. They have generally lower protein and energy compared to cereals. Thus, while their consumption is significantly correlated to worse wasting, it is likely that this is an indication of a household's reliance on certain food-related coping strategies (cheaper but less preferred foods), rather than indicating that tuber consumption leads to wasting. Respiratory illness follows a similar seasonal pattern to wasting, with diarrhea being far more prevalent after the April rains. The use of informal water sources is lowest in the middle of the short dry season and is likely an important contributor to the relative improvement in child wasting at that time. As formal water source use increases, wasting and diarrhea drops. We also find that as meat and fruit and vegetable consumption increases, wasting prevalence tends to drop. Also and notably, Garbatulla is the only site where household food insecurity was correlated to wasting, with food insecurity (along with consumption) being a critical driver during the rainy season and start of the dry season.

**Figure 32. Seasonality of all significant immediate and underlying drivers of wasting, wasting, and food insecurity in in Garbatulla (using raw data from the second year of the study)**




*Note: All variables, other than rainfall, were normalized, whereby you subtract the minimum value from each data point and then divide it by the range. This way, all the variables will have a range from 0–1, allowing them to be presented in the same figure.*

Thus, we find variability in what immediate and underlying drivers are associated with wasting, but we also see that the same driver might not be relevant across different times of year as the effects are mediated by protective factors. What we do find consistent is that in all sites it is the same time of year (middle to end of the long dry season) when all of these drivers are at their lowest. This results in a large drop in wasting at this time, such that in Ngaremara we almost reach the SDG goal levels.

However, it is important to highlight that, other than Ngaremara, all other sites remained (even at the best time of year) at critical (Garbatulla) and emergency levels (Laisamis and Loiyangalani), even with the return of above-average rains in the second year of the study. These findings confirm what we saw in the literature review and hot spot analysis showing the stubbornness of GAM in these contexts, irrespective of whether there are drought conditions or not. This high prevalence during the best time of year highlights that we need to be looking beyond just the immediate and underlying drivers (though we should address them) at the basic drivers, which directly relates to which drivers are significant and the contextual factors that affect the extremely high levels of wasting in the study sites.

## 6.3 Highlighting the basic drivers of persistent acute malnutrition

Here we highlight the basic drivers of persistent acute malnutrition, focusing on the pressures facing pastoralism, its relationship with human nutrition, and the important role of key pastoralist institutions. Livelihood diversification is examined, noting both its benefits and drawbacks for child nutrition. Finally, we explore the pathways to recovery and resilience, before suggesting in the conclusions strategies to mitigate the factors contributing to acute malnutrition while bolstering factors contributing to resilience.

### 6.3.1 Pastoralism under pressure

Across the ASALs, pastoralists demonstrate resilience and adaptability by capitalizing on emerging opportunities and effectively managing risks: these traits have allowed pastoralism as a livelihood system to continue for generations despite external pressures and changing environmental conditions. Key to this sustainability are strategic mobility and customary institutions that enable adaptive resource management and robust social support systems. Pastoralists have increased cooperation with the formal government institutions and services. More recently, pastoralists have integrated modern innovations to enhance efficiency and risk management, including the use of mobile phones for communication, motorcycle transport for quicker movement, and engagement with livestock markets.

Despite remarkable resilience over time, pastoral systems in Kenya and beyond have been experiencing a range of pressures and constraints over multiple decades. The combination of these pressures with economic development and associated emerging opportunities has resulted in the evolution and at times transformation of pastoral systems. While the specific changes depend greatly on context, here we briefly discuss some of the broad pressures acting upon the efficiency of pastoral systems to manage risk and uncertainty. First, the increasing trend towards privatization and individualization of land tenure undermines the common property regime that is crucial for sustainable land management by pastoralists.[32] This shift has led to the loss of dry season grazing reserves, restricted livestock movements, and increased competition for scarce environmental resources across the sentinel sites, exacerbating tensions and distrust between different ethnic groups. Simultaneous efforts by the state to weaken the role of customary authorities in the management of pastoral resources have negatively affected sustainable land use norms that ensured, among other things, the preservation of pasture and water resources for dry season use. The encroachment of urban settlements and the expansion of private and state wildlife conservation areas into pastoral rangelands have constrained migration routes and limited access to pastures; respondents reported that government policies have accelerated these trends. The Community Land Law passed in 2016 would potentially help mitigate these trends, but the act is yet to be implemented.[33]

Second, while economic development has contributed to sedentarization, there are various potential positive gains from the expansion of infrastructure, services, and economic opportunities. To date, these gains remain minimal for much of

32 For a more detailed evaluation of how land access and environmental resource management (NRM) policies, institutions, and relationships are changing in the ASALs, see for example I. Birch, "Natural Resource Management and Nutrition" (Feinstein International Center at Tufts University, USAID Nawiri project, 2021); E. Roe, "A New Policy Narrative for Pastoralism? Pastoralists as Reliability Professionals and Pastoralist Systems as Infrastructure" (STEPS Working Paper 113, Social, Technological and Environmental Pathways to Sustainability (STEPS) Centre, 2020).

33 The Community Land Act (2016) gives effect to Article 63 of the Constitution of Kenya, 2010, which provides for a classification of land known as community land. To this end, the Constitution provides that community land shall vest in and be held by communities.

the local population due to limited market access, high transport costs, and few opportunities for employment in the formal sector. This means that there are relatively few sustainable options for diversification for those who opt out or are pushed out of livestock husbandry. As such, this creates a pressure on the broader pastoral system due to the proliferation of marginal and maladaptive economic options with the potential to harm the asset base, including extensive environmental resource exploitation and banditry.

Third, sedentarization and modernization have contributed to the commercialization of livestock husbandry, with implications for interhousehold sharing and food security. A shift towards greater commercialization has contributed to a decline in traditional kinship and reduced systems for livestock redistribution after shocks. These practices had once been essential for ensuring food security and social support, especially for poorer groups. The erosion of these traditional systems, combined with the substantial herd losses experienced over the past three decades, has undermined the viability and effectiveness of traditional livestock redistribution through horizontal exchanges and other forms of sharing. This has weakened social support institutions, making it harder for poorer households to cope with food insecurity and maintain their livelihoods in the face of economic changes and environmental pressures. In addition, the increased commercialization and monetization of livestock have contributed to the inequity in herd size and livestock ownership, which further undermines social support systems and can increase the vulnerability of the poorest groups. These various systemic changes to and pressures upon pastoralism affect the institutions that support resilience and risk management, with specific impacts for the management of child nutrition and well-being.

## 6.3.2 Pastoralism and human nutrition: relational dynamics

Pastoral systems are inherently flexible and able to adapt to changing ecological and climatic conditions. Inherent within pastoralism is a dynamic relationship among people, livestock, and the environment supported by multiple institutions. We discussed these institutions earlier; here we revisit their specific implications for human nutrition. We start with a discussion of strategic mobility, perhaps the most critical institution underpinning the success and resilience of pastoral livelihoods and influencing human nutrition, and the herder specialist knowledge systems that support mobility. Then we reflect upon the governance of pastoral environmental resources and the wide-ranging social institutions that shape daily life.

### Strategic mobility and associated herder knowledge

Mobility is central to the relationship between pastoralism and human nutrition in that it allows herders to take advantage of the patchy and asymmetric spatial and temporal nutrient distribution in the rangelands. By being mobile, herders can maintain their animals' productivity in the drylands. These benefits of livestock mobility translate directly to benefits for humans in the form of food security, nutrition, and health, especially for children.

Livestock mobility occurs according to seasonal patterns, with variations to allow herders to optimize animal health and nutrition by maximizing opportunities and mitigating risk. Taking security, alliances, and movement restrictions into account, herders seek the best conditions for animals of different species based on seasonal and annual variations in climate and vegetation. To be effective in managing this mobility, herders must possess a vast array of specialist knowledge of vegetation, soils, water sources, animal health, and the required nutrient balance by species and age. They must be able to manage the social relations necessary to ensure shared access to environmental resources. The system of knowledge, skills, and experience is passed generationally and allows herders to plan livestock movements and adjust as needed in real time. These movement strategies aim to maintain the health of the herd and maximize livestock productivity, which includes ensuring appropriate birth patterns to maximize lactation. Following livestock births, herders use careful systems to proportion animal milk for consumption by calves/kids and by households. In nondrought years, small milk herds remain near sedentary villages during the dry season. Households prioritize young children in the allocation of milk, meaning that the management of reproduction and lactation by herders directly benefits the youngest humans. In addition to the link between animal health and milk production, herders receive better prices when selling healthier animals, which means that (depending on the terms of trade)

a household will generally be able to purchase more cereals if and when they need to sell an animal. In these ways, animal nutrition that results from the system of strategic mobility guided by herder specialist knowledge has direct impacts on child nutrition, health, and household food security.

One of the ways in which pastoral institutions manage nutrition is through interactions between the permanent settlements and the mobile *fora* and, in particular, the movement of women and children to the *fora* and the exchange of milk, sharing of food, and transfer of cash between the *fora* and settlements. Despite the fact that women and children among the study population are generally much more sedentarized than in previous generations, many households in settled villages did maintain strong relationships with those in the *fora*, which helps to smooth consumption across all household members. This was done through regular movement (on foot, and by donkey or motorbike) between these locales and the transfer of information by phone (when possible) or by those moving back and forth. Laisamis and Loiyangalani had the greatest number of respondents reporting that their households were split between settlements and *fora*, followed by Garbatulla and Ngaremara. Many female respondents reported that they preferred spending time in the *fora* as compared to the permanent settlements, largely because of the better and more consistent access to milk for children. However, the drought and subsequent greater distance of herds from settlements made regular access to and exchanges with the *fora* more difficult. Despite these challenges and the existence of the protracted drought during the data collection, the survey data show higher GAM rates for children in sedentary settlements compared to children in *fora*. Put another way, both the quantitative data and the preference of mothers clearly illustrate the *protective nutritional role* of being in the *fora*: spending extended periods of time in the *fora*, even in a severe drought period, correlates to improved nutritional outcomes for children under 5 years of age compared to remaining in drought-affected, food-insecure settlements.

**Governance of pastoral environmental resources**

Numerous customary institutions manage the environmental resources that support livestock mobility. These institutions are covered earlier in this report; here we reflect on how these institutions support the critical overlap between pastoral resilience and human nutrition. Central to this are efforts to ensure livestock access to water and pasture throughout the year to maximize animal health and productivity. Respected male elders constituting the Dehda Council among the Boran and the Council of Elders among the Rendille establish and enforce rules for accessing and using drought reserves and dry season water sources. When followed, these regulations help to prevent overexploitation, ensure equitable access, and mitigate conflict. Limiting access to these areas to times of broader scarcity promotes better health of animals during dry seasons or droughts, in turn supporting human health and nutrition. However, challenges to the success of these institutions come from external factors such as protracted multiyear droughts, efforts by state structures to limit the role of customary institutions in governing environmental resources, and gradual transformation of land tenure systems that hinder systems of common property.

When able to function properly, customary institutions that govern environmental resources are often able to take into account the needs of the human population, including the most vulnerable. For example, by January 2023, most herds had left the Thurasi *fora* due to dwindling supplies of water and pasture, moving east towards the Waso Nyiro River. However, elders decided that households with small herds, weak animals, or who were themselves vulnerable (such as single women or those with many young children) would stay in Thurusi. This decision saved these people and herds from an arduous journey and ensured they had adequate access to pasture once the large herds had departed. This example illustrates the flexibility inherent in the customary systems tasked with managing mobility, risk, and resource use, and shows that these systems are able to consider needs of individual households while also managing the well-being of the larger group.

**Social institutions**

Some of the most critical pastoral institutions for the management of human health and nutrition are the informal reciprocity-based networks for sharing

and support. We discussed both childcare and the sharing of milk earlier in this paper; here we reiterate the centrality of these primarily female-managed systems within the study population. Childcare by secondary caregivers enables women to engage in the time-consuming daily labor that underpins the functioning of many households, especially in periods of decreased animal productivity such as occurs in protracted droughts. Such childcare is obviously essential given the necessity of female labor in this context, but may have negative impacts on child nutrition when food insecurity prevents women from leaving adequate food with the secondary caregivers.

The sharing of milk is another critical form of social support with long-standing roots in pastoral traditions of reciprocity and mutual support. Institutions for sharing milk are intricate and often multifaceted, blending sharing of milk for consumption or cash sale or extended loans of animals. Women frequently control milk allocation within and between households, and those who have access to milk may share directly with those who do not. In the Laisamis study site, women reported sharing milk with vulnerable households for the purposes of sale, thereby allowing those households to generate cash to buy cereals and other necessities. Men may facilitate the loan of a lactating or pregnant animal to a household in need. Extended drought, however, negatively impacts these institutions through impacts on animal reproduction (and hence lactation) and by increasing the distance between the permanent homesteads and the *fora*, making regular access to any milk that is available much more difficult.

Numerous institutions underpin and support the pastoralist system and thus impact livestock productivity and human nutrition. Governance of environmental resources and social institutions, such as reciprocity and sharing, further reinforce the resilience and nutritional benefits of pastoralism. These institutions are dynamic and flexible, and are able to shift and adapt based on circumstances and context, but they are also vulnerable to forces such as repeated and protracted external shocks.

### 6.3.3 Livelihood diversification: the pros and cons for child wasting

Pastoral systems have evolved over time to include greater sedentarization and more diversification of activities, both within pastoralism—such as mixed-species herds and animal trade—and also in sectors that may be outside of pastoral production but often support it, such as transport. The data for this study highlight both the range of diversification (i.e., across multiple activities) and the specificity of certain forms of diversification by site (e.g., fishing in Loiyangalani, farming in Garbatulla, and casual labor in Ngaremara). Importantly, with regard to sustainability and resilience, there is a distinction between diversification for survival or coping purposes—such as the collection and sale of firewood by women as the only means of feeding their households during the drought—and diversification as part of strategic adaptations and spreading of risk into multiple activities by different household members (such as sending some children to school or engaging in trade). Some activities—such as fishing—may be both a survival strategy and a longer-term form of adaptation, depending on the motivation of the household, the balance of risks to reward, and the longer-term aspirations and investments arising from fishing income. In addition, some strategies may be maladaptive, meaning that they fall outside the law (such as banditry or brewing), are harmful to others or to the shared environmental resource base (such as charcoal burning or firewood sale), or aim to deny others access to water, pasture, or forest resources.

Diversification usually plays out differently along lines of gender, age, education, wealth, location, and skills. Here we briefly discuss the ways in which diversification by gender seems to influence child nutrition in the sentinel sites. Able-bodied men are at the center of pastoral production, engaging in the strenuous work of herding and guarding livestock. In simplified terms, we can say that men are the primary providers for the households who rely primarily upon pastoral livelihoods, with women in these households playing important but complementary roles in the care of sick animals, milking and herding small ruminants close to home, and managing the domestic and reproductive spheres. The further a household moves from pure pastoralism and into increasingly diverse activities, the greater the active economic role is for women. In agro-pastoral households, for instance, women usually play a much

larger role than men in cultivation. As households add more diversified activities onto their livelihood portfolio, women play an ever-increasing role, *especially* when this diversification is motivated by survival rather than investment goals. This is because women face fewer sociocultural constraints on diversifying their activities as long as they remain within parameters viewed as an extension of accepted domestic roles. This means that women can engage in a range of activities in the service sector and environmental resource exploitation with minimal social risks. (In contrast, women who attempted to move beyond these domestic parameters—into, for instance, heavy construction or truck driving in the ASAL context—faced a number of social, cultural, and economic hurdles.) Men face similar social approbation if they move out of accepted male roles, but the range of open alternative roles for men is often limited within both pastoralism and numerous other societies. These factors mean that—when faced with a crisis—female household members are often the first to engage in alternative economic activities to make ends meet.

Within the study, the diversified activities pursued primarily by women are normally labor and time intensive, have extremely marginal returns, and may entail security risks. Women must engage in these activities for up to 12 hours per day and sometimes for multiple days, and are often unable to take their children—including breastfeeding infants—with them due to the various risks. Crises such as protracted drought lead to an increase in women's workload and time burden as they diversify their activities in an effort to meet their household's basic needs. This leads to more time that mothers are separated from young children, which in turn affects caregiving behaviors and further exacerbates health risks and poor nutritional outcomes for these children.

Lastly, as illustrated in Figure 14, the four activities classified as maladaptive (forest product collection and sale, charcoal collection and sale, brewing, and chipping stones) are all dominated by women. These maladaptive activities are unsustainable or destructive over the longer term. Women's heavy engagement in these activities is likely to be damaging to both their own nutrition and well-being as well as contributing to the child acute malnutrition prevalent in these locations.

Our analysis reveals the advantages and disadvantages of diversification for nutrition. Women's involvement in coping and survival strategies is essential for household survival due to the decreased productivity of livestock during the drought and the increasing number of households unable to forge sustainable livelihoods through livestock production alone. However, the predominantly female engagement in these marginal and maladaptive activities poses risks, adversely affects childcare and the well-being of women and children, and provides minimal food or income. On the other hand, diversification opportunities that allow for strategic and sustainable adaptations can allow for a distribution of risk across different activities and engagement in these activities by household members of different ages and genders. This diversified and sustainable portfolio can help to bolster and improve nutrition.

## 6.4 Pathways to recovery and resilience

Pastoralist systems are adapted to manage extreme climate variability. While one poor rainy season may not overstretch the system or even negatively affect individual herders, the growing frequency of droughts and consecutive failed rains have placed increasing strains on these systems. These pressures have resulted in extended periods of reduced productivity (in terms of reproduction and lactation) and livestock losses due to disease, weakened livestock condition, raids, and flash floods associated with heavy rains in March/April 2022. Consequently, there has been widespread severe household food insecurity and a generalized shortage of fresh milk, a vital component of the diet.

As explained above, pastoralist institutions have shown remarkable adaptability in addressing these challenges through customary environmental governance and herder drought management strategies, which have extended livestock mobility and maintained intergroup relations. Despite the strain on community social support systems, sharing and reciprocity remain prevalent, giving food, sharing assistance, and providing childcare.

These long-standing institutions are not only foundational to resilient livelihoods but also serve as the frontline of disaster response, supporting and protecting livelihood systems while providing immediate day-to-day help and support at the community level. Thus, these pastoralist institutions

represent a community-based drought management system that leverages knowledge, practices, and social structures while taking a broader landscape-level view of the spatial distribution of resources, ecological conditions, and social relationships. This holistic approach considers the entire ecosystem and the interconnectedness of its elements, supporting sustainable and adaptive resource management.

Despite the lush landscape following the March/April 2023 rains, recovery was not assured due to heavy livestock losses, weak animal conditions, and disruption in the usual seasonal cycle of livestock reproduction and availability of milk. Delays of up to five months in the breeding cycle of goats and up to a year for camels were expected, thus prolonging the shortage of fresh milk and leading to low consumption levels by young children. Restoring livestock numbers to their former levels after heavy losses is an extended and gradual process that depends on more than one good rainy season, and can be interrupted by multiple factors. This delayed recovery has prolonged the shortage of fresh milk and thus contributed to the persistence of emergency levels of child malnutrition.

Perspectives on recovery and rehabilitation differ by stakeholder. Drought relief agencies may consider the disaster to be over with the resumption of the rains, while pastoralist communities understand that reestablishing herds and resuming production is a slow process. Recovery does not necessarily mean restoring former predrought herd levels, but it does require the general resumption of pastoralist production for drought-affected communities, including generating regular income and animal-source foods. Customary systems of environmental governance and herder drought management strategies will almost certainly adapt themselves to these challenges.

Effective recovery will require not only proper environmental governance and adaptive drought management but also a shift in women's livelihood activities from high-risk, marginal endeavors to sustainable, adaptive opportunities. This shift will only occur when and where livestock productivity improves and women can move away from the extremely labor-intensive activities that separate mothers and children for extended periods. However, recovery will be uneven. Many households have lost all livestock and won't rebuild herds, and others have shifted out of pastoral production entirely. Some households have found or will find sustainable alternative livelihood activities that can be performed by various household members. Meanwhile, many other households will continue to rely on women's subsistence activities in marginal sectors to ensure basic survival.

## 6.5 Methodological insights and research priorities

The persistence of high GAM rates despite the long-term presence of numerous national and international NGOs and UN organizations underscores that our current understanding and approach to addressing the drivers of PGAM are incomplete. To address this knowledge gap, we designed a longitudinal mixed-methods sentinel study to understand the spatial and temporal variability of outcomes and the immediate, underlying, and basic drivers. An emphasis on the basic drivers allows us to look beyond treatment and prevention interventions to systems strengthening and drawing attention to the reduction of wasting as a policy imperative for stakeholders at all levels. In this section, we highlight some of the key learning around this methodology and approach in the Kenyan ASALs context and implications for future research.

### 6.5.1 Implications for methodology in the context of persistent GAM

Most studies on child wasting are predominantly quantitative in nature. The results lend themselves best to individual- and household-level comparisons and hence focus primarily upon individual- and household-level drivers of wasting. These drivers relate primarily to the immediate and underlying drivers of GAM. However, this approach misses the basic-level drivers that can affect the entire community or population. Variables often included in quantitative nutritional surveys, such as "household livelihood," "distance of cattle from the village," etc. reflect specific attributes of the basic drivers, but the resulting data provide little or no contextualization. Without an understanding of livelihood systems, institutions, and environmental conditions that enable such activities, the role of the basic drivers cannot be objectively analyzed or addressed. For example, in our study, the link between wasting and the main reported livelihood varies across our sites, showing that what it means to be a livestock herder

in one site might not have the same relationship to nutrition as in another site. Thus, a mixed-methods approach with a strong emphasis on in-depth longitudinal qualitative inquiry should be a requirement for any work done on persistent GAM.

A key advantage of the sentinel site approach is its ability to provide in-depth data on locations representing different livelihood specializations and linked to different ecosystems and resources (environmental, social, economic, political, or societal). This approach allows for a comparison across four sentinel sites, offering deeper insights into community-level determinants of acute malnutrition. Unlike spatial livelihood zones[34] for quantitative surveys, which may overaggregate data across communities or fail to capture historical community knowledge, perspectives, and preferences, the sentinel site approach effectively reveals local livelihood systems and related institutions, as well as their wider influences and interconnections.

Longitudinal data are essential in highly variable climatic contexts where climate variables directly influence household activities and exposures. Our study found that almost every variable had a seasonal component, with differences by site. This highlights the need to focus on temporal variability to understand the peak timing of drivers and when they change in tandem with wasting and hence need to be addressed. Traditional baseline, midline, endline approaches may not yield useful results in such contexts. Additionally, climate data (temperature, precipitation, vegetation) for the region of interest should always be analyzed rather than relying on predefined categorical seasons. For example, even when a season is described as "failed rains," there may still be significant seasonality. In our study, the first year of data collection occurred during an extended drought, yet seasonal variability was observed to almost the same degree as in the nondrought year, differing only in the overall total amount of rain or vegetation (i.e., total amount of rainfall was greater in Year 2 than in Year 1).

The findings also have specific methodological implications for measuring and defining wasting. First, *when* we measure wasting matters. Given high seasonal variability, surveys might identify above-emergency levels of acute malnutrition at one time of year, while the prevalence could be much lower a few months later, even coming close to meeting the SDG goals. Information on both peak and nadir levels of wasting is important; peaks can inform the timing of targeting of interventions, while nadirs can show us what is achievable with regard to child nutrition. However, only comparing wasting data collected in the same calendar month across years or in different sites may not be appropriate (i.e., don't just compare April one year with April another year). Our research shows that while all sentinel sites generally have two peaks of wasting, the severity and which peak was highest varied by sentinel site. Similarly, comparisons across years using once-off surveys conducted in the same calendar month might also be misleading, given the high climatic variability in the seasons themselves.

Second, *how* we measure wasting matters. Relying solely on MUAC can obscure differences in malnutrition across sex and age that are observed with WHZ (as girls and younger children are generally more likely to be identified as malnourished using unadjusted MUAC). In contexts where older children are at greater risk of becoming wasted, MUAC also leads to a lower prevalence as it often misses older children who might be wasted. While MUAC adjusted for height and age yields results closer to WHZ findings, it still underestimates prevalence compared to WHZ. Thus, great care needs to be taken in how wasting is measured, and transparency should be provided on the limitations of each method, including WHZ. Ideally, better data on functional outcomes, such as mortality, associated with the different measures of wasting are needed to determine the most appropriate index, or combination of indexes, for preventing malnutrition and mortality in a population.

Third, on *whom* we collect anthropometric data matters. Most nutrition surveys focus on pregnant and lactating women when collecting and analyzing adult nutrition data. However, our data on MUAC for all female caretakers underscore their high level of vulnerability and the robust relationship between their nutritional status and that of their children. Better information on the nutritional status of the

34 https://fews.net/east-africa/kenya/livelihood-zone-map/march-2011.

entire household reveals the interlinked nature of caretaker and child nutritional status, which has direct implications for whom in the household is targeted when acute malnutrition prevalence is high.

### 6.5.2 Implications for future research

The longitudinal mixed-methods study identifies gaps in our understanding of persistent GAM that need to be addressed with additional research on:

- analysis of missingness as it relates to *fora* migration
- relationship between anthropometric indicators and indices with body shape and functional outcomes
- livelihood variable construction: how to take into account livelihood strategies using quantitative data

We found highly varying rates of attrition across the study sites in the first year of the longitudinal study. In Year 1, compared to the initial household sample, we were missing 29% of households in Laisamis, 12% of households in Ngaremara, and 11% of households in Garbatulla. The site-specific variation in missingness is attributed to strategic mobility of livestock (though of course it's not the only thing that accounts for it) both through qualitative follow-up on the missing households as well as the site-specific distribution of households found in the *fora* (in Year 2 data collection). While we were able to follow some children to the *fora*, it was not part of the original study design or funding, and hence was only done in Year 2 and only in select areas. Thus, we need to carry out follow-up longitudinal research that includes a representative sample of *fora* households and tracks them to any and all *fora*. Currently, migrating households are likely not included in standard program evaluations or monitoring surveys, including key national surveys such as SMART and DHS. In order to design programs and policies that address both the specific vulnerabilities and the sources of resilience of this mobile group, we need to both understand how their missingness might bias existing data sources and make sure they are included in those data sources to accurately represent the population of the ASALs.

The research shows that the indices we use to define wasting (WHZ, MUAC, MUAC for age, and MUAC for height) result in very different assessments of the severity of malnutrition. The indicator of choice further affects what child sub-samples (younger vs. older; girls vs. boys) are more likely to be captured as wasted and also to influence both findings of seasonal trends and trends over time. To be able to select the most appropriate indicator, we need to better understand how it relates to functional outcomes. The relationship with functional outcomes might be different given the severity of the emergency and thus needs to be reviewed in the presence of a humanitarian emergency. The ultimate goal in humanitarian work is to save lives, and thus identifying which indicator (for this population) is the best leading proxy of mortality would allow for better selection of the appropriate nutritional index. Similarly, we need to understand how body shape is directly linked (or not) to the differences in indices and in relation to mortality.

The last implication for research has to do with how we construct and understand the livelihood variable. In quantitative research, we usually use a categorical variable on the main source of income or food for the household and thus assume that the livelihood categories are mutually exclusive. To account for this slightly incorrect assumption, usually a livelihood diversification variable is also included as a numeric variable of all the livelihood activities the household practices. However, the qualitative work clearly shows that while there might be a dominant livelihood that relates to the history of the household, rarely is this livelihood practiced exclusively. We propose further investigation into how these different livelihoods are clustered and hence how those clusters are associated with the outcomes of interest such as child nutritional status. Identifying resilient and vulnerable clusters of livelihoods might allow for more effective targeting as well as the design of livelihood support programs.

# 7 Conclusions and Implications of the Findings

The persistence of child acute malnutrition for the past 20 years or more has been further proven by the study findings, confirming these sentinel sites are indeed malnutrition hotspots. Study findings show that older children (ages 3–5 years) are at a greater risk of acute malnutrition and that female caretaker nutritional status is strongly correlated with child nutritional status in the household, findings that have implications for information systems, program design, and targeting. Malnutrition has dire consequences for the individual child, in terms of risks of disease, death, and development issues. Moreover, these persistently high rates are indicative of deeper, more serious problems linked with entrenched systemic failures that, in the time frame of this study, Nawiri has been unable to fully address. The study findings have major implications for all stakeholders, as they reflect deeper failures and missed opportunities of both development and humanitarian systems. The sustainable prevention of child acute malnutrition is a collective responsibility, from the village to the highest level of government, and cannot be ignored.

The study findings shed light on the basic drivers of child acute malnutrition in the Kenyan ASALs. This analysis and understanding of basic drivers contextualizes and explains the consistently high rates of child malnutrition (and their association with maternal nutritional status). The results are complex, demonstrating seasonal and spatial differences in drivers of malnutrition, how they are linked to livelihoods, climate, and environment, and how they interact with and are shaped by the multiple institutions and relational dynamics that are foundational to supporting resilient livelihoods and community social support mechanisms.

We share below a review of the implications of the study findings for response, including:

1. nutritional assessments, surveys, and information systems
2. effective responses to shocks and seasonal stresses
3. sustainable livelihoods and adaptive diversification
4. formal and informal institutional frameworks
5. learning, uptake, and systems strengthening

Incorporated under each of the above areas are considerations for policies and legal frameworks, assessments, monitoring and evaluation, direct interventions or investments, and further research.

## 7.1 Implications for nutritional data collection and analysis (surveys and surveillance)

This study's anthropometric implications have particular relevance for data collection and analysis for the Standardized Monitoring and Assessment of Relief and Transitions (SMART) surveys and also the Kenya Demographic and Health Surveys (KDHS). Additionally, there are important implications with relevance for the National Drought Monitoring Authority (NDMA), the Kenya Food Security Steering Group, and the county-level steering groups supporting the seasonal food security and nutrition assessments.

1. Presentation of GAM rates
    - Disaggregate GAM rates by sex and age groups (e.g., separate 6 months to 23 months, and 24 months to 59 months).
    - Disaggregate geographically as far as possible given the high level of spatial variability to allow the identification of hotspots.
2. Additional anthropometric variables
    - For NDMA monitoring, consider incorporating child WHZ, child MUAC-for-age, caretaker MUAC.
    - Collect and analyze adult MUAC from all females, not just pregnant and lactating ones.

3. Data aggregation
    - Consider the implications of data aggregation (by county, sub-county, ward, season, etc.) for the level of detail needed for appropriate analysis of drivers, design, and targeting.
4. Seasonal assumptions
    - Avoid simplistic assumptions regarding fixed climatic seasons or the same seasonal patterns across different locations, even if in the same administrative zone.
    - Use remote sensing climate data to establish seasonal conditions and enable seasonal comparisons with other data.
    - Avoid using categorical variables to measure seasonality (i.e., dry versus rainy season; harvest vs. postharvest, etc.).
5. Timing of data collection
    - Consider the utility of SMART surveys given the seasonal variability, and only use if combined with analysis of seasonal conditions.
    - Scheduling SMART surveys: review the timing of SMART surveys (currently mainly in cool dry season) and consider conducting during GAM peaks—November/December or April (rainy seasons)—and at the likely lowest GAM levels in July/August/September.
6. Improve population representation in surveys
    - Address exclusion of fora households from SMART surveys, assessments, and monitoring in order to ensure more representative results.
7. Variables for assessing food security, livelihoods, nutrition, and health
    - Use longitudinal study findings to strengthen health, nutrition, and food security information systems by ensuring those indicators that were found to be significant are routinely included.
    - Consider the seasonal behavior prevalent in almost all variables (outcomes and drivers). Collect retrospective MAHFP if aiming to determine seasonality of food insecurity.

## 7.2 Implications for effective responses to shocks and seasonal stresses (treatment and prevention of malnutrition)

The study findings show the reverse of the expected trend that younger children suffer high GAM rates compared to older children (ages 3–5 years). The most recent Kenyan DHS also shows the trend of older children having higher GAM rates. To ensure that this pattern is not being overlooked, we recommend the following:

1. Review age-specific targeting criteria to ensure malnourished children from 3 to 5 years are targeted. Note that a single MUAC cut-off (e.g., less than 125 mm) is likely to exclude some older children whose WHZ is < −2 z-score.
2. Extend the policy of prioritizing infants and young children beyond "1,000 days from conception in a child's life" to include children from 3 to 5 years.
3. Expand targeting criteria in malnutrition hotspots where GAM rates are above the emergency threshold, e.g., conduct blanket coverage of all children or households with children below 5 years of age. Blanket targeting is more efficient and the effects less likely to be undermined by sharing. For example, implement food distribution for all households with children under 5 years and provide social protection (cash distributions) for vulnerable households.
4. In malnutrition hotspots, expand nutrition screening programs to include all women caregivers.
5. Improve the coverage of outreach, screening, and treatment programs to cover women and children in the *fora*. For example, expand community screening through the use of "family MUAC[35]" and other methods to increase screening coverage, with particular focus on *fora* populations.
6. Expand treatment coverage by using simplified approaches to treat wasting; for example:
    - Include integrated management of acute malnutrition as part of integrated

35 Caregivers are trained to use the MUAC tape to regularly screen their own children for signs of malnutrition.

community case management. The latter is designed to extend essential services for the treatment of common childhood diseases to hard-to-reach communities.

- Consider a simplified combined protocol to integrate the treatment of severe acute malnutrition and moderate acute malnutrition into a single, streamlined protocol, using a single product.
- Review simplified admission criteria to ensure older children are not missed. Research is ongoing on various approaches, including in Kenya, some with promising positive results.

7. Review community-level services for children aged 3 to 5 years; for example, access to nursery schools and nursery school feeding programs.
8. Ensure the needs of mothers of malnourished children are considered and addressed as part of the treatment of child malnutrition.
9. Monitor and report on the relapse of children following discharge from treatment for up to six months, and develop follow-up strategies for community-based support. Consider relapse as an indicator of program performance in persistent GAM areas.
10. Review the appropriateness, coverage, and efficacy of typical nutrition-sensitive programs aimed at prevention of malnutrition in the Kenyan ASALs (particularly given the lack of evidence on impact).
11. Tailor response strategies according to the specific community-level drivers of acute malnutrition, which vary seasonally and operate in different locales or hotspots. Understanding how drivers change over time (seasonally) and in space (as hotspots shift, for example) is vital for a successful prevention program.

## 7.3 Implications for sustainable livelihoods and adaptive diversification

Recently, many global nutritional programs and interventions aimed at preventing wasting have focused on food systems. These programs emphasize the need to increase the year-round production and consumption of safe, diverse, and nutritious foods, especially for women and children.[36] In Isiolo and Marsabit, most people rely on pastoralism, and sometimes agro-pastoralism and fisher-pastoralism, to meet their food, income, and other needs. Therefore, a food systems approach in the Kenyan ASALs should start with a focus on people's established livelihood systems and how people are adapting and diversifying, as reviewed in this study.

Our analysis highlights the pros and cons of livelihood diversification for nutrition. Women's heavy involvement in marginal and time-intensive survival strategies is often risky, with at times adverse effects on the well-being of children and women. These activities are often maladaptive and have extremely low returns, providing paltry amounts of food or income. On the other hand, the nutritional benefits can outweigh the risks when diversification involves strategic adaptations into more sustainable sectors and the spreading of risk across multiple activities by different household members. Implications from this study for stakeholders at the county, national, and international level include:

1. Ensure community livelihood profiles are available and applied in the planning stage of external interventions. This should include analysis of what people do by age and gender, including their livelihood production strategies, adaptive diversification, coping and survival strategies, and their access to resources and institutional frameworks.
2. In the context of severe food insecurity, consider blending cash and food, and better coordinate coverage to prevent overlapping programs.
3. Prioritize humanitarian interventions that support pastoralist livestock production and mobility,

36 USAID, "USAID Position Paper on Child Wasting" (USAID, 2023).

and ensure they are adapted to the specific local context.[37] For example, in Laisamis provide fodder distribution for young kids (who would otherwise die).

4. Address barriers to mobility and support mobility to distant drought reserves.
5. Enhance transport systems and networks between communities and distant *fora* for community members.
6. Support strategic livelihood adaptations that spread risk and enhance resilience, ideally through a focus on existing local institutions. In the sentinel sites for this study, this would include strengthening value chains for milk products and fish and supporting small-scale irrigated farming.
7. Strengthen community-based childcare systems through outreach and targeting of secondary caretakers (grandmothers and others).
8. Broaden program objectives to include monitoring indicators of community-level recovery, such as tracking community-level rates of malnutrition and monitoring the implementation of community action plans to provide adequate care and support of children, especially those from 3 to 5 years.

## 7.4 Implications for strengthening systems and institutions

In order to create substantial and sustainable reductions in the prevalence of acute child malnutrition in the ASALs, change will need to take place at the level of systems and institutions, including legal and policy frameworks. Systems strengthening needs to begin at the institutional level.

The situation in the Marsabit and Isiolo study sites during the extended drought would have been markedly worse without the pastoralist institutions that support mobility, govern environmental resources, and facilitate social safety nets of sharing and exchange. These systems and institutions enabled at least some animals to survive the drought; the gradual return to productivity of these animals provides the basis for the rebuilding of herds. However, the customary pastoralist institutions are themselves vulnerable to the effects of protracted and compounded shocks, such as repeated or extended droughts overlaid with intergroup conflict. The loss of large numbers of animals, for instance, eradicates the medium of exchange for customary sharing networks (animals and milk), systems of reparation, and social institutions such as marriage. Barriers to mobility also prevent the effective functioning of the pastoral system, including measures to manage access to resources and mitigate and resolve the conflicts that can occur in areas of resource competition.

To date, most nutrition interventions focus specifically on the malnourished children and sometimes their family members, with little to no acknowledgement or attention to the local social systems, networks, and relationships that connect and support women, children, and their families. Instead, social sharing systems are sometimes blamed by international actors for undermining therapeutic and supplementary feeding (i.e., when foods are shared beyond the intended beneficiary). External efforts and inputs should aim to complement and match these existing institutions

37 Livestock Emergency Guidelines and Standards (LEGS), *Livestock Emergency Guidelines and Standards. Third edition* (Practical Action Publishing, 2023).

and social support systems, including through the following means:

1. Protect land and environmental resource rights, including access to drought grazing reserves and the collective or co-management of water resources.
2. Support pastoral mobility as a policy priority, combined with the protection of migration routes and access to resources.
3. Ensure conflict sensitivity in program design, conflict resolution, and peacebuilding.
4. Develop preparedness plans and anticipatory actions in readiness for the return of the rains post-drought. For example:
    - Ensure availability of and access to mosquito nets in advance of the rainy season.
    - Monitor and provide weather forecasts to herders linked to local anticipatory actions, such as moving animals from flood plains and ravines to higher ground.
    - Consider community-based mechanisms for the delivery of cash and food aid interventions.
5. Mapping existing social support networks and institutions could help to define appropriate targeting mechanisms for distribution of cash, food, and longer-term development inputs.

## 7.5 Implications for learning, uptake, and systems strengthening: knowledge is power

To ensure that the new evidence leads to more effective policy and deeper institutional change, it must be incorporated into an uptake strategy that promotes evidence-based learning and multilevel systems strengthening. Further review of the implications of this study for specific policies, programs, and practices should be driven by stakeholder interests. Participatory processes are essential to accommodate divergent perspectives and varied knowledge of stakeholders, in order to reach a shared understanding of drivers and potential solutions. The multiple stakeholder perspectives and varying levels of knowledge can be a challenge for promoting learning. Thus, findings must be incorporated into a wider learning agenda that is relevant to the target audience and in a suitable format.

Local-level dissemination and uptake is a crucial part of the learning and uptake process, given the existing institutions that support resilience and nutrition, and is linked with local community action. Recognizing and targeting local actors' interests and expertise when planning, implementing, and disseminating research findings are crucial. The shared knowledge that emerges from these processes can become the foundation for debate between local development actors and communities in local priority-setting, implementation, and monitoring of programs for addressing the basic drivers of malnutrition and strategies for sustainably reducing levels of persistent acute malnutrition.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