World Journal of Agricultural Science and Technology
2025, Vol. 3, No. 1, pp. 12-23
https://doi.org/10.11648/j.wjast.20250301.12

Research Article

Drought Impact on Livestock Production and Mitigation Measures by Smallholder Dairy Farmers in Teso South Sub-County, Kenya

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Abstract

Climate change impacts in Busia County have direct effects on reduced and unpredictable rainfalls and indirect effects of reduced availability of livestock fodder for the smallholder dairy farming. Despite the immense contribution of this sub-sector to the county's Gross Domestic Product, not much has been done to profile the direct effects on smallholder dairy farming and how farmers cope with them. To produce effective strategies for managing and coping with climate variability, there is need for smallholder dairy farmers to differentiate climate-related risks from other agricultural production risks. Clearer understanding of climate-related risks and their associated impacts on livestock production forms the foundation for continued learning and choice of strategies that are likely to enhance mitigation measures. This study therefore delved into understanding the drought impacts and how smallholder dairy farmers in Teso South Sub-County cope with them. Mixed design approach was employed. Primary data was collected using semi-structured interview schedules from 246 smallholder dairy farmers. Data was analysed using descriptive and inferential statistics (ANOVA) via SPSS Version 23. Results showed that the impact of drought was moderate but had no statistically significant difference among the various agroecological zones. The study also discovered that the various coping mechanisms of interest were not commonly utilised by farmers but showed significant variations within the three agroecological zones. The study recommended that further research should be done to determine the commonly used drought coping mechanisms in the area since it was apparent that drought had an impact on smallholder dairy production.

Keywords

Drought, Impact, Coping Mechanisms, Smallholder Dairy

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Received: 7 April 2025; **Accepted:** 18 April 2025; **Published:** 19 May 2025

1. Introduction

1.1. Background of the Research

Variations in climate have shown diversity and adversity in impacts on human systems, water scarcity and food insecurity [1]. Climate change is aggravating the occurrence of extreme weather events like perennial droughts which represent a significant hindrance for the economic growth of the third world countries, leads to mortalities, destruction of livelihoods and critical rural infrastructures as well as reduction of capital stock [2]. Of all climate-induced disasters, drought has been identified as the most impactful in terms of devastation and cost [3]. Prolonged droughts and related disasters are major causes of the breakdown in the balance in resource use among the livestock keeping communities. They are a major constraint to rain-fed agriculture especially in arid and semi-arid areas [4]. However, climate change predictions point that many areas will witness droughts with more frequency and more severity. Smallholder farmers usually lose their livelihoods and agricultural investment [5]. During the same periods, these farmers are unable to cope without external aid in the form of relief packages from governmental and non-governmental bodies. In Africa, it is projected that the impacts from natural disasters will be significant despite having a greenhouse gas emission rate of less than 4%. Africa is expected to be one of the regions most affected by climate-related shocks [6]. Climate change acts as a multiplier of risks as well as an amplifier of the intensity of extreme weather events as well as the vulnerabilities [7]. The Intergovernmental Panel on Climate Change (IPCC) has pointed out a trend of future warming scenarios, which stress the seriousness for the crisis. Africa's temperatures are projected to increase at rates higher than global averages ranging from the lowest of 0.2 ℃ and 0.5 ℃ at the low and high end respectively for each decade [8]. The climate variability impact is expected to induce the vulnerability to livestock production systems through impaired feed intake, metabolism and body defence mechanisms [9]. Livestock rearing in the African continent encounters numerous stressors which through interaction with climate change and variability can magnify the vulnerability of livestock-rearing communities. These stressors include but not limited to degradation of rangelands, increased limited access to water resources and fragmentation of grazing lands [10].

According to IPPC's numerous reports, climate change is one single-most responsible thing for the change in rainfall quantities and patterns accompanied by the several degrees of extreme weather events in East Africa in recent years. According to the EAC Regional Climate Vulnerability Impacts Assessment (VIA) report 2018, the GDP contribution of agriculture has gone down especially in Tanzania. This is due to increasing climate vulnerability and changing trends leading to reduced agricultural productivity, partly because of the region's smallholder farming communities' over-reliance on rain-fed agriculture [11]. Reduced rainfall in majority of the areas in the sub-region has placed tremendous pressure on smallholder livestock farmers. Body wasting due to pasture and water scarcities means livestock fetch reduced prices leaving pastoralists with reduced disposable income to acquire basic foods [12].

The Western Kenya region has suffered reduced (below-average) rainfalls in the recent past with maize prices rising by up to 30 percent, an increase occasionally sustained by imports from the neighbouring Uganda [12]. These climate-related events result in loss of lives, property and livelihoods, resulting in weakened food and nutrition security of the concerned populations [13]. Consequently, in Kenya, climate change presents both direct and indirect impacts on livestock. Direct effects reduce livestock numbers and their products, and this is primarily driven by increased temperatures and frequent heat waves [14]. The alternating hot and dry seasons have led to a significant reduction in biomass accumulation for various types of grass growing in lowland areas. Rinderpest, pasteurellosis, foot and mouth disease, contagious bovine pleuropneumonia, anthrax, diarrhoea, skin and lung diseases, as well as endo- and ecto-parasites are significant infectious diseases and pests affecting livestock during drought events. Climate change escalates this situation, for example, among 65 livestock diseases of significance to poor people, 58% are climate sensitive [15]. Additionally, the consequences of drought on livelihoods include food shortages, famine, forced sale of livestock to buy grains, reduction of livestock herd sizes, increased exploitation of woody vegetation cover among others [16].

Pastoralism is the mainstream livestock rearing system in the Busia County. It is characterized by high dependence on natural pastures. Currently, the traditional rearing practices are not able to respond efficiently to the recurrent animal feeding and watering requirements [17]. Therefore, in the last few years pastoral resources in the region have strongly deteriorated in quantity and quality, spatial distribution and livestock access. In this period, cattle products declined because pasture ran out, while many which were taken to boreholes consumed all the grass around them, so that other livestock taken there later starved.

Livestock rearing is very important for Busia County. Its contribution to the County Gross Domestic Product (GDP) is high with the Dairy Sub-sector taking prominence [18]. This sector employs a higher percentage of the rural population constituting an important source of their livelihood. The County has dairy cattle population of 25,358. It also has 210,443 dual purpose cattle kept for milk production and beef production. Currently, the County produces 27,367,551 litres/year of milk with Nambale, Teso North, Teso South and Butula Sub-counties respectively leading in production.

In the Teso South Sub-County, which is characterised by ambient climatic conditions, pasture resources are rich in

nutritive components and constitute attractive sources of livestock herds coming from different areas within the region. The Sub-County entirely has 3,832 acres under Napier grass, 150 acres under hay, 342 acres on *bracharia* and approximately 5,000 acres on browse and natural pastures. This study aimed at assessing drought impacts on livestock production and mitigation measures in the Teso South Sub-County.

1.2. The Problem

Climate change impacts continue to be witnessed in Busia County with direct effects on reduced and unpredictable rainfalls and with indirect effects of reduced availability of fodder. Despite the immense contribution of this sub-sector to the county's GDP, no single study has been done to profile how farmers cope with the drought impacts. To come up with effective strategies for managing and coping with climate variability, there is need for smallholder dairy farmers to differentiate climate-related risks from other agricultural production risks. Clearer understanding of climate-related risks and their associated impacts on livestock production forms the foundation for continued learning and choice of strategies that are likely to enhance mitigation measures. This study therefore delved into understanding the drought impacts and how smallholder dairy farmers in Teso South Sub-County cope with them.

1.3. Purpose of the Study

The purpose of this study was to assess the impact of drought and the coping mechanisms by the small holder-dairy farmers in Teso South Sub-County.

1.4. Objectives of the Study

The objectives were:

1. To assess the farmers perception of drought on smallholder dairy production.
2. To describe the impact of drought on smallholder dairy production.
3. To describe the drought coping strategies adopted by smallholder dairy farmers.
4. To determine the difference in the impact of drought on smallholder dairy production.
5. To determine the difference in coping strategies adopted by small holder dairy producers.

1.5. Research Questions

1. What is the smallholder dairy farmers' perception of drought?
2. What is the impact of drought on smallholder dairy production?
3. What are the drought coping strategies adopted by smallholder dairy farmers?

1.6. Research Hypotheses

1. H_{01}: there is no statistically significant difference in the impact of drought on smallholder dairy production.
2. H_{02}: there is no statistically significant difference in drought coping strategies adopted by smallholder dairy farmers.

1.7. Significance of the Study

Kenya is among the developing countries bearing the brunt of climate change witnessed by recent frequent drought events. Smallholder dairy farming is one of the mainstays of Busia County's economy, yet farmers continue to suffer losses occasioned by this catastrophe. This study looked at the impact of drought and how farmers cope with them. This is important for policy making so that the County government and other stakeholders understand, and address issues of concern related to climate change.

1.8. Justification of the Study

Drought impact of climate change is a matter that has significance in Kenya. The means that farmers adopt to adapt to climate variation events may differ from strategies employed to adapt to drought. Therefore, it is critical to clearly understand the farmers' adaptation to drought as a means for designing and executing appropriate drought adaptation mechanisms to promote sustainable agriculture in Teso South Sub-County. The study was therefore meant to expand theoretical knowledge and understanding of drought adaptation strategies.

1.9. Limitation of the Study

The research only gathered information from smallholder dairy farmers, hence the generalization of the findings to other farming ventures was impossible. Equally, it sought certain information which required the farmers' understanding of climate change and its impacts hence limited data would be gathered from farmers with minimal educational attainment.

2. Methodology

2.1. Research Design

The study adopted a mixed design approach.

2.2. Study Location

This study was done in the Teso Soth Sub-County. The Sub-County is in Busia County of the Western region of Kenya. It is bordered by Uganda to the West, Teso North Sub-County to the North, Bungoma County to the East and Nambale and Matayos Sub-Counties to the South. The

Sub-County has a land area of about 302.9 km^2 with an arable land area of approximately 223 km^2 and a human population of about 170,000 people with 555/km^2 population density. Its average annual population growth is 2.0%. It has a bimodal rainfall pattern with a range of 1000 mm-1500 mm and temperature range is 14 ℃ - 30 ℃ whereas altitude is undulating with a range of 1200-1500 meters above sea level. The area's agro-ecological zones are Low Midland 1 (LM_1), Low Midland 2 (LM_2) and Low Midland 3 (LM_3). The Sub-County has 26,895 livestock farming households with 902 exotic dairy cattle and 11,093 indigenous cattle [19].

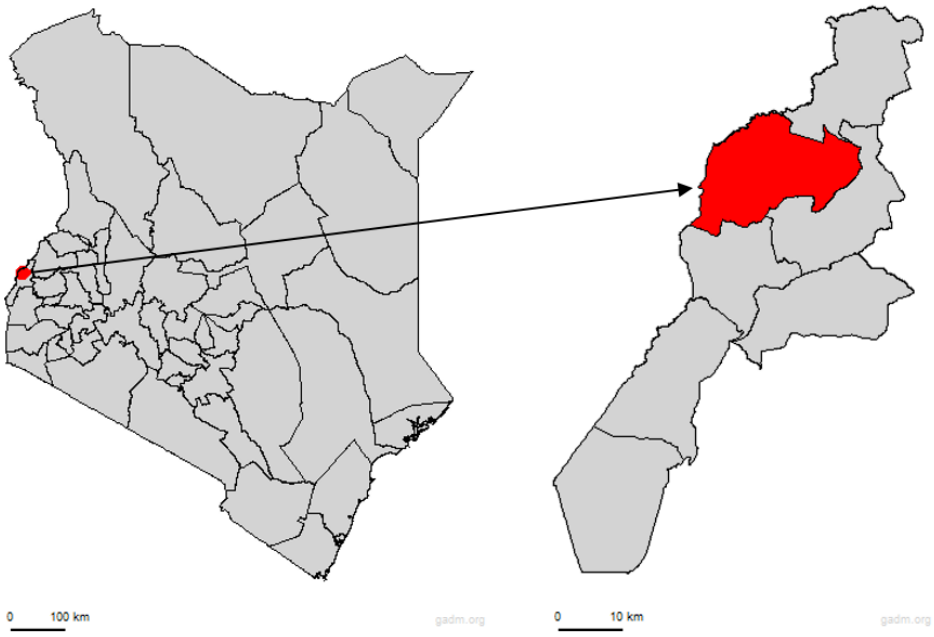

Figure 1. *Map of Teso South Sub-County.*

2.3. Sampling Procedure

Sampling was done using a multistage technique to arrive at an appropriate sample size. Relying on the Busia County Government agro–climatic zoning, the study area was stratified into Low Midland 1 (LM_1) (600-650 mm-predominantly Chakol North and Amukura West Wards), Low Midland 2 (LM_2) (650-700 mm-Angorom, Chakol South and Amukura Central Wards) and Low Midland 3 (LM_3) (700-735 mm-predominantly Amukura East Ward) (Table 1). Cluster sampling technique based on the agro-ecological homogeneity of the area was employed to determine the number of households residing in each similar agro–climatology zones and then an estimation of the sample size was done basing on Cochran (1963) as shown in the equation.

$$n_0 = \frac{z^2.p.(1-p)}{e^2}$$

e: desired level of precision, the margin of error.

p: the fraction of the population (as percentage) that displays the attribute.

z: the z-value, extracted from a z-table.

The equation was applied to get a sample of 20 percent of the households. Thereafter, systematic random sampling was used to proportionately get the total number of households residing in each of the similar Agro-Ecological Zones, multiplied by the required sample size (i.e., 246) divided into the total number of households of the study area (i.e., 41,803) (Table 1).

Table 1. *Sample size determination in AEZs.*

AEZ	Total Households (hh)		Collected sample size (n=246)		Total area coverage	
	hh	%	n	%	sq km	%
Low Midland 1 (LM1)	6109	14.6	36	15	454.5	25.6

AEZ	Total Households (hh)		Collected sample size (n=246)		Total area coverage	
	hh	%	n	%	sq km	%
Low Midland 2 (LM2)	34,324	82.1	202	82	1297.2	73
Low Midland 3 (LM3)	1370	3.3	8	3	24.8	1.4
Total	41,803	100	246	100	1,777	100

2.4. Data Collection

The research assistants visited the identified farmers at convenient times to collect data. From the 246 respondents, the relevant information was gathered by filling-in the semi–structured interview schedule.

2.5. Data Analysis

Data was analyzed using SPSS Version 23.0. Descriptive statistics were used to describe data on demographics as well as research questions. Data on objective one was presented and described. Data on objective two and three was described presented as indices generated from four and three items respectively, interpreted as 1.00-1.65= low, 1.70-2.35= moderate and 2.40-3.00= high, for impacts of drought and 1.00-1.65= not common, 1.70-2.35= common and 2.40-3.00= very common for drought coping mechanisms. To test the hypotheses, ANOVA was employed.

2.6. Expected Findings

This study was expected to reveal various ways in which drought has impacted on smallholder dairy production. It was expected to bring out the coping strategies farmers were adopting to respond to the drought impact on smallholder livestock production.

3. Results and Discussions

3.1. Demographic Characteristics

The demographics of the respondent are as shown in Table 2.

Table 2. *Demographic characteristics.*

Characteristic	Frequency	Percent
Agro-ecological zone (n=246)		
Low Midland 1 (LM_1)	36	14.6
Low Midland 2 (LM_2)	202	82.1
Low Midland 3 (LM_3)	8	3.3
Total	246	100.0
Gender (n=246)		
Male	168	68.3
Female	78	31.7
Total	384	100.0
Age (n=243)		
<20	9	3.7
20-29	24	9.9
30-39	64	26.3
>39	146	60.1
Total	246	100.0
Level of education (n=246)		
No formal education	74	30.1
Primary	87	35.3
Secondary	46	18.7
Post secondary	39	15.9
Total	246	100.0
Main Source of livelihood (n=240)		
Animal husbandry	11	4.6
General/mixed farming	229	95.4
Total	240	100.0
Household size (n=246)		
<3	79	32.1
3-6	83	33.7
>6	84	34.1
Total	246	100.0
Farm size in acres (n=246)		
<1	82	33.3

Characteristic	Frequency	Percent
1-2	106	43.1
>2	58	23.6
Total	246	100.0
Number of dairy livestock kept (n=245)		
1-2	175	71.4
3-4	58	23.7
>4	12	4.9
Total	245	100.0
Number of years in livestock husbandry (n=239)		
<4	88	36.8
4-10	95	39.7
>10	56	23.5
Total	239	100.0

In this study, agro-ecological zones were the sampling units. As can be seen from the results in Table 2, Low Midland 1 (LM_1) had 14.6% of the respondents whereas the majority (82.1%) came from the Low Midland 2 (LM_2). The remaining 3.3% came from Low Midland 3 (LM_3).

With respect to gender, majority (68.3%) of smallholder dairy farmers in the study location were males while only 31.7% were females. This implies that majority of the farmers practicing smallholder dairy production are males, with just about a third being women. With respect to age, 3.7% of farmers were less than 20 years while 9.9% were in the age range of 20-29 years. Furthermore, 26.3% were in the 30-39 age bracket while majority (60.1%) were older than 39 years. This implies that most of the farming population is ageing while very few young people are involved in this kind of agricultural venture.

Education level is a key factor since it influences many aspects including decision-making by the farmer. In this study, 30.1% of the farmers had no formal education while slightly more than a third (35.3%) had completed primary school. Similarly, those who had secondary education as the highest attainment were 18.7% whereas just 15.9% had the post-secondary school qualifications.

The study also sought to determine if animal husbandry was the main source of livelihood, and the results were that only 4.6% depended on it. Majority of farmers practiced mixed farming upon which they derived their livelihood, implying that farmers in the study area have not embraced pure dairy farming for profit and that it can be used as the main venture to get a living from.

With respect to the family size, the distributions within categories were almost equal with 32.1% having a household size of less than 3 members, 33.7% having 3-6 members while the other segment of 34.1% of the families were composed of more than 6 members. This presents a finding than the average household size for the farming community is in the range of 3-6 members.

Farm size determines the farming activities a farmer can undertake. For this case, a third (33.3%) of the farmers had less than 1 acre for farming activities as well as homestead. On the other hand, 43.1% of the farmers had 1-2 acres, while 23.6% of them had more than 2 acres under their ownership and use.

The study also sought to find out a matter of interest, that is the number of dairy livestock kept. It found out that majority (71.4%) of farmers had 1-2 dairy animals while slightly less than a quarter (23.7%) kept 3-4 animals for milk production. A very small number of farmers (4.9%) had more than 4 dairy animals. This therefore represented smallholder dairy production to the truest of its meaning. The farmers were also asked to indicate the numbers of years they had been in livestock production and the results indicated that 36.8% had been in the venture for less than 4 years. Furthermore, 39.7% had practiced livestock farming for a period ranging from 4 to10 years. Slightly less than a quarter (23.5%) had done it for more than 10 years.

3.2. Perception of Drought

The study sought information to determine the farmers' perception of drought, and the results are as shown in Table 3.

Table 3. *Perception of drought.*

Item	Option	Frequency	Percent
Meaning of drought	Less or no rain in a season leading to drinking water scarcity for livestock	199	80.9
	Increased atmospheric temperature	47	19.1
	Total	246	100.0
Drought is best described as mismanagement of water resources by those responsible for managing water	True	104	42.3

Item	Option	Frequency	Percent
	False	142	57.7
	Total	246	100.0
Have you experienced droughts in the past few years?	Yes	231	95.1
	No	12	4.9
	Total	243	100.0
What is the frequency of occurrence of severe droughts in your area?	0-5 years	232	94.3
	6-10 years	14	5.7
	More than 10 years	0	0.0
	Total	246	100.0
How do you acquire information related to drought?	Through T.V and/ radio	174	70.7
	Through newspapers	6	2.4
	Through social media	30	12.2
	From extension officers/agricultural field days	36	14.6
			100.0

Farmers were required to indicate what the term drought meant to them and the results showed that majority (80.9%) understood it as "having less or no rain in a season leading to drinking water scarcity for livestock". On the other hand, only 19.1% understood drought as having "increased atmospheric temperature". To this end, it can be said that majority of the smallholder dairy farmers understand the true meaning of drought, while the remaining minority needs more sensitization to have a clear understanding of the meaning of drought.

The respondents were equally asked to show if it is true or not that the best description of drought is that it is the mismanagement of water resources by those responsible for them and 42.3% indicated this as false while that majority (57.7%) showed that this was false. This is an indication that majority of the farmers can clearly describe what drought is.

Asked whether they had experienced drought in the past few years, majority (95.1%) of the farmers indicated that they had, while only 4.9% indicated that they had not. This is an indication that drought is a very common phenomenon in the study location. Therefore, serious interventions need to be put in place for farmers to be shielded from such.

On how frequent droughts do occur in the study area, the majority (94.3%) indicated that it is a common phenomenon which occurs every 5 years while very few (5.7%) showed that they occur every 6-10 years. No respondent indicated that droughts occur after every 10 years. This therefore shows that droughts are a common thing in Teso South Sub-County.

Drought information helps the farmer to gain more understanding of it. Therefore, the source of information regarding drought is crucial for farmers. Having been asked how they obtain information regarding drought, the majority (70.7%) indicated that their main source of drought related information is newspapers. A small number (2.4%) indicated that they get such information from the newspapers while another substantial number (12.2%) cited social media use as the main source of relevant information. It can also be seen that 14.6% got that information from agricultural extension officers or during the agricultural field days. This implies that the penetration of extension services to where farmers need them is very low in this location.

3.3. Impact of Drought

Drought tends to have devastating effects on dairy farming. To understand the impact on the study location, the participants were asked to indicate how it impacts certain indicators, and the results are shown in Table 4.

Table 4. *Impacts of drought.*

Item	Option	Frequency	Percent
Growth performance	Low	79	32.1
	Moderate	132	53.7
	High	35	14.2
	Total	246	100.0
Level of production	Low	68	27.7

Item	Option	Frequency	Percent
	Moderate	129	52.4
	High	49	19.9
	Total	246	100.0
Disease incidences	Low	43	17.5
	Moderate	91	37.0
	High	112	45.5
	Total	246	100.0
Indirect (Reduced feeds and water availability)	Low	39	15.9
	Moderate	63	25.6
	High	144	58.5
	Total	246	100.0
Index for drought impact	n = 246 Minimum =1.25 Maximum = 3.00 Mean = 2.11 Std. Deviation = .50		

Drought can have many negative impacts to dairy production. In this study, the researchers set out to determine the ways in which smallholder dairy production is impacted on by drought events. On growth performance, 32.1% of farmers indicated that drought had a low impact while more than half (53.7%) showed that the impact was moderate. On the other hand, 14.2% of the respondents showed that drought had a high impact on growth performance of smallholder dairy livestock.

Regarding the level of production, 27.7% of farmers revealed that drought impact was low, while majority (52.4%) showed that it was moderate. A small proportion (19.9%) were witnessing reduced production because of drought effects.

Diseases have significant negative effects on dairy livestock production hence for this study, farmers were asked to indicate its impact on occurrence of diseases. In this regard, 17.5% indicated that drought related disease incidences were low while 37.0% showed this to be moderate. The study further revealed that a huge proportion (45.5%) of the farming population had the belief that diseases tend to occur when droughts hit. This concurs with other findings that argued that elevated temperatures and changed rainfall patterns speed the spread of vector-borne diseases as well as micro-parasites, including introduction of new diseases [20].

Drought can also have indirect effect including reduced feed and water availability for smallholder dairy farming. Based on this, 15.9% of farmers showed that drought had low effect while about a quarter of them (25.6%) experienced moderate effect of drought. In the contrary, majority of farmers (58.5%) were experiencing reduced feed availability because of droughts. This is in line with the findings which ran into concluding that climate change reduces productivity of grazing lands as well as carrying capacity, leading to increased levels of nutritional stress in farm animals, hence negatively impacting on the farm's productivity [9].

Overall drought impact index

Form the four items which the farmers were engaged in, an impact index of 2.11, described as moderate was generated. It means therefore that drought events tend to be of notable levels hence a high level of attention should be given to ensure that production is not hugely affected.

3.4. Drought Coping Mechanisms

Response to drought effects is key if farmers are to sustain a high level of dairy production. In this regard, farmers were asked to indicate how they respond to the drought effects and the results are shown in Table 5.

Table 5. *Drought coping mechanisms.*

Item	Option	Frequency	Percent
Disposal of livestock	Not common	108	58.1
	Common	49	26.9
	Very common	32	15.0
	Total	189	100.0
Provision of supplementary diets	Not common	117	49.0
	Common	95	39.7
	Very common	27	11.3
	Total	239	100.0
Lease of grazing land	Not common	144	75.0
	Common	34	17.7
	Very common	14	7.3
	Total	192	100.0
Index for drought impact	n = 239 Minimum = .33 Maximum = 2.67 Mean = 1.31 Std. Deviation = .45		

From Table 4, majority farmers (58.1%) said that disposal of livestock during drought is not a common strategy for them whereas about a quarter of them (26.9%) agreed that this is a common strategy they do use. Furthermore, only 15.0% in-

dicated that disposal of livestock is a very common strategy working for them when drought strikes. This indicates therefore that majority of farmers would opt not to dispose their livestock but rather find other coping mechanisms during periods of drought. This is contrary to other findings which suggested that livestock owners hugely considered that the destocking of animals was as an operation was a good approach to drought mitigation and consequently affected the quantity of beef presented in the markets [21].

During droughts, supplementary diets too could be used as a coping mechanism. Nearly half (49.0%) of farmers rarely used this strategy, while 39.7% used it frequently. Very few farmers (11.3%) showed that supplemental feeding is a very common strategy they use. Supplemental feeding in dairy livestock is implemented, but it is infrequently utilized by farmers. Majority may be adopting other strategies. These findings align with other studies suggesting that supplemental feeding can be used as a part of a production cycle to help match feed demand to feed supply or set aside as a measure during drought [22].

Farmers may also lease grazing land to get feeds for livestock during droughts. It can be seen here that three-quarters of farmers (75.0%) do not commonly use this strategy. It can as well be reported that 17.7% of them commonly lease grazing land while a small fraction (7.3%) would commonly resort to this during drought.

Overall coping mechanisms index

Based on the three items, an index of 1.31 was calculated. This is described as a not common. It means therefore that farmers in Teso South Sub-County not commonly adopt the various drought coping mechanisms. Smallholder dairy farmers should be informed about strategies to mitigate the adverse effects on livestock during droughts.

3.5. Test of Hypotheses

3.5.1. Null Hypothesis 1: There Is no Statistically Significant Difference in the Impact of Drought on Smallholder Dairy Production

To determine if there was a statistical difference in the drought impact in the three agroecological zones, a one-way ANOVA was computed and the result is shown in Table 6.

Table 6. *One-way ANOVA results in difference in drought impact.*

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.344	2	.672	2.741	.067
Within Groups	59.588	243	.245		
Total	60.932	245			

From the test results, the mean difference is not significant indicating that the impact of drought showed no statistically significant differences in the three agroecological zones ($p = .067; .05$). This implies that the impact of drought did not vary significantly in the three agroecological zones.

3.5.2. Null Hypothesis 2: There Is No Statistically Significant Difference in Drought Coping Strategies Adopted by Smallholder Dairy Farmers

To determine if there was a statistical difference in the drought coping mechanisms among the three agroecological zones, a one-way ANOVA was computed, and the result is shown in Table 7.

Table 7. *One-way ANOVA results in difference in drought coping mechanisms.*

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	10.945	2	5.437	34.300	.000*
Within Groups	37.654	236	.160		
Total	48.600	238			

*Mean difference is significant at .05 level

From the test results, the mean difference is significant indicating that the drought coping mechanisms showed a sta-

tistically significant difference in the three agroecological zones ($p = .000; .05$). This implies that the impact of drought varied significantly in the three agroecological zones, and the selection of the coping strategies by farmers had no statistically significant similarities.

4. Conclusions and Recommendations

The study was meant to assess the impact of drought and the coping mechanisms by the small holder-dairy farmers in Teso South Sub-County. The findings indicated that smallholder dairy farmers perceived drought differently among the three agroecological zones. It further showed that the impact of drought was moderate but had no statistically significant difference among the various agroecological zones. Farmers rarely used the coping mechanisms, but their usage varied significantly across the three agroecological zones. The study suggested further research to identify common drought coping mechanisms in the area, noting its impact on smallholder dairy production.

Abbreviations

IPCC	Intergovernmental Panel on Climate Change
EAC	East African Community
VIA	Climate Vulnerability Impacts Assessment
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
LM_1	Low Midland 1
LM_2	Low Midland 2
LM_3	Low Midland 3
AEZ	Agroecological Zone
ANOVA	Analysis of Variance

Acknowledgments

The authors acknowledge Alupe University, through the Research Directorate for the financial assistance that facilitated the conduct of this research work.

Author Contributions

Ongang'a Peter Odhiambo: Conceptualization, Software, Formal analysis, Funds acquisition, Investigation, Methodology, Writing of Draft, Project Administration

Omoga Charles Owuor: Data curation, Methodology, Project administration, Writing – review & editing

Mwongula Albert: Conceptualisation, Investigation, Validation, Writing – review & editing

Funding

This research is funded by Alupe University's 2024-2025 Annual Research Grant.

Data Availability Statement

The data is available from the corresponding author upon justifiable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Biography

Ongang'a Peter Odhiambo is a holder of Doctor of Philosophy in Agricultural Education and Extension from Kisii University, with more than five years of university teaching. He is currently a lecturer of Agricultural Education and Extension at Alupe University. Dr. Ongang'a has extensive research experience in agricultural extension and teaching backed up by the various workshops and conferences attended, as well as publications in this field.

Omoga Charles Owuor is currently a Senior lecturer at Alupe University and is the chair, Management Science, Development studies and communications Department, School of Business Economics and Human resource Development. Dr. Omoga additionally, champions the schools Quality Assurance activities and an external examiner for Kisii University among other administrative duties. He holds Ph.D in Business Information Systems; Masters in Business Administration specializing in Management Information System (MIS); B.Ed (Science) and a Cisco Certified Network Associate. He is a member of the Kenya Institute of Management (KIM)

Mwongula Albert currently works at Alupe University, School of Science, Technology and Engineering, Department of Biological and Agricultural Sciences. Mwongula is an MSc Holder in Microbiology from Moi University. Currently pursuing his Doctorate in Microbiology at Masinde Muliro University of Science and Technology. He is the Chair of Biological and Agricultural Sciences Department as well as a lecturer of students taking courses in Biological Sciences. In addition, he serves as a member to Prevention of HIV infections Committee in the University. Lastly, Mwongula is a member of American Society of Microbiology with Global Outreach Contributing membership (Member ID: 200104704).

Research Field

Ongang'a Peter Odhiambo: Agriculture subject teaching in Kenya with focus on non-conventional approaches to agriculture teaching in schools with bias in supervised agricultural experiences where learners are actively involved in practical learning processes; Youth participation in agriculture at local levels is another area of focus; Establishing Schools that are Responsive to the Needs of Competency Based

Agricultural Education: the Future Farmers of Kenya Project.

Omoga Charles Owuor: Research interest includes Information Systems adoption, Artificial Intelligence and Cloud computing

Mwongula Albert: Research interests are: Molecular epidemiology, Virology, Bacteriology, Parasitic and Infectious Diseases and General Microbiology.