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Analysis of Challenges to the Sustainability of Livestock Food System in Isiolo County, Kenya

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***Abstract*— Dryland landscapes experiences greater challenges in the regional and international trade for livestock and livestock products due to systems of production, quality control and safety measures. The objective of this study was to characterize livestock food system in Isiolo County and evaluate factors that affect the sustainability of the systems. The main value chains identified were camel milk, beef, sheep and goat products. The food system is driven by domestic trade which face greater threats to suffice sustenance in livestock and livestock products trade due to weak market integration and poor access to regional and international markets. Weak institutional coordination, insecurity and persistent droughts were notable barriers to sustainability of livestock food system in Isiolo County. Environmental degradation accruing from climate related risks and other stressors of biodiversity are also major threats to sustainable livestock production, hence affecting this livelihood system.**

***Index Terms*— Food system, value chains, food quality, food safety, Regulatory framework.**

I. INTRODUCTION

Livestock food system in arid and semi-arid regions of the world and particularly dry lands of the Sahel and Horn of Africa experiences challenges in sustainable production and marketing systems. This is mainly due to high prevalence of climate change and climatic variability predisposing frequent droughts and inappropriate land use systems exacerbating uncoordinated livestock movements from one area to another in search of scarce pastures and water resources (Colonna *et al.*, 2014; Nzuma, 2014; Davidson, 2011; Green, 2006). These pastoral migratory patterns pose threats to market efficiency. This phenomenon has contributed to low production, poor quality and safety standards for livestock and livestock products traded (IGAD, 2014). In Isiolo County, the major value chains that constitute the livestock food system include cattle, camel, sheep and goats products. Currently, the livestock sub-sector contributes less than 2% to the counties revenue base mainly due to informal trade practices in livestock food system, weak institutional coordination mechanisms, lack of implementation of the existing policies and legislations (CIDP, 2016). These therefore, have direct implications with the overall compliance with the national, regional and international requirements for sustainable trade in food system.

Recent studies indicate that livestock food system contribute significantly to the livelihoods of about one fifth of the global population and there is increasing demand for livestock and livestock products driven by ever increasing global human population estimated at 9 billion by the year 2050, increasing incomes and subsequent urbanization (Breeman, 2015; Thornton *et al.*, 2013). This phenomenon indicates expanding market opportunities for the livestock products which are anticipated to stimulate the development of livestock food system and increased productivity for sustenance. However, although the future perspective of livestock food system to meet the global demand is inevitable, there are barriers to its sustenance due to quality and food safety requirements. This will therefore necessitate the need for policies that focus on sustainable production systems and trade practices commensurate with national, regional and international standards. Our study analyzed the challenges to sustainable livestock food system for domestic, regional and international trade. The parameters investigated included the socio-economic and environmental concerns affecting the value chains traded and regulatory mechanisms that influence sustainable trade and environmental integrity in Isiolo County, Kenya.

II. MATERIALS AND METHODS

A The study site

The study was carried out in Isiolo County, upper eastern region of Kenya with an estimated area of 25,570km^2. Based on the Kenya 2009 population census, Isiolo County population is estimated at 143,294 persons comprising of 73,694 males and 69,600 females and was projected to reach 191,628 persons by the year 2017 (KNBS, 2016). The population density is estimated at 4 persons per km^2 while the annual growth rate is 3.7 per cent. However, there are high poverty and illiteracy levels in the County standing at 77% and 85% respectively. The rainfall pattern is bimodal characterized by long rains from March to May (MAM) and short rains from October to December (OND). Generally, the rainfall is highly unreliable and unevenly distributed. Most parts of the area receive 150-300 mm during normal seasons while the highest is 650 mm around Isiolo central. About 95% of the county is classified as arid while only 5% is semi-arid thereby making the area favourable for livestock production (GOK, 2015). The temperatures are high throughout the year ranging from 27^{o}C - 30^{o}C in almost all the parts of the

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County. This coupled with rainfall unreliability exclude economic production of rainfed crop production as a livelihood strategy. Hence, livestock keeping is considered the main source of livelihood for the citizens of Isiolo County who are mainly pastoralists with very few ago-pastoralists. The main sources for production of livestock and livestock products are Garbatulla, Merti and Isiolo Central sub-counties. These also form the three administrative units of Isiolo County and our study area.

B The study design

The study used an inductive approach in a descriptive research design. This involved characterizing food system and evaluating socio-economic challenges and environmental stressors affecting sustainable trade of the value chains in Isiolo County.

C Methods of data collection and analysis

The study used both qualitative and quantitative data collection methods. Primary data was collected from households, focus groups, key informants and observations. Using a cluster sampling technique 100 households from Isiolo central, Garbatulla and Merti sub-counties were interviewed using semi-structured questionnaires. The distribution of households within the three clusters was determined as adopted from Kothari, 2011. Ten focus group discussions were also carried out in each sub-county. Officials from County departments of livestock and veterinary services, Public health, National Environment and Management Authority (NEMA), National Drought Management Authority (NDMA), REGAL-AG formed the key informants who were interviewed using a schedule. Secondary data collected was based on literature review in form of documents analysis and field observations. The documents analysed included department annual reports, sector policies and strategic plans, Isiolo County Integrated Development Plan (CIDP), periodicals and research journals that were relevant to our study. In our data analysis, quantitative data were analysed for frequencies of variables such as locations of value chains and destination markets. Framework analysis was undertaken for qualitative data.

D Results and Discussions

The results were categorized into factors that affect the supply chain of livestock and livestock products trade, challenges in attaining quality and safety products for regional and international trade and environmental risks that affect sustainable livestock food system.

(i) *Factors influencing sustainable supply chain of livestock trade in Isiolo County*

There are various challenges that accrue from attaining sustainable livestock value chains trade in the County. The major threats to sustainable food system in our findings included low market prices predisposed by insecurity, poor market access, lack of reliable buyers for live animals, high transportation costs and high prevalence of trade sensitive diseases and pests. The results are presented as shown below.

Table 1: Summary of barriers to sustainable food system in Isiolo County

Problems	Responses		Percent of Cases
	N	Percent	
Low market prices	34	23.9	50
Insecurity	32	22.5	47.1
Poor access to reliable market	30	21.1	44.1
Few & unreliable buyers	18	12.7	26.5
High transportation costs	11	7.7	16.2
High prevalence of trade sensitive diseases and pests	4	2.8	5.9
Bad weather (drought)	3	2.1	4.4
Competition for grazing resources (influx)	3	2.1	4.4
Poor roads	2	1.4	2.9
Lack of market information	2	1.4	2.9
Brokers menace	2	1.4	2.9
Language barrier	1	0.7	1.5
Total	142	100	208.8

The study indicate that the major challenges facing the productivity of value chains is low market prices (23.9 per cent), Insecurity (22.5 per cent), distance from consumption areas (21.1 per cent), Lack of reliable buyers (12.7 per cent), high transportation costs (7.7 per cent), high prevalence of trade sensitive diseases and pests (2.8 per cent), bad weather (associated with drought episodes), competition for grazing resources (each 2.1 per cent), poor road networks (1.4 per cent), lack of market information (1.4 per cent), middlemen or brokers menace (1.4 per cent) and language barrier (0.7 per cent) respectively.

Low market prices

The problem of unstable and persistent low market prices (24%) offered at the local markets commonly categorized as

primary and secondary markets is perceived differently by different value chain actors. The pastoral producers who are the dominant sellers to these markets associate low prices offered with monopolistic market channel dominated by middlemen and external buyers of similar motives. These middlemen who are a combination of brokers and itinerant small scale traders take advantage of the ignorant pastoral producers who have little access to market information. The producers (pastoralists) perceive the existing market system as a "negotiated deal" between the brokers and external (medium and large scale) buyers. The sellers such as producer groups, individuals and local small scale traders interviewed responded that there is little or no interaction amongst them and the main buyers (local large scale traders and external buyers) and this scenario make the conditions for trade very poor. This findings concur with a study conducted in the Horn of Africa which determined that livestock sellers in most parts of these areas are disadvantaged and hence do not come face to face with the buyers for price negotiations (Akilu, 2013). In most times they are temporarily forced to hand over the animals for predetermined and negotiated prices by the middlemen. It is imperative to note that at the end of the day the middlemen are the major beneficiaries while the pastoral producers are the most disadvantaged.

Many producers interviewed also expressed their dissatisfaction of the current market conditions due to unfavourable market prices and insecurity which is another cause of low and fluctuating market prices. The sellers argue that the buyers will always delay for purchasing livestock and when they arrive at the market they provide predetermined and unfavourable prices. This is a habitual market strategy used by local medium scale and external traders in collaboration with middlemen or brokers to discourage sellers from long periods or hours for negotiations. Hence at most instances the sellers have been forced to sale their stock at what they termed "throw away prices". The condition for waiting too long in market to access willing buyer until late evening hours also impose fear among the sellers who mainly come from far areas such as Merti and Garbatulla sub-counties and Samburu and Marsabit counties. Hence the buyers are perceived to take advantage of persistent insecurity in the area which is also a main contributor to unfavorable or low market prices.

However, the traders on the other hand claim that the phenomenon for low prices is mainly due to poor quality and type of animals traded. The prices differ amongst species (e.g. cattle, shoats and camels). The quality of animals required by traders depends on the tastes and preferences of their clients or consumers. The observations from the different markets surveyed indicate that most of the livestock traded in the markets is of poor quality due to aged (too old), weak and culls therefore do not meet the standards for export trade. The external traders (e.g. from Meru, Thara Nithi, Nyeri and Nairobi) select the few prime animals that meet the standards for their requirements and reject the others. These products that do not meet the required standards for external traders (e.g. cattle, sheep and goat products) are considered low value products and these are mainly consumed in the County for domestic consumption. It is important to indicate that the poor quality of the products is also associated with types of local breeds kept in the area. Although Isiolo County could be the main source of "Boran breed" cattle (e.g. for quality meat), currently the county is flooded with local cross breeds (small east African cattle or Zebu and local Somali breeds) which are inferior to the original Boran cattle breed. In summary low market prices is also a complex issue linked to poor quality animals exacerbated by inadequate pastures and disease control mechanisms.

Insecurity

Household interviews and focus group discussions carried out indicated that the major source of insecurity in the County is associated with deteriorating land resources for grazing (pasture and water) thus exacerbating resource use conflict among the neighbouring pastoral communities who often practice migratory grazing practices. Insecurity is also perceived to be aggravated by porous borders (e.g. Ethiopia and Somalia) and illegal trade in firearms at these border lines and therefore contributes to inconsistent trade practices due to fear to access reliable markets with better prices offered. Many of the respondents interviewed claimed they only sale their stock or animals when there is pressing needs e.g. household needs for foodstuff, school fees and other cultural festivals and in many instances due to security reasons they opt to sale their stock to nearby and safe market centres. However, when they decide to take animals for sale to secondary markets like Isiolo central and Oldonyiro with co-management models (CMM) they are faced with challenges of proper market regulations that are all inclusive for sustainable trade. The major concern is that the sellers do not have any other alternative means to dispose off their stock other than what they term *"throw away prices"* i.e. selling animals at unfavorable prices. This is because most sellers are not willing to return back with their stock or travel further to better markets due to long distances and insecurity involved. Hence this is a big concern for attaining sustainable trade for food system in the County.

Poor access to reliable markets

Our study establishes that the major sources of livestock for trade include Oldonyiro, Kipsing, Isiolo central, Merti, Duse, Belgesh, Bulesa, Kinna, Korbesa, Merti, Eskot and Garbatulla. The main feeder markets to Isiolo central market are from Merti and Garbatulla sub-counties. These areas are located 202 km (e.g. Merti) and 230 km for Korbesa in Garbatulla sub-county respectively. Thus there is poor market access by majority pastoral producers due to long distances from final consumption market centers like Isiolo central market. The pastoral communities (producers) have the tendency to sell their products (e.g. live animals or by-products) to the nearest market. This is because of the number of animals sold at any one time. In most instances they sell their animals when need arises *(i.e. food stuff, school fees, medical expenses, gifts etc)*. These are immediate reasons and often distort the producers from soliciting for markets with better prices or market information. Hence distance is a major challenge and they opt for nearest market.

The study also reveals that about 85 percent of the livestock (e.g. cattle and shoats) traded in the county end up at Meru County (e.g. Maua, Kangeta and Meru central),

Tharaka Nithi, Nyeri and Nairobi counties through informal trade. Only 15 per cent of the cattle traded in the county end up in Isiolo for domestic use (*e.g. through the local slaughter houses and butcheries*). This research finding compares well with the study conducted recently by IIRR (2017) which indicate that 90 per cent of the livestock traded go to other counties. However, insecurity (22.5 %) has also been found to influence market accessibility and therefore poses great challenge to the sustainability of livestock food system.

High transportation costs

Transportation of live animals is a major challenge in the County mainly affecting the transporters and distributors due to poor roads, distances involved and high levies or taxes (mainly from police check units and barriers). This has inflated the transportation cost by almost 50 per cent. According to the livestock market associations (LMA's) interviewed during the FGD, there are challenges in the high transportation charges (e.g. an average of KES 1,500 per cattle) when ferried on trucks without other miscellaneous expenses incurred that accrue from various police barriers straddled along the transit roads. The movement permits also only allow transportation of animals between 6.00 am and 6.00pm in the morning and evening respectively. This is a big menace for livestock traders due to bad roads and chronic insecurity in the area which is prevalent during day time. It is also important to note that this time schedule was a colonial sentiment that restricted the movement of animals during night. This is an area that needs to be amended in the livestock movement legislations within the County. However, the question of disease surveillance that is crucial for external trade should not be compromised by these anticipated legislations.

(ii)Challenges facing quality and safety measures for sustainable livestock food system

The quality and safety of livestock and livestock products traded is dependent on livestock production systems and general husbandry practices. The information collected from the stakeholders engaged in livestock value chains in the County reveal that the chain function is a continuity of processes and systems starting from the input suppliers, the production stage, trade, processing and distribution and finally the consumption stage. The type of animal breeds used for production and trade are local breeds with low productivity. The findings indicate that the current status of low quality products is firstly, aggravated by inadequate input supplies evidenced by inadequate forage, weak artificial insemination (AI) technology adoption for breed improvement, uncoordinated stockists in provision of services and inappropriate drug administration and use by pastoral producers predisposing chronic disease prevalence and drug resistance. Secondly, pastoral production system is dominated by communal land use practices and migratory patterns exacerbating extensive land degradation, local breeds and uncontrolled breeding practices resulting to extensive inbreeding and low quality products. Thirdly, livestock and livestock products trade face poor grading practices, unstable market prices, lack of feedlots at market places, poor road networks (infrastructure) and multiple taxations of live animals while on transit (trucks) to destination markets. Fourthly, there is poor meat hygiene and flaying practices, inadequate waste handling and management and low quality meat for export trade. Fifthly, inadequate safety standards experienced in the County is highly influenced by inefficient trade regulatory mechanisms, inadequate capacities for processing and product specialization among the value chain actors for target markets.

Low capacities in investment opportunities

This is evidenced by lack of business models (e.g. business plans) for rational trade among the various levels of value chain actors. Out of 20 value chain groups interviewed only four 4 groups had business plans for their activities constituting 20 per cent only. Among these (20 per cent), majority of them (80 per cent) do not have quality vision, mission, goals and targets for consistent profit making and sustainable commercialization of their products. Value chains is commercial oriented and should have promising business models.

Poor networks among the value chain actors

The findings of this study indicate that the market networks among the value chain actors especially between the pastoral producers and the traders or buyers is weak. The sellers (mainly pastoral producers) are not allowed to deal or bargain face to face with buyers during marketing of animals. However, other small scale traders are free to mingle or bargain for the prices they demand with the rest of the buyers (internal or external). The pitfall for this scenario is that there is lack of information flow or negotiations between the buyers and sellers on quality of animals required for the different levels of markets such as domestic, regional and international markets. Some external exporters have specifications for type of products required for specific markets. For example, the foreign markets require prime cuts for beef products. These are grade one and grade two category animals. However, grade two and grade three category animals are mainly traded for inter-county and national levels by the external traders. It is imperative to indicate that most of the current live animals traded at local slaughter houses are either grade three or four respectively. This information is only known to the external traders and middlemen while the local sellers are often restricted from understanding these market dynamics. The producers therefore are highly exploited due to these weak interactions with main buyers.

Although middlemen (commonly referred to as brokers) are important actors in market linkages, they are highly associated with challenges to sustainability of the existing value chains in the County. This is because they contribute to weak interactions hence cause informal marketing system by hindering face to face prices negotiations among the sellers and buyers. This has necessitated many producers and/or sellers avoid the formal markets due to fear of intimidation and victimization by brokers. This phenomenon contributes to problem of evading taxes by producers and other traders. The resultant effect coupled with shortage of livestock and veterinary departments' extension staff will end up to low tax collection resulting to an overall poor County revenue collection. However, the traders and processors interviewed insist that no market can operate without middlemen or

brokers. The traders interviewed insist that the *"brokers"* have a crucial role in the chain as they connect different actors (local and external traders) in the chain. These brokers are also used by traders for traceability purposes in case of animal theft or any other undisclosed anomalies during the marketing.

Weak food system regulatory mechanisms

Over ninety per cent of households interviewed responded lack of awareness on Isiolo County policies and legislations for quality and safety standards. The pastoral communities have also inadequate capacities and knowledge of the existing global, regional and national trade requirements for the value chains traded. Although livestock and livestock products are traded widely both at domestic and inter-county level, the quality and safety health measures are below the global standard requirements for external trade. This is due to lack of adherence to animal identification and traceability (AIT) and effective surveillance and control of Trans- boundary diseases such as Rift Valley Fever (RVF), PPR, Camel sudden deaths among others. Although the Isiolo County Sale Yards Act, 2016 is in place, it is not implemented due to weak institutional coordination's and regulatory frameworks which exacerbate poor enforcement for the existing policies and legislations affecting livestock food system. There is need for capacity needs assessments in order to provide adequate trainings and skills among the various node actors in the chain *(input suppliers, producers, transporters, traders, processors and distributors respectively).* This low capacities of the pastoral communities towards sustainable trade is also due to lack of an all-inclusive market regulation in the County. There is inadequate enabling environment to safeguard the interests of the most disadvantaged i.e. *the producers*. The challenge is that animals are taxed once they enter the sales yard and after that the sellers are *"left on their own"* without any guidance on the prevailing market prices. This scenario enables the brokers to manipulate the sellers as they have already gone into *"debt"* for paying taxes for animals in the yard for sale. This temporary debt (taxes) finally force the sellers to sale their stock at "throw away" prices or unfavourable amounts in order to settle their debts. Hence the traders and brokers take advantage of the low capacities of the impoverished pastoral communities in market dynamics. Thus more attention should be towards merchandising the market infrastructure with effective and inclusive market regulations.

The trade licenses for livestock and livestock products export trade such as "NO objection" and movement permits are controlled from the National level (i.e. Kabete veterinary centre) while the County can only provide permits for domestic and national levels. The disease free zones (DFZ's) and holding grounds are also national activities although the activities of the livestock sub-sector including the export abattoirs are devolved. These have implications with operationalization of the export abattoirs and regular management practices. There is also challenge of unskilled labour force and poor waste management in the local slaughter houses. Unskilled labour contributes highly to poor adherence to safety health measures for handling processed products. This is evident at the slaughter houses and those dealing with milk processing for beef and camel milk value chains respectively. There is high wastage of hides and skins due to poor flaying and treatment practices hence subjecting them to low grades and low prices subsequently. Poor waste management at the local butcheries and slaughter houses in the County is also a major concern. There are poor mechanisms for disposal of wastes such as offal's, blood, hides and skins and also lack of efficient incinerators at local slaughter houses to mitigate the impacts.

Weak regulatory mechanism is also evident in poor disease surveillance and control in the County. There is inadequate trained veterinary staff to monitor and report disease occurrences effectively. The former stock routes, watering points, disease free zone (DFZ) and screening areas have now become settlements (inhabited), and the former dry season and strategic drought reserve grazing areas have all been turned to all seasons grazing areas. The disease control infrastructures such as cattle dips and crushes for vaccinations and treatments are also dilapidated and require massive rehabilitations. The former grazing reserves for animals trekked on hoof have also been turned to all seasons grazing zones thus making the sustenance of animal welfare for sustainable trade more difficult. Currently, the Isiolo holding ground (124,000 acre) has been invaded by unscrupulous land grabbers and hostile pastoral groups for grazing thus predisposing difficulties for effective livestock screening and quarantine measures when deemed necessary during the operationalization of the Isiolo export oriented abattoir.

There is also greater challenge in efficient and effective veterinary inspection services especially in live animals trade due to porous borders. This phenomenon contributes to uncontrolled stock flow and high incidences of trade sensitive diseases such as foot and mouth disease (FMD), Bovine tuberculosis, Anthrax, PPR and contagious bovine pleuro pneumonia (CBPP). However, although there are no cases of "mad cow disease" which is another important and sensitive global trade disease reported in the County there is inadequate capacity or knowledge, and technical expertise to handle such sensitive diseases in case of occurrence. The rinderpest disease has been eradicated in the country but the limitation is that the equipment's for testing the disease are only available in Nairobi for the whole country. Foot and mouth disease (FMD) is also only tested in Kabete veterinary laboratories in Nairobi. The only disease that the County can diagnose is the Contagious bovine pleuro pneumonia (CBPP) with only one animal health officer trained currently in the County.

(iii) Environmental challenges affecting the sustainability of livestock food system in Isiolo County

One major objective of this study was to analyze the environmental risks that affect the sustainability of potential livestock value chains. An environmental risk assessment is the evaluation of challenges and the ability of the pastoral communities to take advantage of the opportunities or cope with the consequences (Christensen et al, 2007). In his study (Ericksen, 2008), reveals that adaptations that are implemented to lessen the vulnerability of food systems to

climate variability do not result in dire consequences for environmental and social outcomes, so as to further aggravate vulnerability in the future. In order to obtain quality information the study solicited information both from quantitative and qualitatively sources through primary and secondary data. The primary data was obtained from the camel milk cooperative societies in the County to analyze the variability in quantities of milk sold inter-annually and between seasons. They included the Anolei cooperative society, Tawakal cooperative society, Isiolo dairy cooperative and other milk vendors. We analyzed the effect of environmental risks on productivity of value chains in terms of quantities of milk traded obtained from the value chain actors' business records and data analyzed using statistical methods (ANOVA, Least significant difference (LSD) and Coefficient of Variation (CV) in order to determine variability between years (2014-2017) and seasons (short and long) respectively.

Analysis for Inter-annual variability of livestock products traded in Isiolo County (2014-2017): The Case of Camel Milk

Table 2: ANOVA table indicating Inter-annual variations in quantities of milk sold in litres (2014-2017 years)

Source of variation	d.f.	s.s.	m.s.	F	P
Year	3	4217000000	1406000000	15.73	<.001***
Residual	44	3931000000	89350000		
Total	47	8149000000			

Key: d.f. =Degrees of freedom; s.s. = Sum of squares; m.s. = Mean square F=Ftest P=P(0.005)

Table 3: Quantity of milk sold by years

Year	Quantity sold ± 2728.6	
2017	84689	A
2016	70790	B
2014	63130	BC
2015	60618	C

$LSD_{(0.05)}$ = 7777.1
$P_{(0.05)}$ <0.001
CV(%) = 13.5

The results on inter-annual variability in quantity of milk sold over the 4 years showed a significant ($p< 0.05$) difference using Fisher's LSD test at 5% level. There was more quantities of milk sold during the year 2017 than the rest. While the year 2016 was slightly different in terms of quantity of milk sold but there was much more similarity between 2016 and 2014. However, low milk trade was realized during the year 2015 among the others. This scenario concur with other studies previously conducted which reveals that inter-annual variability and respective seasonal variations suggest a shift in the bi-modal rainfall pattern which has several implications for rain fed agriculture (Christensen, 2007; Boko et al, 2007; Kunstmann, 2005). However, although this phenomenon may not be likely the same for other value chains considered most vulnerable to climate variability (e.g. cattle, sheep and goats) the findings of the study indicate some level of resilience and reliability in production and trade of camel milk in the County.

Determining Variation in Quantity of milk sold (litres) during long (MAM) and short (OND) seasons (2014-17)

Table 4: Wet season's data for quantity of milk sold (2014-2017)

Season/Year	**2014**	**2015**	**2016**	**2017**	**Totals**
MAM	189,335	207,585	224,689	267,820	**889,429**
OND	190,055	179,300	385,553	256,800	**1,011,708**
TOTAL Quantities of milk sold (litres)	**379,390**	**386,885**	**610,242**	**524,620**	

Source: Field survey, 2018

Table 5: ANOVA table for quantity of milk sold (litres)during MAM and OND seasons

Source of variation	d.f.	s.s.	m.s.	F	P
Year	3	2228000000	742700000	7.86	0.001
Error	20	1889000000	94430000		
Total	23	4117000000			

The findings on the determination of variation in quantities of milk sold (litres) during the MAM and OND of the 4 years under study showed significance ($p< 0.05$) difference between the two seasons. The Means squares were separated using Fisher's Least Square Difference (LSD) test at 5% level. Hence this result concurs with other studies conducted in the Horn of Africa which determined variability in seasons in most parts of arid and semi-arid regions. This variability is linked to variations in precipitation between the seasons (Christensen, 2007).

Coefficient of variation for quantities of milk sold

Table 6: Quantity of milk sold by years

Year	Quantity of milk (litres) ±3967.3	
2017	89620	A
2016	74369	B
2015	66664	B
2014	65432	B

$LSD_{(0.05)} = 11703.4$
$P_{(0.05)} = 0.001$
CV(%) = 13.1

The quantities of milk sold over the 4 years were also compared to determine the coefficient of variation and LSD. The Values not sharing the same letter (a, b) are significantly different at $p< 0.05$. There was no significance difference in the years2014, 2015 and 2016 in Long and short seasons. The result also indicate that LSD(0.05) = 11703.4 and the coefficient of variation as 13.1 % giving precision and validity of the study. However, there was more quantities of milk sold in 2017 (higher than the other 3) indicating significance difference. There was more milk sold during the short rains than the long rains season. This concludes that the short rains season (OND) is becoming more reliable than the long rains.

Table 8: ANOVA table for quantity of milk sold (litres) in dry and wet season

Source of variation	d.f.	s.s.	m.s.	F	P
Season	1	852500000	852500000	5.37	0.025*
Error	46	7296000000	158600000		
Total	47	8149000000			

Results on quantity of milk sold during dry and wet season showed a significant ($p< 0.05$) difference. Means were separated using Fisher's LSD test at 5% level.

Table 9: Quantity of milk sold in dry and wet seasons

Season	Quantity sold (litres) ± 2570.8
Dry	65592
Wet	74021

$LSD_{(0.05)} = 7318.1$
$P_{(0.05)} = 0.025$
CV(%) = 18.0

The mean quantity of milk sold during the dry season was 65592 litres while that sold during wet season was 74,021 which gave a variation of ± 2570.8 over the four years. The mean of quantity of milk traded during the wet season was higher than the dry season that concurs with $P_{(0.05)} = 0.025$

These scenarios have major implications on sustainability of food system processes especially on the aspect of production and consumption. This variability in climatic conditions and negative consequences like droughts do not affect only camel milk value chains but also impact notably on cattle (beef) and shoats value chains. A good example is the drought episode of (……) in Kenya which affected or rather expelled the KLMC from exporting meat both regionally and internationally. Apparently, up to date Kenya has not yet put any rationale or sustainable mechanisms to combat the consequences experienced especially on food quality and safety.

Analysis of the drought trends in Isiolo County (2002-2017)

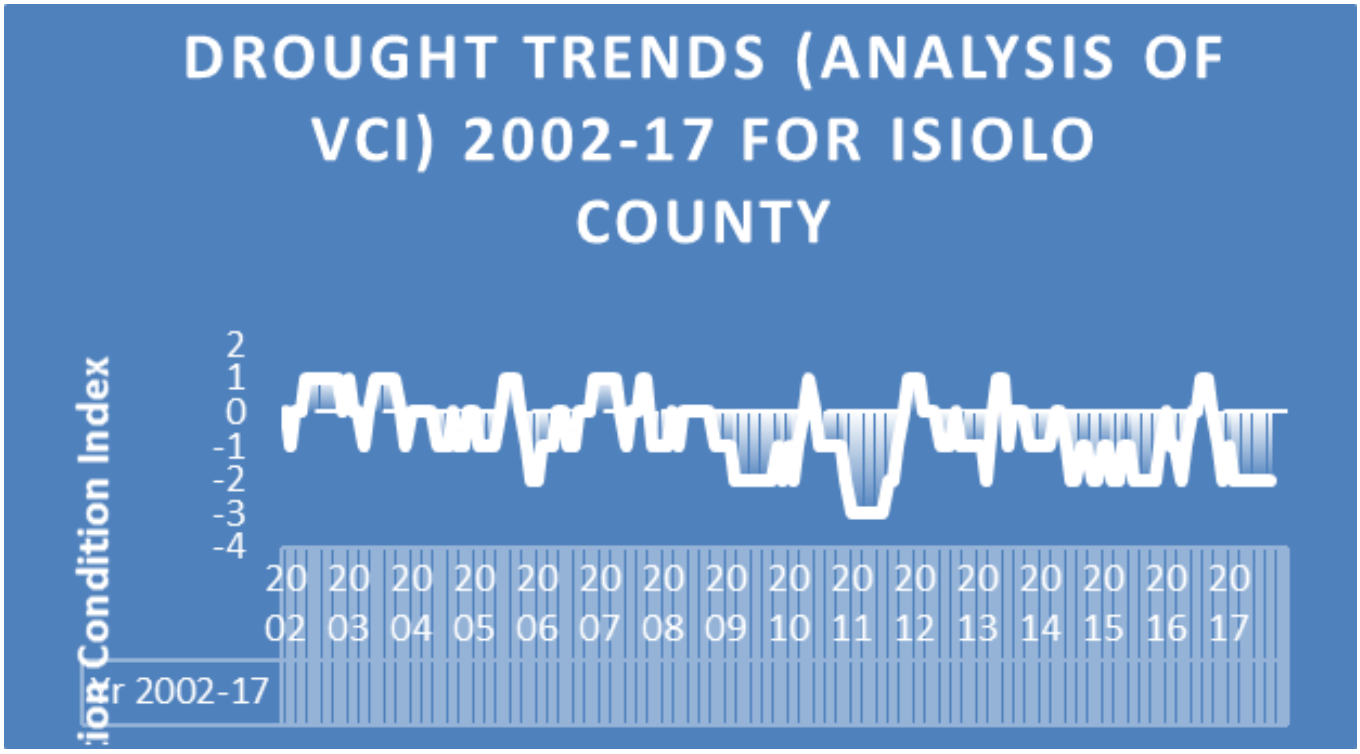

Figure 1: The trend of the drought episodes in Isiolo County is summarized in the figure

The scale Zero (0) is considered a duration of normal rainfall with good vegetation regeneration or greenness. This scenario is commonly referred to "normal rainfall". The scale 1 (one) is an indication of prolonged rainfall usually termed as '*above normal'*. Negative one (-1) indicate impacts of below normal rainfall seasons with poor distribution in terms of time and space. This phenomenon usually leads to partial or poor regeneration of vegetation. The rainfall pattern is irregular and poorly distributed. From the above time series (years) analysis of the indices from 2002 to 2017, its apparent that most rainy seasons were below normal ending up in insignificant vegetation condition regeneration hence minimal vegetation condition.

In our triangulation, there is extensive degradation of the grazing resources especially forage and pastures due to intensive and recurring droughts for the last decades. Although the livestock numbers is also perceived to have surpassed the carrying capacities but it's evident that the main cause of degradation is due to unreliable and poorly distributed rainfall pattern coupled with poor land use systems in the County. These necessitate competitions for scarce resources thereby stimulating frequent frictions and conflicts over grazing resources (pastures and water) among the neighbouring pastoral communities and wildlife conservancies. Hence there is uneven utilization of grazing resources due to insecurity even where there are moderate pastures for grazing. The fear of grazing far areas with good pastures has the effect that the grazing areas near water points and settlements are extensively over utilized while the far and insecure areas with plenty of pastures are underutilized. Thus there is irrational oscillation of livestock migratory patterns cause inconsistent supply of livestock and livestock based products to the primary consumer markets. This phenomenon of inappropriate use of grazing resources and insecurity has also greatly affected the traditional institutions such as "deedha" in enforcing their by-laws and local regulations in grazing control and resource use management.

The assumption of this study is that assessment of rainfall performance alone cannot be complete without evaluation of its impact on natural vegetation whose effect is usually a function of performance in terms of spatial and temporal distribution. In normal circumstances, a culmination of several failed seasons sum up into droughts episodes resulting to poor and prolonged range conditions.

Inappropriate pastoral land use system

The main challenges that influence the sustainability of livestock food system are centered in socio-economic and environmental issues concerning pastoral land use systems. This is attributed by the socio-cultural practices of the pastoral communities in the County who mainly practice nomadic pastoralism as their main land use system. The findings of the research indicate that these cultural practices (e.g. traditional livestock production and land use system) can no longer sustain the existing value chains traded. The major reasons are that: (i) Firstly, the production system is challenged with the availability of adequate grazing resources because the county is always on alarm and emergency drought cycle hence low volumes and quality products for trade (ii) secondly, in order to meet global standards for the trade of livestock and livestock by-products, an overall sustainable livestock food system require certain processes and standard regulations from production to final consumption stage. It is therefore imperative to have a reliable regulatory framework for productive livestock food system and sustainable natural resources utilization and conservation.

III. CONCLUSION

The productivity and the sustenance of livestock food system face extreme threats due to intensifying degradation of grazing resources (water and pasture) and insecurity concerns exacerbating low quality and unstable market prices. Weak regulatory mechanisms and poor institutional coordination on food system has also contributed greatly to poor quality and safety measures for livestock and livestock products to meet standards for global trade. In order to meet global standards for sustainable trade of livestock and livestock by-products, there is need for establishing an effective and efficient livestock food system regulatory framework that can enhance enforcement and implementation of existing policies and legislations.

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