Mapping of Livestock Value Chains as a Tool for Understanding Disease Risks in Agro-Pastoral Systems of Kajiado County, Kenya

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Abstract

BACKGROUND

Ruminant production plays a major role in the Kenyan livestock sector, but they face a myriad of disease threats including zoonoses. The objective of this study was to map the ruminant livestock value chains and describe disease risks and their implication to pastoral livelihoods in Kajiado South sub-county, Kenya. This area is characterised by a highly intertwined wildlife-livestock-human interface which is ideal for transmission of zoonoses and other livestock diseases to connected systems and farms.

METHODS

The study used a cross-sectional design, where primary sampling units were people including pastoralists who operated in critical livestock value chain nodes including slaughterhouses, slaughter slabs and livestock markets. Data were collected using focus group discussions (FGDs), semi-structured interviews (SSIs) and key informant interviews (KIIs) using published participatory methods including listing, probing and pairwise ranking.

RESULTS

A number of constraints to livestock production including diseases, poor extension services and drought were encountered in the study area. In the disease constraint, they treated their animals by themselves, whichlead to misuse of drugs thus to antibacterial resistance. The kind of diseases they may contract due to their livelihoods were mentioned among others, anthrax, brucellosis, Rift Valley Fever, tuberculosis, tapeworms and rabies, in that order. Foot and mouth disease (FMD) and lumpy skin disease (LSD) were mentioned across the FGDs that using the animal products, the pastoralists came down with similar flu symptoms.

CONCLUSION

From the pastoralists' point of view the inputs in the value chains were self-medication of their animals leading a possible misuse of drugs without proper withdrawal periods; they were able to identify the disease risks including zonooses they were faced with. A better understanding of infection processes at the along the ruminant value chains is needed to minimise disease transmission, and it is this which this study aimed to improve.

1 Introduction

Agriculture and in livestock sub-sector, is an important contributor to the overall Kenyan economy. Recent statistics estimate that the sub-sector accounts for approximately 10% of the National Gross Domestic

Product (GDP) (30% of the agricultural GDP) and employs about 50% of the national agricultural labour force. Majority of the Kenyan communities have keep livestock for food, transport, draught, prestige, and as capital assets as a long time tradition. In addition, communities depend on their animals for other cultural needs such as paying bridal price and performing traditional ceremonies. Among the main breeds kept are the East Africa Zebu, the Boran cattle, East Africa goats, the Galla goats, Red Maasai sheep, Black Head Somali sheep. The National census of 2009 showed that Kenya's animal resource base comprised of 17.5 million cattle, 27.7 million goats, 17 million sheep, 3 million camels, 31.8 million domestic birds, 1.8 million donkeys and an undetermined number of companion, game and aquatic animal (KNBS, 2010). Ruminants (cattle, sheep and goats) were reared mainly for four functions, namely; meat, milk, skin and wool according to order of importance (FAO, 1986).

It has been estimated that about 14% of livestock in developing countries at some point are infected with one or more zoonoses and that each infection reduces their productivity by around 10% (Grace, 2013). FAO has estimated that the value of livestock production to USD 639 billion per year in developing countries, thus the loss may be estimated. The human health costs of zoonoses are typically equal or greater than livestock sector losses(World Bank, 2012). With a burgeoning of population, there is increased demand for sources of animal protein and with intrusion into forests, thus worsening the already alarming situation. Africa will need a twofold meat production in order to meet protein needs of the growing population by mid-21st Century (Alexandratos & Bruinsma, 2012). It is well known that over 60% of Emerging Infectious Diseases (EIDs) are zoonotic in nature and that 70% of the zoonotic EIDs come from wildlife (Jones et al., 2008). The apparent risk for EIDs from wildlife sources continues to pose a challenge across Africa.

Food borne diseases in the value chain from farm-to-fork are universal public health problems and the implications are great including health and economic losses (Le Loir et al., 2003). Food borne diseases or food poisonings are defined by the World Health Organization (WHO) as an illness or diseases of infectious or toxic nature caused by the consumption of foods or water contaminated with bacteria and/or their toxins, parasites, viruses, or chemicals. The World Health Organization (WHO) estimated that in developed countries, up to 30% of the population suffers from food borne diseases each year, whereas in developing countries up to 2 million deaths are estimated per year (WHO, 2015). Many diseases are communicable and caused by micro-organisms that enter into the body via food.

One of the major challenges that could limit full realization of benefits of this expanded market opportunity by livestock farmers is disease. Zoonotic diseases are caused by a diverse group of pathogens that are transmissible from animals to humans. Seventy-five percent of all pathogens infectious to man including newly emergent infections are of zoonotic origin (Jones et al., 2008). The emergent pathogens can often be traced back to ecosystem changes associated with expanding human populations, food insecurity, and unsustainable use of natural resources, all of which result in biodiversity loss and changes to ecosystem function (Mazet et al., 2014).

It is estimated that over 60% of meat consumed in Kenya is beef with Nairobi city being the major consumption hub (Kenya Market Trust, 2014). Several factors can influence the occurrence of microbes in meat. After slaughtering, meat can be contaminated by microorganisms from water, air, and soil, as well as from the workers and equipment involved in the processing. In the later processing steps of the fresh meat chain (i.e., handling, cutting, and storage), abiotic factors such as temperature, gaseous atmosphere, pH, and NaCl levels select for certain bacteria, allowing colonization of the meat surface by different spoilage-related species and strains (De Filippis et al., 2013). Many factors may contribute as sources of contamination of carcasses along the chain of slaughter, including the animal's skin and dung, equipment such as machines and cutting tools, an unhygienic environment, non-compliance with proper slaughter processes, and a lack of personal hygiene (Kh et al., 2012). Contamination of meat with microbes starts early in the process, originating from the hides and intestines of animals, and is transferred to the carcass during slaughter (Bell, 1997). Risks associated with the consumption of contaminated meat and meat products can be reduced by implementing systematic controls from farm-to-fork. Recognizing the role and potential benefits of ruminant production for food security and economic empowerment for pastoralists in Kajiado County, Kenya, the County government of Kajiado have elaborate projects to promote local ruminant production and improve thier incomes in the region. For instance, in their study, (Cook et al., 2017) found that majority of slaughterhouse workers own livestock and a number of workers have a second occupation, predominantly in other aspects of the meat production industry, including as farmers or butchers, and are therefore exposed to animals and meat products outside the slaughterhouse. This therefore, increased exposure may act as a source of infection or a potential for dissemination since these activities are independently associated with disease exposure.

There has been an alarmingly increase in drug resistance to frequently used antimicrobial agents in human and animal production is a public health challenge globally (O'neill, 2016). Currently, the world health organization has reported high levels of antimicrobial resistance, indicating a strong correlation with the scale of antibiotic consumption (WHO, 2017)). The role of livestock in the emergence and dissemination of both antimicrobial resistance (AMR) bacteria and their resistance determinants to humans is poorly understood and controversial ((Marshall & Levy, 2011)(Woolhouse et al., 2015). Various studies have suggested that AMR bacteria and their AMR determinants can be transmitted from food animals to humans via direct contact and/or through animal products (Howells & Joynson, 1975) (Aminov & Mackie, 2007)(Jakobsen et al., 2010); (Overdevest et al., 2011); (Kluytmans et al., 2013). The reports have indicated high antibiotic resistance levels in *Escherichia coli*, *Salmonella*, *Staphylococcus* and *Streptococcus* among other bacterial diseases. Nevertheless, other factors like suboptimal treatments, self-prescriptions, drug non adherences, have also promoted development of drug resistance (Dar et al., 2016).

This study aimed to map out livestock value chains and the disease risks and their implication to pastoral livelihoods in Kajiado County, Kenya.

1.1 Hypothesis

Within the context of susceptibility due to climate change, not investing enough in the health and productivity of livestock and plants, particularly will result in poorer control of diseases and reduced productivity thus leading to food insecurity and livelihoods and ultimately impacting on human health (Queenan et al., 2017). Creating healthy conditions in one health approach for community livelihoods can mitigate key threats to public health and agricultural biosecurity while facilitating environmental stewardship. Misuse of the antibiotics in the farms during production processes plays a role in the development of anti-microbial resistance along the food chain.

The overarching hypothesis was that there was a significant burden on human health that results from the ownership and consumption of livestock and their products in Kajiado County.

- 1.2 Research questions investigated

1. What were the important structures in the value chains – slaughterhouses, markets, input supplies in Kajiado County?

2. What were the constraints to the livelihoods in the value chain?

3. What were the grazing patterns for the pastoralists?

4. What variety of antibiotics that were commonly used in the farms and farmers' attitudes around observing withdrawal periods?

5. What were the governance issues around these chains other food borne risk practices?

6. What kind of products and by-products from the farming systems and where were they sold?

7. To what extent were livestock keepers aware of antimicrobial resistance in Kajiado County in Kenya?

2 Methodology

2.1 Study Area

Kajiado County is located in the southern rangelands of Kenya at an altitude ranging from 1100m at the floor of Rift Valley, to 1,800m above sea level near Mt Kilimanjaro; enclosed within longitude 36.00E – 37.80E and latitude 1.250S – 3.120S. Kajiado County is divided into five constituencies namely Kajiado Central, Kajiado North, Kajiado South, Kajiado East and Kajiado West which are further divided in to five (5) Wards each. Kajiado County has a total population of 687,312 and a surface area of 21,901km2 with a population density of about 31 persons per km2. The cattle population by 2009 was 246,829 heads, (Data, 2013). Most of Kajiado County lies in the semi-arid and arid zones characterized by warm and hot climate with temperature mean of 25ºC. The rainfall pattern is bimodal, with high average of 1,250mm and a low average of about 500mm per annum, (Bobadoye et al., 2014). Kajiado County covers an approximated area of 21,900.9 square kilometres. The area is characterised, particularly with high wildlife-livestock-human interface which was ideal for high burdens of zoonotic diseases. Kajiado County had two main livestock production systems: nomadic pastoralism and mixed livestock and crop farming

systems (agro-pastoralism) practised around up-coming urban centres. Again, the area is an agro-pastoral set-up neighbouring Nairobi metropolitan which is a major hub for meat markets. Kajiado County is adjacent to the Capital City of Kenya, Nairobi. Kajiado's County neighbours include counties of Nairobi, Machakos, Makueni, Narok, Taita Taveta and Kiambu counties (Fig. 1).

2.2 Data Collection

The study was conducted in January and February 2020. The study involved a qualitative baseline field survey. The study used a cross-sectional design, in which the primary sampling unit were slaughterhouses and slabs, and livestock markets within which all eligible and consenting value chain pastoralists were interviewed. Data were collected using focus group discussions (FGDs), semi-structured interviews (SSIs) and key informant interviews (KIIs) using published participatory methods including listing, probing and pairwise ranking. In addition, triangulation was used to collect and crosscheck the information (Thrusfield, 2018). The value chains involved mapping the flow of inputs into the farming systems around Oloitokitok Sub-County (Kajiado South), describing the farming characteristics especially around disease management and use of antibiotics to treat infections of ruminants.

Focus group discussions were conducted in three purposefully selected wards (Kimana, Imbirikani and Entonet Lenkisim) close to the Amboseli National Park led by a member of the research team with support from local government extension personnel who were conversant with the Maasai culture and language.

2.3 FGDs Demographics

The study involved 10 FGDS comprising six to eight participants per group and only one group of abattoir owners of four making a total 73 participants. In terms gender representation, women were 24 owing to the fact that more men are involved at abattoirs in the chain. The participants mean age was 35.9 with youngest at 22 while the oldest was 65. The participants' formal education ranged from none, primary, secondary, college to university.

2.4 Data Management

Through careful listening and interpretations the data were recorded in note books, and data were later collated in MS Word documents. Framework method of thematic content analysis of the data were done to identify the emerging themes that describe an activity or a specific profile in the chain (Gale et al., 2013). At the end of the interview, demographics of respondents' data were taken. The chains were conceptualised in Figs. 2a and 2b.

3 Results

3.1 Description of Input Supply for Agro-pastoral Systems

In the FGDs the study focused on the general challenges the pastoralists faced that included livestock diseases in addition to poor local breeds among others (Figs. 2a and 2b). There were poor extension services in addition to lack of vaccines against common diseases. The community was not aware of the best breeds to keep in order to sustain the environment. The pastoralists were in agreement with the Sub-County Veterinary Officer (SCVO) on the issue of poor local breeds that need improvement. Some instances there were long phases of drought leading to scarcity of water and pastures. In general, there were instances of inadequacy of water when the rains failed. There was generally inadequate land for grazing their livestock due to land subdivisions. The pastoralists lacked the technology on how to conserve pastures or convert to hay to be used during drought. The groups mentioned theft of livestock as one of the challenges.

As expected and owing to the proximity to Amboseli National Park, there were human / livestock – wildlife conflicts and compensation, if any, from Kenya Wildlife Services was low or nil. There were small scale markets leading to prevailing poor prices for their livestock. Only one big market at Kimana trading centre (Fig. 1). Contributing to the poor prices on offer, the county levies were high for the pastoralists / traders. They replenished their stock from these local markets. They sourced veterinary medicines from the local markets but vaccines from the government extension offices.

The Maasai pastoralists grazed their livestock on their communal land while others on private ranches. For the small number who practiced dairy farming under zero-grazing, they cut and carried fodder for their animals or purchased hay. During severe drought, they had limited options and ended up grazing in the Amboseli National Park (protected area) albeit illegally. In search of pasture and water, they drove their animals to the neighbouring country, Tanzania, although recently they had been discouraged since the seizure and auctioning of their animals by the Tanzanian Government. Others were forced to travel as far as Mombasa County in search for pasture and water for their animals during severe drought. They also grazed their animals in both the conserved and natural forests.

3.2 Description of the Livestock Production Systems

Livestock traders played an important role in the ruminant value chains. They usually interacted with middlemen (brokers), butchery owners, live animal transporters, county government workers for cess, and public health officers for movement permits according to meat control Act. They also interacted with fellow livestock traders others who were of Somali origin. They also dealt with some dishonest people who may have stolen animals and wanted to trade. They faced challenges of drought as few animals would be available for sale. They encountered losses due to low sales and still must pay cess to the local government. After the deal was made and in case the animals died, the buyers were supposed to report within seven days in order to resolve any disputes that may have arisen. They transported their livestock on hoof from one market to another and sometimes used motorised vessels. The good season for trading was from January to June while December was bad due to flooded market although they traded throughout the year. Whenever their animals fell sick before they sold, they treated them by themselves. This kind of trade was done by both gender. They traded in ruminants and others on donkeys where upon

there is specialization on small or large ruminants or donkeys. In the course of trading, they incurred costs such transportation, cess, permit, personal expenses and treatment of the sick animals.

Livestock Diseases, as a constraint encountered by pastoralists when interviewed in their local names and later translated to English, included Foot and Mouth Disease (FMD), Malignant Catarrhal Fever (MCF), Lumpy Skin Disease (LSD), Rabies, Brucellosis, Contagious Bovine Pleuropneumonia (CBPP), Anthrax, East Coast Fever (ECF), Peste des petits ruminants (PPR), Abscesses, Tsetse and trypanosomosis (AAT), Black quarter, Bloat, Worms (helminths), Bovine Ephemeral Fever (BEF), Heart water, Mastitis, Tick Infestations, Snake bites, Enterotoxaemia and Biting flies.

The pastoralists were able to list various signs of when an animal was sick. These included loss of demeanour, stop chewing cud, rough hair coat, milk drop in milking cows, emaciation, excessive salivation, diarrhoea, stop feeding, lying down (recumbent), coughing, sudden death in some cases. These signs were mostly noted during the mornings or evenings.

It terms of management of the disease constraint, they isolated the sick and treated by injecting drugs by themselves (which is against the Laws of Kenya Animal Diseases Act Cap 364), deworming, dip washing, called a veterinary health worker for vaccinations and in cases of difficult mastitis. Some pastoralists applied traditional medicines in cases of diarrhoea, abortions and retained after birth. In other cases, they restricted the water intake.

In addition to the disease constraint, the pastoralists were asked the kind of zoonotic diseases they may contract due to their livelihoods. They mentioned among others, anthrax, brucellosis, Rift Valley fever, tuberculosis, tapeworms and rabies, in that order. Interestingly, FMD and LSD were mentioned across the FGDs that using the animal products while the animals exhibited the signs, the humans came down with similar flu symptoms. Aware that they may contract diseases from livestock, they took various precautions which included treatment and vaccinations of their animals, acaricide spraying, boiling milk before drinking, cooking meat and deworming of humans in the whole family. They sometimes did not eat dead animals especially of suspected anthrax cases. In case of anthrax, they reported to local veterinary office of suspect cases as required by the OIE for notifiable diseases. When they fell sick they visited hospitals and others used traditional herbs / medicine. The practices they engaged in which risked them contracting diseases included eating raw kidneys, liver and blood tissues from freshly slaughtered livestock for some.

The pastoralists were asked about the kind of drugs the commonly used to treat various diseases and conditions. They mentioned them by their trade names as Adamycin®, OxVet® (Oxytetracycline), Pen and Strep® (Penicillin and streptomycin), Tylo-Gold® (Tylosin), Veriben® (Diminazene aceturate) and assorted dewormers (anti-helminthics). They also used common salt and dip washes (acaricides). They sourced the drugs from the many agro-vets (There were eight agro-vet shops in the Sub-County, three in Kimana and five in Oloitokitok town) and hawkers during market days. Others used traditional herbs. Asked whether they were aware of antibiotics, they were able to identify the first listed three drugs as antibiotics. However, they did not observe drug withdrawal periods neither the dosages because they

privately treat their livestock thus end up under-dosing the animals. Some pastoralists observed dosages but all the interviewed were not aware of antimicrobial resistance.

3.3 Output Distribution Channels for Livestock and their Products

The pastoralists mentioned lack markets as one of the challenges, however, there were major market outlets that included Kimana, Oloitokitok, and Rombo in Kajiado South Sub County. Other smaller market outlets were Illasit, Isinet, Kaambu, Esselengei and Simba Cement centres. They also went as far as Emali and Sultan Hamud along the Nairobi-Mombasa highway and Kibwezi in Makueni County.

In the ruminant value chains, there were four slaughter houses and six slaughter slabs which are classified as such in the meat control Act. These were Sing'aru, Kimana Digital and Kamlesh in Kimana Centre while others were found in Loitokitok, Rombo, Imbirikani, Simba Cement, Entarara, Illasit and Isinet. The busiest slaughter houses / slabs were located in Kimana.

The abattoir owners usually interacted with meat traders, meat inspectors, flayers and other slaughter workers, public health officials (four times a week), security officers, farmers, National Environmental Management Authority (NEMA) officials, hides and skin traders for business among others. The NEMA officials visited three times in a year. They might experience harassment from meat traders when there was delay in slaughtering, argument for non-payment after slaughter services. Sometimes butchery owners brought sick animals or stolen animals for slaughter thus arose disputes. On waste management, they put viscera contents on manure shed to cure and later sold or used as fertilizer. The dead animals, condemned parts, blood were disposed in a condemn pits. Some abattoirs sold the non-meat parts. The peak season for slaughtering was usually in December during festivities. They slaughtered throughout the season but during peak season it went up to ten oxen and 25 small stock. During low season 2–3 oxen and 7–10 small stock. The major costs involved was that of water, electricity, workers, fence reconstruction. They were not aware of any diseases they may contract due to their occupation. The owners aspired to get a cold room in the near future.

In the value chains, there are meat transporters who ferried meat on motorcycles in special registered meat boxes for that purpose according to the Kenya meat Act (Cap 356). In the course of their work, they interacted with butcher-men, flayers, meat traders (butchery owners), meat inspectors, traffic police and county officials. The prices varied depending on whether large stock or small stock carcasses and the deal was usually verbal. They transported only one type at a time. It was peak business during December, good business from April to August but low during the month of January. They did not experience any challenges so long as they observed the laid down rules from the meat inspector such having personal protective equipment (PPE), six monthly medical checks and registered meat boxes as specified in the meat control Act. There were no women involved in the meat transport business. In case of any disputes, the manager of slaughter houses / slabs tried to resolve them. The major costs incurred during meat transportation included motorcycle investment and repairs, fuel, registration of meat boxes, purchase of

PPE, medical checks. Possible routes of germ contamination included use of dirty boxes, mixing the parts e.g., viscera and carcass parts, contamination in case they fell down during transportation.

Meat traders (butchery owners) were important in the value chains and interacted with other players like meat inspectors, customers who purchased their meat, the flayers, viscera cleaners, meat transporters, tea venders, county officials, livestock traders and public health officials among others. The dealings were usually verbal and meat traders usually set the prices per kilogram of meat sold. The public health officers were usually strict on them and sometimes incurred losses due to condemnation of parts or whole carcass as this is set out clearly in the meat control Act. The costs were sometimes high due to middlemen (brokers). The business season was low during the months of January and February because of overspending during December and due to school fees many animals were on offer at that time but business peaked from March to December. They usually bought animals for slaughter from traders or directly from farmers and transported them on hoof or sometimes on motorised vessels. They had to pay for animal movement permit. They had to comply with many conditions such as paying for trade licences, taxes, medical checks and the calibration of the weighing scales, otherwise they would be in problems. Before slaughter, they fed their animals on communal land. They incurred losses in case of animal deaths before slaughter, treatment costs when they fell sick and the meat that was unsold on the third day which was thrown away. All gender were involved in the meat trade. Major disputes were resolved by chiefs and their assistants. The major costs incurred included trading licences, transport, water, electricity and rent. They added value by selling roasted and boiled meat served with ugali (maize meal) to customers in kiosks (Figs. 2a and 2b).

4 Discussion

Participatory approaches have been successfully used in other epidemiological studies (Mochabo et al., 2005). However, some authors have argued that whereas these methods provide information on diseases more efficiently, it is important to enhance them with diagnostic tests for purposes of triangulation (Wesonga et al., 2010; Catley et al., 2012).

Pastoralism (keeping domestic herbivores) has been defined as both an economic activity and a cultural identity in the ASALs (Nyariki and Amwata, 2019) and contributes between 10–44% GDP for African countries. In this study, pastoralists mentioned the many challenges they faced which also have been discussed extensively other authors that include Fratkin (2001), Leyland & Catley (2002), Chengula et al. (2013), that would be attributable to population growth; shrinking of grazing land due to cropping, ranching, game parks, and rapid urban growth; livestock economy commoditization; displacements due droughts and famine; and poor extension services. Poor extension services was mentioned as one of the challenges which still is a challenge as found by Gitonga et al. (2016). However, Maasai pastoralists in Kenya since time immemorial, have raised their livestock in wildlife inhabited areas where livestock-wildlife interactions occur mainly at watering and grazing areas (Bedelian & Ogutu, 2017).

In their study, Nthiwa et al. (2019), MCF, ECF, FMD, CBPP and AAT diseases were given prominence by Maasai pastoralists as the most frequently occurring in cattle herds which were also mentioned by the pastoralists in Kajiado South Sub-County in the current study. Livestock diseases significantly impacting on their livelihoods included contagious caprine pleuropneumonia, lumpy skin disease and foot and mouth disease, which were ranked high (Onono et al., 2019). These results further corroborated with a previous report which was done in Narok County, (Onono et al., 2013) diseases as a major constraint.

Like all pastoralists, the Maasai that were interviewed were able to identify general signs of disease when an animal was sick and their management as well. Other authors (Profitós et al., 2013), have reported use a variety of strategies to prevent diseases including smoky fires against flies and mosquitoes, prophylactic use of veterinary medicine, and vaccinations. Herders identified the diseases on the basis of symptoms presented; for example, excess saliva and blisters on the mouth and hooves, non-movement as Nunuk (Bovine ephemeral fever).

The pastoralists used both traditional and modern medicines to manage the various livestock diseases and conditions. This has been reported elsewhere by Jones et al. (2020). When they treat their animals themselves and only report to the veterinary officer after so many trials without success (Chengula et al., 2013). For instance, Kuria et al., (2002) reported that the unauthorized sale of veterinary drugs by agro-veterinary shops, self-medication by pastoralists, use of wrong veterinary drugs, injection needles and route, and overdosing of chemotherapeutic veterinary drugs led to food safety concerns like drug residues and development of drug resistance. Gross misuse and abuse of veterinary drugs by pastoralists was reported by Lamuka et al. (2017).

The pastoralists appeared to poorly understand the burden of zoonoses they faced. This is corroborated with Munyua et al. (2019) who agree that the burden and transmission dynamics of many zoonotic infections are poorly understood in developing countries, including Kenya. Moritz et al. (2013), noted that since pastoralists live in such close proximity to their animals, and so many zoonoses are endemic, it raises the question why pastoralists do not recognize this category of diseases and do not have a specific term for zoonoses. In this community, brucellosis ranked second while other authors have indicated that it is the most common zoonotic infection globally with more than half a million human cases annually (Pappas et al., 2006). Brucellosis was ranked as a top priority zoonosis in Kenya due to the socio-economic burden and amenability to control. However, establishing the true morbidity and socio-economic impact of the disease is a challenge because of misdiagnosis and underreporting (Munyua et al., 2016) and indeed the Government of Kenya launched a National Strategy for the Prevention and Control of Brucellosis in Humans and Animals in Kenya (2021–2040). Other pastoralists reported anthrax, rabies, brucellosis and Rift Valley fever as a zoonotic diseases in Northern Kenya counties (Mohamed et al., 2019). Shirima et al. (2003) reported that zoonotic diseases affecting livestock keeping communities in Tanzania were listed as rabies, anthrax, tuberculosis, brucellosis, Foot and Mouth disease (FMD), Cysticercosis, plague and tapeworms. Similarly, FMD was cited as being zoonotic in the current study.

The Maasai pastoralists enumerated and were well versed on a number of drugs they used to treat their livestock. Roderick et al. (2000) also noted that in most cases, pastoralists gave a single injection rather than a course of treatment, whereby similar sentiments were fielded during the interview. They sourced the drugs from various agro-vets and hawkers during market days without prescriptions. Ngom et al. (2017) found that drugs were provided to pastoralists without prescription, and pastoralists administer these drugs to their animals by themselves.

From the results, the Maasai pastoralists had a pattern of grazing which is consistent with other studies (Notenbaert et al., 2012) where they have developed management systems based on strategic mobility that is driven by factors such as seasonal availability of grazing land and water resources, avoidance of areas with known livestock disease outbreaks as well as availability of markets. Large protected areas were established over the last century in regions previously used by pastoralists as grazing areas (Butt et al., 2009), first as game reserves and then as national parks such as Amboseli National Park in the study area. This has led to human-livestock-wildlife conflicts. A danger to the continued practicality of pastoral production and livelihoods would be attributed to sale of pastoral lands and the associated trend toward settlement of pastoralists for crop culture. (Fratkin & Roth, 2005). This was well captured that there is shift from communal land to private ranches in the current study. But during severe drought their patterns change to go even across the border to Tanzania with fears of seizure and auctioning their livestock.

Multiple actors, such as livestock traders, brokers, transporters, exporters, processors, butchers and meat distributors play different roles in securing the supply of livestock to domestic and international markets. One of the sources of incomes to pastoral households is through livestock sales that serve as a buffer against risks arising from droughts and epidemics (Otte & Chilonda, 2002). Therefore, livestock markets, when functional, play an important role in securing pastoral welfare by offering opportunities to destock and restock herds after droughts. Local traders and long distance play an important role in connecting pastoralists to consumers in urban areas as they purchase livestock from rural areas (Guyo M Roba et al., 2017). Roba et al. (2019) studied the profitability of such business for both the local traders and long distance traders in Marsabit County while Onono et al. (2015), showed the importance of large livestock traders in these local markets. The traders reported trekking their livestock on hoof sometimes which may enhance disease transmission as found out by Alarcon et al. (2017).

The current study was carried out around the slaughter houses / slabs and around the biggest livestock market, Kimana in Kajiado South. During the interview with the slaughter house / slabs managers / owners indicated that on market days, the meat traders come as far as Nairobi. This is supported by Alarcon et al. (2017) and, Nairobi and Mombasa cities remain the key terminal markets accounting for 75% of country’s meat consumption (Kenya Market Trust, 2014). Meat was transported by small scale traders for local market consumption using motorcycles while the large scale meat transporters used vehicles for the outside county markets which is consistent with Alarcon et al. (2017) findings.

Taken together, the inputs in the value chains from the pastoralists view have been pointed out as misuse of drugs without proper withdrawal periods, they were able to identify the zoonotic risks they were faced

with. The next phase is to swab at the abattoir node to further unravel foodborne risks and antimicrobial resistance.

Declarations

Ethics approval and consent to participate

Ethical approval for this study was obtained from the International Livestock Research Institute (ILRI) Institutional Research Ethics Committee (IREC), University of Liverpool Ethics Committee and a permit from National Commission for Science, Technology & Innovation. The participants in the focus group discussions (FGDs) in the study gave their oral consent to participate after the objectives and scope of the project had been explained.

Consent for publication

All authors read and for the publication.

Availability of data and materials

The data are available in hard copy.

Competing interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Author Contributions

All authors were involved in conceiving and design of the original research. MKM conducted the field work. MKM and OJO analysed the data for the original research for this article. MKM wrote the final article. All the author(s) read and approved the final manuscript.

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Figures

Figure 1

See image above for figure legend.

Figure 2

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