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One health insights into pastoralists' perceptions on zoonotic diseases in Ethiopia: perspectives from South Omo Zone of SNNP Region

Samuel Tefera Alemu[1*], Debebe Ero[2] and Siobhan M. Mor[3,4]

Abstract

Zoonotic diseases negatively impact pastoral communities in Ethiopia. In addition to impacts on human health, the interaction between people, livestock and environment which is so fundamental to the pastoralist way of life, means zoonoses pose additional challenges to social bonds and protection networks. These challenges are compounded by adverse impacts from climate change, poor health care services, market problems and cultural practices that increase pastoralists' vulnerability to zoonotic diseases. This research adopted a grounded theory approach and attempted to capture the perception of Hamer and Dassenetch pastoralists on zoonotic diseases and rangeland health through focus group discussions and key informant interviews. Involved in the research were human and animal health experts, and woreda (Woreda is a third level of administrative unit in Ethiopia following region and zone) level government officials. Thematic framework analysis was used to analyse the data. Zoonotic diseases are a significant public health concern and have a substantial economic burden on local livelihoods. Poor access to human and livestock health services contributed towards the widespread transmission of zoonotic pathogens. In most cases, pastoralists were aware of the possibility of zoonotic disease transmission from livestock to humans and were cognizant of infections contracted from animals. However, the level of risk perception from zoonotic diseases and the subsequent measures of protection was poor. In almost all cases, despite pastoralists' awareness of zoonotic diseases, they did not consider zoonoses as harmful to human health as they are to animals. It was evident that the burden of zoonotic diseases was high in livestock camps away from settlements in Hamer while for Dassenetch the resettlement clusters created a conducive environment for transmission. This research underscored the importance of engaging with local communities on the risk implications of zoonotic diseases including those related to their food habits and practices.

Keywords Disease, Livestock, One Health, Zoonotic, Ethiopia

Introduction

Pastoralism is a fundamental subsistence livelihood strategy dating back to the global warming era that ended the Pleistocene Epoch (Little 2015). Pastoralism is a significant economic sector in Ethiopia which attempts to retain flexibility under growing constraints and risks (Tsegaye et al. 2014). It is the dominant production system practised in the drylands and involves tracking and use of grazing and water across rangelands (Truebswasser and Flintan 2018). Pastoral livelihoods can thus be

*Correspondence:
Samuel Tefera Alemu
samuel.tefera@aau.edu.et
[1]Center for African and Asian Studies, College of Social Sciences, Addis Ababa University, Addis Ababa, Ethiopia
[2]School of Social Work, College of Social Sciences, Addis Ababa University, Addis Ababa, Ethiopia
[3]Institute of Infection, Veterinary and Ecological Sciences, University of Liverpool, Liverpool, UK
[4]International Livestock Research Institute, Addis Ababa, Ethiopia

considered as livestock-dependent mobile production systems that represent an adaptive strategy to life in harsh and marginal environments. Pastoralists in Ethiopia have a profound knowledge of the social and ecological contexts of their livelihood both spatially and functionally. Such understanding helps them adapt to and build resilience through customized resource use, knowledge management, production and disease treatment techniques in harsh environments where health service supply and delivery is a challenge (Kula et al. 2016; Rettberg 2010; Samuel and Biruk 2023).

Pastoral and agro-pastoral areas in Ethiopia experience inefficient access to and delivery of public services (Flintan 2014; Morton 2005). A persistent cycle of inappropriate policies and practices has been one of the most important contributors to local problems. These policies were neither consistent with pastoralism nor responsive to its uniqueness and contributed primarily to pastoral vulnerability (Humanitarian Policy Group 2009). Despite improvements in the delivery of veterinary services and animal health infrastructure, most development projects have not met their expectations (Prichard and Leonard 2021). This is mainly due to bias towards stimulating production at the expense of the socio-cultural systems, lack of knowledge on pastoral behaviour by planners and decision-makers, the top-down approach used by development facilitators and researchers and underestimation of the power of traditional institutions as well as the lack of utility of indigenous knowledge and understanding of the functioning of arid and semi-arid pastoral systems (IIRR 2004).

The interdependence between humans and animals introduces risks and opportunities (Bardosh 2016). In particular, contact with animals and animal products increases the risk of transmission of diseases from animals to people ('zoonoses') (Pieracci et al. 2016). Zoonotic and other emerging infectious diseases are a growing threat to global health, economy, and security which is being compounded by the influence of global warming on zoonotic disease epidemiology (Rupasinghe et al. 2022). Nading (2013) further highlights how changes in the anthropogenic landscape lead to the emergence of diseases. According to Bardosh (2016), zoonotic disease outbreaks reveal social orders making the boundary between social, political and biological events difficult to separate. Nonetheless, the study of zoonotic diseases in the Horn of Africa region is often on outbreaks triggered by endemic diseases with little investigation into the incidence, transmission dynamics and economic impacts on humans and livestock (Kemunto et al. 2018).

Control of infectious diseases in pastoral regions is still a challenge due to a number of factors including movement in and out of rangelands by unquarantined livestock through rustling, unregulated cross-border trade and poor disease treatment services. In Ethiopia, zoonoses account for a substantial burden of infectious diseases in humans, most of the burden of which is borne by poor livestock producers (Mulema et al. 2020). With limited veterinary and human health services, this remains a particular challenge for resettled households who live in remote locations. The settlement has the potential influence on reduced livestock and human mobility, habitat fragmentation and controls over herd splitting. This in turn can result in more frequent contact through the encampment of livestock in villages, increasing the possibility of zoonotic disease outbreaks in settlements.

Health service provision in pastoralist areas typically involves interventions directed at human and livestock health separately and tends to disregard the environment in which both depend for their survival. More recently, there have been attempts to integrate human, animal and environmental health service provision in pastoralist areas using One Health approaches Griffith et al. 2020a, 2020b; (OHHLEP 2022). One Health is a collaborative and multi-disciplinary approach that recognizes that the health of humans, animals, plants and the wider environment are interdependent (ref). Ethiopia launched its National One Health Strategy in 2018 with the goal of improving coordination across sectors to prevent, detect and rapidly respond to zoonotic diseases and related health challenges, including in pastoral areas where people have strong consumption, aesthetic and economic ties with their livestock. The risks from zoonotic infections can be untangled through empirical One Health research to guide the development of effective interventions (Gezahegn et al. 2021).

Accordingly, this research aimed to identify the perceptions of pastoralists on the occurrence and causative factors of zoonotic diseases, local treatment knowledge and how diseases affect social bonds and support network systems.

Methods

This study used a qualitative approach based on applied grounded theory. Grounded theory is a process of generating theory from data, which includes collecting the data, then coding and analysing the data (Noble and Mitchell 2016). The study was founded on primary sources to substantiate the arguments presented in the discussions. Identification of themes and key concepts followed the coding of the collected data and subcategories and categories that were developed. The research took place in village settings under tree shades in communal open spaces that are often customary spots for

public gatherings and socio-political gatherings. This created an atmosphere of openness, and people demonstrated their consent prior to the study. This helped research participants to freely communicate with the research team.

Data collection

The research was conducted in Hamer and Dassenetch woredas of the South Omo Zone in the South Nations and Nationalities Peoples Region of Ethiopia (Fig. 1). Predominantly, pastoral and agro-pastoral areas were selected purposively. These included Shanqo, Wegnraki Lika and Kizo livestock camps in Hamer and Seyus, Arokole and Ermeed clusters in Dassenetch. In this paper, the term 'livestock camp' is used to refer to the location where pastoralists keep their livestock while 'clusters' refers to scattered human settlements. A total of 10 key informant interviews (KII) and six focus group discussions (FGD) were conducted in the selected sites. Data collection was undertaken between January and May 2021. Prior to arriving in Hamer woreda, the research team made communications with relevant stakeholders in the South Omo Zone in Jinka and Hamer and Dassenetch woredas. After obtaining a research permit to start the fieldwork, topic guide contents were pilot tested informally through consultations made with zonal and woreda health, livestock, agricultural and pastoral development experts and officials. Networks established during previous fieldwork helped in facilitating activities of this research (Lumborg et al. 2021; Samuel and Kaneko 2020; Samuel 2017; Samuel 2014; Samuel et al. 2016). After reviewing the topic guides and assessing the relevance of the research questions, the fieldwork commenced as planned. The research team had a male principal researcher supported by female and male research assistants.

Focus group discussions

Focus group discussions (FGDs) provide a platform for participants to explain and clarify their views and

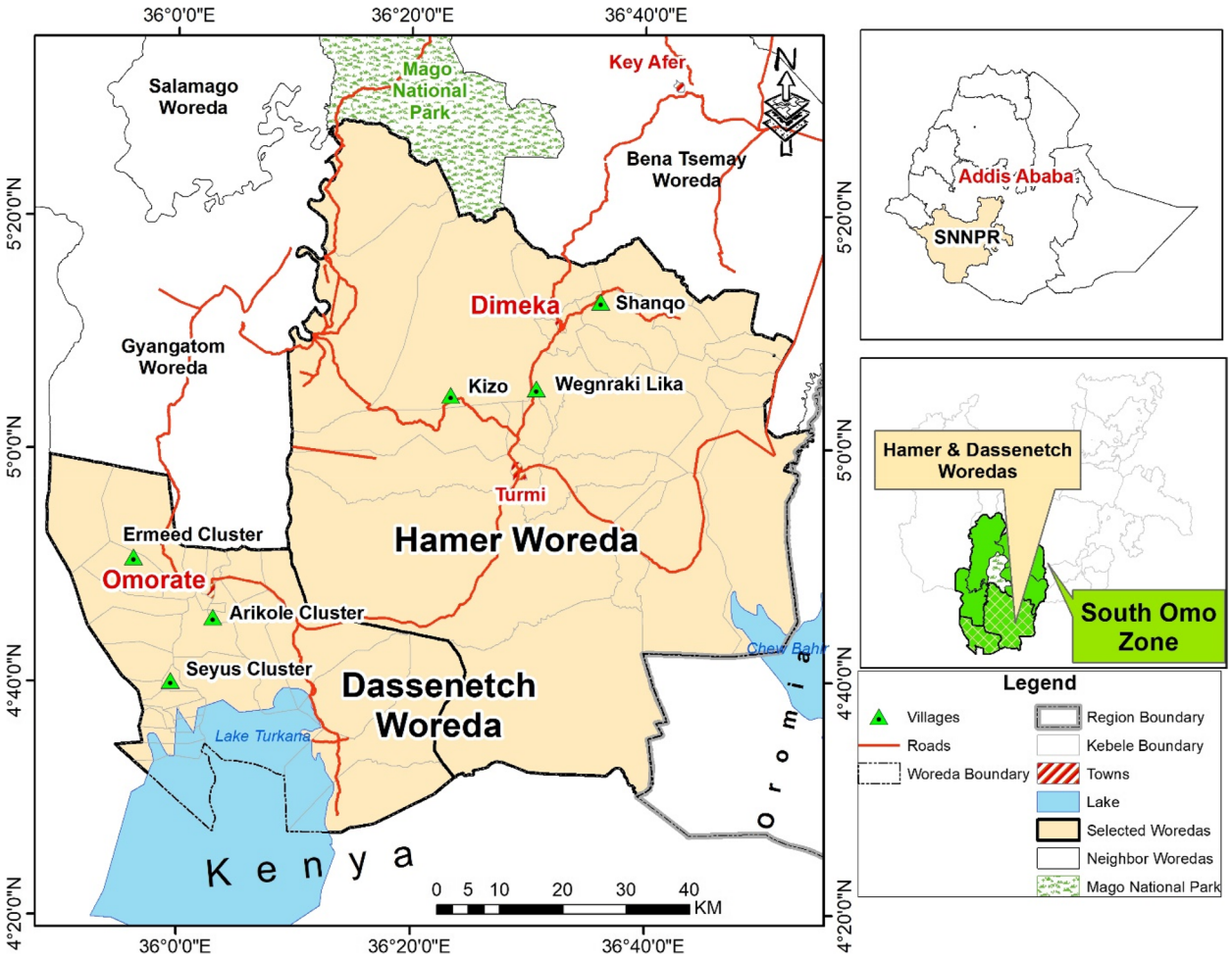


Fig. 1 Ethnic map of South Omo Zone displaying Hamer and Dassenetch woredas

perspectives on commonly shared values, norms and knowledge (Krueger and Casey 2015; Howell 2013; Kitzinger 1995). In both Hamer and Dassenetch woredas, one FGD was conducted in each of the three sites purposively selected in consultation with local elders and experts to showcase zoonotic disease incidence and rangeland health challenges in human settlements and livestock camps. Male and female participants aged > 18 years were in attendance. Focus group participants included community animal health workers, elders and herders.

Convenience sampling was used to select the participants of the focus group discussion. The size of participants fell within a range of 6–10 with the exception of 13 attendees in Shanqo in Hamer woreda. This conforms to the recommended size to generate rich discussion (Braun and Clarke 2013; Howell 2013). The composition of FGDs is displayed in Table 1.

The focus group discussions were conducted by the main researcher, assistant researcher and the support of an interpreter. The focus group discussions were conducted in the research sites in Hamer and Dassenetch using the respective languages. They were real-time translated into Amharic to help the researcher and the assistant researcher to probe further discussion arising from the FGDs. The FGDs in both woredas were recorded on an audio recorder and transcribed after each discussion.

Key informant interviews

Key informant interviews help generate primary data and facilitate the development of an in-depth understanding of the context and provide in-depth interpretations and descriptions that increase the validity, reliability and generalizability of a research using multiple methods through evaluating and interrogating personal accounts (Howell 2013; Walliman 2006). The research used a semi-structured approach while at the same time allowing for deviation into further discussion. The key informants were development experts and sector bureau officials, aged > 18 years. All informants were men as there were no women holding such positions during the time to discuss with. Informants were chosen for their knowledge and experience of environmental, human and livestock health care and for their in-depth understanding and experiences on zoonotic disease management. The key informants' interview aimed to address the research objectives of mapping the perceived burden of zoonotic diseases and the impact of zoonotic diseases on society. Purposive and snowball (network) sampling was used to gain access to well-informed informants. The researcher with facilitation support from an assistant researcher and interpreter carried out all interviews. A total of 10 interviews were conducted in the Hamer and Dassenetch languages, five in each woreda. All interviews took place in the key informant's duty station at the woreda offices. The Hamer and Dassenetch language interviews were real-time translated to help the researcher probe further discussion. The key informant interviews used a topic guide to facilitate discussion. All interviews were recorded on an audio recorder and transcribed into Amharic and English languages following the discussions.

Table 1 Information of research sites, gender and number of focus group discussion participants

Research site	Gender		Total
	Male	Female	
Hamer woreda			
Shanqo	7	6	13
Wegnraki Lika	4	2	6
Kizo	5	2	7
Dassenetch woreda	16	10	26
Seyus cluster	8	-	8
Arikole cluster	5	2	7
Ermeed cluster	4	2	6
	17	4	21

Analysis

A thematic approach was used for data analysis (Ritchie and Lewis 2003). Textual and audio data materials obtained from various sources such as KII, FGDs, researcher's observation and field notes were transcribed, triangulated and analysed by the research team. Themes were produced from codes and categories generated manually. Excel was used to produce the figures presented in the paper. The transcription started in the field in order to benefit from an iterative mechanism to the research, which allowed the researchers to review the development of the discussions (Pope and Mays 1995). A validation workshop that was held after the fieldwork informed the analysis work.

Results

Knowledge about zoonotic diseases

Studies by Queenan et al. (2017) indicated the use of syndromic terms as well as local understanding and perception of zoonotic and other health conditions in humans and livestock among pastoral and agro-pastoral communities (Mangesho et al. 2017). In order to examine the knowledge about zoonotic diseases and their level of understanding, participants were asked how they understood the term 'zoonotic disease'. Since the concept of zoonosis is unacquainted with the community,

we began by clarifying that 'zoonotic disease' is a disease that spreads from animal to person or human to animal. In the discussion, despite not recognizing zoonoses as diseases caused by pathogens such as viruses or bacteria, the participants could categorize zoonoses in broad but descriptive ways.

The first categorical explanation is related to symptoms they observe in both animals and humans. Through observation, they recalled symptoms such as acute diarrhoea, skin lesions, swollen lymph nodes, poor appetite, nasal discharge and unusual shivering. When their livestock show these zoonoses symptoms, they immediately isolate them to prevent them from spreading disease to the remaining livestock herd and people. The second categorical explanation mainly focuses on transmission mode, from an infected animal either to a healthy animal or from animal to human. According to their explanation, zoonotic diseases are generally transmitted through consuming milk and meat from sick animals, bites and contact with infected animal blood, fluids and skin, as well as inhalation due to close contact with animals. Notably, all the participants explained that some infected people display similar symptoms to their livestock, such as acute diarrhoea, poor appetite and skin lesions.

Risk perception

In almost all discussions, a similar level of risk perception was observed among the participants. That is, when we asked them their perception of risk, despite the perceived threat of infections contracted from animals, the community still consumed meat from sick cattle or shoats and often-dead animals. Risk perception was low among FGD participants from both Hamer and Dassenetch woreda. Responses below attest to this claim:

> *Goats sometimes develop swelling and die. Then we simply eat them then after we feel pain and often serious illness. (FGD3-Male-1-Kizo)*

> *We do not know the root causes of the disease because we are not educated. When our animals died, we do not know how they are infected and where the disease came from, but when they die, we eat. If people die, we bury them in the ground. But if an animal dies, we eat it, which is our tradition transferred from generations. (FGD2-Male-1- Wegnraki Lika)*

The FGD participants inaccurately perceive the risk associated with consuming infected animals. The preference the community attaches to meat as food, the prestigious value of animals along with cultural considerations of wasting meat as inappropriate practices further justify why people consume meat from infected animals regardless of the risks perceived.

Most common diseases

Participants identified the most common zoonotic diseases in their respective areas throughout the group discussion by associating clinical signs seen in suspected animals. Despite differences in understanding specific diseases across study areas, upon prioritization, the FGD participants identified rabies, anthrax, brucellosis and tuberculosis as major threats to human and livestock health by associating syndromes presented in suspected animals. The participants were asked to name and characterize zoonotic diseases in resettlement and livestock camp locations. They identified anthrax by name but described the others through their clinical symptoms.

The zoonotic diseases that have always been there according to the discussion were rabies (known as *bashchere* in Dassenetch and *kensna* in Hamer), anthrax (known as *guamadich* in Dassenetch and *ithima* in Hamer), brucellosis (known as *bilibilem* in Dassenetch and *bulenta* in Hamer) and tuberculosis. Many of the participants were sceptical of the presence of zoonotic pathogens that transmit from humans to animals. This is because of low awareness of the potential for transmission of diseases from humans to animals and vice versa.

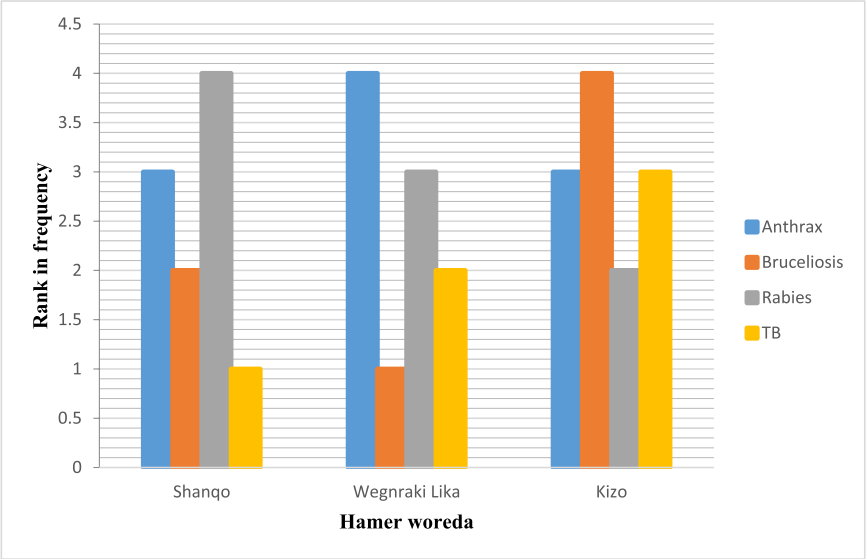
The perceived burden of the zoonotic disease across woredas is depicted in Fig. 2a, b.

Anthrax was perceived locally to have been present for generations. They frequently described it as a major threat to human and livestock health in both woredas and the syndrome characterized by swelling and bloody discharge from the nose and ears. They also confirmed that they recognized symptoms like fatigue, loss of appetite and unknown black spots when humans are infected. According to the FGD participant, they described it as:

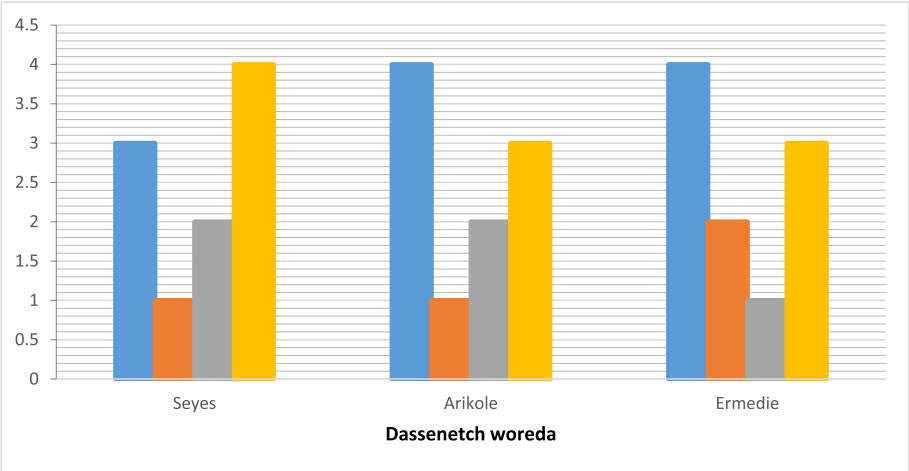
> *We recognize the disease that occurs in cattle as ithima, for example, in which the cattle swells, then dies, and becomes contagious with only a tiny amount of blood. We don't eat swollen cattle meat, and we don't sleep on their hides because it's contagious. If we do, we swell like the cattle. [FGD2-Male-3- Wegnraki Lika]*

A key informant from Hamer woreda also confirms that cutaneous anthrax is a significant challenge. According to the experts:

> *There is a cutaneous type that has been confirmed in a few kebeles while utilizing hides. The nature of the disease is seasonal, which makes it more likely to recur, as it can remain hidden in the soil for many years. [Male Hamer woreda, veterinarian]*



(a). Zoonotic diseases in Hamer



(b). Zoonotic diseases in Dassenetch

Fig. 2 **a** Common zoonotic diseases in Hamer. **b** Common zoonotic diseases in Dassenetch

Dassenetch livestock officer also confirmed that anthrax occurs every year.

In the majority of cases, anthrax, according to the FGD participants, is spread during the rainy season following a prolonged dry season. In addition to seasonal factors, the disease as they explained it is transmitted when they carelessly use infected hides for use as a mat.

FGD participants identified rabies (*bashchere* in Dassenetch and *kensna* in Hamer) as a zoonosis. Most of the FGD participants recognized that rabies is transmitted to humans through the bite or scratch of infected dogs. Participants in the group discussion stated that the most commonly known sign of a rabid dog is behavioural change, salivation, aggressiveness, intimidation and finally isolation to avoid any sound. As the participants described it, other rabid animals show some common symptoms like the infected dogs, but they are unsure how to handle it or treat the disease through traditional healers. Despite both Hamer and Dassenetch FGD participants identifying it as a rarely occurring disease, the perceived prevalence is relatively higher in Hamer than in Dassenetch due to their close settlement around Mago Park. According to a Hamer FGD participant, they have encountered rabies in their area and described their experience as follows:

> *Rabies in our area is not very common, but it appeared seasonally [it is localized]. A man we knew, our relative, died two months later after being*

bitten and having many symptoms such as backache, nausea, and throbbing. As a treatment in our tradition, there are rituals following which the medicine is taken in four directions, and then the person gets relief through diarrhoea and vomiting. If this does not cure the person, we assume that there is a complicated problem, and then [they] will die. [FGD-1-Male-5-Shanqo]

Brucellosis (*bilibilem* in Dassenetch and *bulenta* in Hamer) is the other complex disease identified by the FGD participants in both woredas that affects cattle, goats and sheep. Despite the absence of local knowledge on the causes of brucellosis, the FGD participants consider that it comes from consuming raw milk and hygiene problems during an abortion. In the discussion, they notably identified that children who consume milk and women who are commonly in contact with the animal are the most vulnerable. The majority of the FGD participants agreed that women are particularly vulnerable to brucellosis because they are in charge of all household activities, surroundings and treatment procedures of animals. Herders and elders who potentially consume raw milk and cattle products are vulnerable. Because of brucellosis, it reduces milk production, especially during an abortion, and their income from selling livestock and livestock milk.

Bovine tuberculosis (commonly known as TB), according to the FGD participant, is a disease that is identified as a problem in Dassenetch and somehow uncommon in Hamer woreda that spreads from animals to humans. The disease is characterized during the discussion by weight loss and respiratory complications. The FGD participants from Dassentech agreed that they acquired the disease possibly through inhalation and drinking their raw milk. The participants explained that drinking raw milk is the common way that TB is transmitted from animals to humans.

Spatial and temporal factors associated with zoonotic disease recurrence

It is important to understand the geographic distribution and timing of zoonotic disease outbreaks to improve surveillance. Based on the discussion with the FGD participants, they emphasized that the change in the environment is one significant factor for zoonosis occurrence. As stated by the FGD participants, the place the disease recurs is influenced by environmental conditions.

FGD participants from Hamer woreda revealed that almost all Hamers' cattle are found in the Kizo grazing area near Mago Park due to the recurring drought. As the researcher observed, resource scarcity has led to many cattle settling in the area, potentially exposing them to diseases. Aside from a densely populated village and crowded settlement, the animals only have access to a few water sources, which increases their interaction. As a result, their disease risk is exceptionally high. An FGD participant described the scenario:

The gathering in Kizo is for pasture, and crowding our cattle in one place exposes us to human-animal disease. We accept that being together is risky because it continues to accelerate the spread of the disease. Of course, in Kizo, cattle are exposed to diseases mostly while drinking water because water places are few. [FGD-1-Male-2-Shanqo]

Kizo grazing land is closely connected to the Mago Park, and they often feed and water their cattle in the park. Due to their proximity to wildlife and the incursion of the pastureland by invasive species, they are sometimes experiencing undiagnosed diseases. An FGD participant confirmed that:

Due to scarcity of pasture land and recurring drought, our livestock regularly graze in the Mago park area. There is an unusual fly [FGD-1-Male-5-Shanqo]

The participants from Wegnraki Lika also added that:

The animals are more vulnerable to emerging zoonotic diseases because Kizo is the only pasture area and proximity to wild animals in the Mago Park. This is the only pasture we can find, and its proximity to wildlife, combined with the pressure from the crowd of Hamer cattle, contributes to the disease's spread and loss of livestock. [FGD-2-Male-1].

We believe that ithima causes cattle to swell, and lung diseases that affect goats emerge from the Mago Park. The disease has now spread beyond the park's boundaries. [FGD-2-Male-4].

In Hamer woreda, based on the researcher's observation, human settlements in Kizo and around the Park are common. Every Hamer household has a cattle camp in Kizo grazing areas. The settlement in Kizo, as explained by the FGD participant, is ascribed to a lack of pasture for livestock and recurrent droughts. It was evident during the fieldwork that, given the lack of pasture and water, the society is putting pressure on the ecology and setting of the Park.

In Dassenetch woreda, flooding is a common occurrence due to their settlement in the riverbed. Because of the flooding, people have faced forage scarcity and have been required to move to new areas forming resettlement clusters. The [re]settlement is arranged by cluster, and

each cluster may hold three or more kebeles. From the researcher's observation, it is evident that the traditional drought and disease coping mechanism, mobility, is limited due to the flood-induced settlement and fear of conflict with neighbouring ethnic groups like Nyangatom. As a result, as stated by an FGD participant, the inability to access pasturelands due to flood, fodder scarcity and severe disease outbreaks have occurred in history that has never been seen before.

Another spatial aspect of zoonotic disease recurrence is the Seyus cluster's proximity to the Kenyan border and the practices of frequent cattle raiding in the area with the Turkana community of Kenya. The communities in the Seyus cluster do not strongly associate cattle raiding with cross-border disease transmission. It is often the case that raided cattle could be infected and mixed with their cattle, increasing the probability of spreading diseases. Despite the perceived fear, the community is still engaged in cattle raiding as a custom and did not fear possible infection.

Seasonality and major causes of zoonoses

Seasonality is associated with specific diseases, and zoonoses intensify after a long dry season. On a related note, seasonality was identified with societal lifestyle and practices. Pastoralists' seasonal contact during birthing is one example mentioned by the FGD participants. According to the participants, the rate of contact while milking increases during the birth season. Accordingly, children and the elderly who consume milk and women who milk the cows are the most vulnerable social groups.

Another critical point that has been identified during the FGD concerning seasonality is grazing mobility patterns. According to the participants, grazing in the pastoralist community is based on the seasonal calendar, and mobility patterns are determined by resource availability and disease risk. Therefore, during the dry season, livestock are moved to places with good pasture and water resources.

Again, despite not recognising zoonoses as diseases caused by pathogens such as viruses or bacteria, the discussion revealed knowledge of some underlying causes. In animals, the major causes are perceived to be proximity to wildlife areas like Mago Park; ticks, insect bites and soil for anthrax; and overconcentration in certain places like Kizo grazing areas. The water wells are not protected, and some animals urinate there and sometimes fall into the wells.

Seasonality is an intrinsic characteristic of ecological systems, and both acute and chronic infectious diseases have seasonal incidence. Based on the FGD with the local community, the study identified that seasonality significantly contributes to perceived zoonotic disease occurrence. Seasons are the other factors where some diseases appeared when there are rains after a prolonged dry season. Uncontrolled livestock mobility for either market or grazing, floods and cattle raiding are also agents for transmissions. During cattle raiding, the looted animals might be infected, which was common in the Dassenetch community.

When asking questions about the causes of zoonotic diseases, the biomedical convention of classifying aetiology as viral, bacterial, fungal and parasitic was not used. The local community rather identified the causes of the diseases in terms of their transmission mode.

The causes of zoonotic disease transmission, according to the discussion, were categorized into four: direct contact with blood, urine, fluids and saliva; indirect contact like proximity to wildlife and soils; bites from vectors such as ticks; and foodborne including consuming raw milk and eating dead infected animals.

In humans, causes included the consumption of raw milk, eating infected animals and carless handling of animals with brucellosis or direct contact with infected animals through blood, urine and other fluids. For example, while cleaning the cattle camps, the individual touches the dung, urine and other fluids. In addition, the discussion from FGDs showed that, in most cases, people are aware of the possibility of zoonotic disease transmission from livestock to humans and cognizant of infections contracted from animals. According to the discussion with FGD participants, seasonality is multilayered. According to FGD participants, environmental factors such as rainfall play a significant role in disease occurrence. Tsetse fly [locally called a fly from buffalo] emerges during the rainy season in Hamer woreda. They also had the same experience with anthrax, which spreads during the rainy season after a long period of the dry season. In the discussion, brucellosis mostly did not associate with a specific season but soars high during birthing periods. Among all the FGD participants, they agreed that the seasonal pattern shows peaks associated with the perceived prevalence of diseases.

> *Many diseases occur when it rains a lot and after prolonged drought. When a new bush grows, livestock start getting infected. Due to these, we have been losing much livestock that is an asset to our livelihood. When there is an extended drought and a little rain appears, the cattle get sick while eating. Also, when it rains after a long dry season, the running water creates a small pond and when our livestock drink the water, they get infected and die. In our tradition, we do not dispose dead animals, and when we eat their meat, we get sick. [FGD-1-Male-Shanqo]*

The Dassenetch FGD participants in Seyus and Arikole clusters also added that:

> *It usually occurs in September, but it can occur in August as well; the disease is associated with rain. When it rains after a prolonged dry season, the diseases began to spread. [FGD-1-Male-Seyus cluster]*

> *Seasons have a great impact. Many diseases are associated with seasons like anthrax outbreak during rainy season and tuberculosis that had coughing during a cold-dry season. [FGD-2-Male-Arikole Cluster]*

According to the FGD participant, in Hamer woreda, during the dry season, livestock moved to the Kizo grazing area and often around Mago to access good pasture.

Most importantly, as stated by the participants, while grazing, particularly in Mago Park, livestock come into contact with wildlife reservoirs, increasing their exposure to zoonotic pathogens and unknown diseases.

Zoonotic diseases treatment

The FGD participants outlined the three treatment options: traditional through healers, common local practices and modern animal health posts. As explained by FGD participants, traditional healers are local doctors who heal using herbal medicines for both animals and humans. They perform rituals to avoid disease incursion, locust invasions and any other unknown outbreaks. When referring to a zoonotic disease with no local name, a Wegniraki FGD participant conferred that:

> *We have a local medicine called kera, which we administer to those who are shivering and bleeding. Previously we blended herbs, administered these mixtures, and our cattle or sheep or goat managed to survive. When a person is infected, he or she drinks kera as well, but now we are no longer cured despite drinking it. [FGD-2-Male-Wegnirak]*

Another participant said that:

> *We adhere to our culture; we make rituals, which adults lead. We have a mass prayers culture referred to as Barjo ala where people congregate and adults perform rituals in a public space. So, we believe the disease will not spread because they spiritually fence the entire village. It may be a human or animal disease, but the ritual will work and the disease will go away if the people of this village believe and harmonize in one heart. [FGD-2-Women-Wegnirak]*

The other traditional practice used in the study area as a treatment is isolating the infected person or animals to mitigate further risk from zoonoses. One participant describes the traditional quarantine system:

> *When cattle and sheep/goats get sick or infected, they show illness signs such as nasal congestion, the expulsion of blood from their mouth, acute diarrhoea, and mouth dryness. Accordingly, we first quarantine the infected animal and withhold water for about two to three days. Then we give them our traditional medicine that is a mixture of different herbs with water. [FGD-1-Male-6-Shanqo]*

The Dassenetch FGD participants also conveyed that:

> *All we have to do is tie up or isolate the infected animals, prevent them from drinking too much water, and then give them ginger and pepper to drink. We do this to keep the disease from spreading throughout the cattle's body, and we sometimes use modern medicine, such as antibiotics to protect our animals. [FGD-1-Male-6-Seyus]*

> *In addition, if an animal dies from anthrax, we bury it far away from our area and prohibit the use of its hides; however, we occasionally eat the dead animal for food and become infected. [FGD-2-Male-2-Arikole]*

Concerning humans, the participants explained their way of treatment as follows:

> *If the infected is human, the family isolates the person in one place and treats them with maximum care. Since animal-human diseases are contagious and thought to be transmitted, the family prepares separate plates and utensils for the patient. We do not be close to a rabid person; the family only cares and treats the patient. [FGD-1-Male-Shanqo]*

A Kizo participant also shared their experience:

> *We often buy medicine from the town and administer it ourselves. When we report to an expert, they sometimes provide medical care. The disease itself has a season once it gets sick and then disappears on its own. [FGD-3-Male-2-Kizo]*

Despite knowledge of treatment, animal health experts in both woredas indicated the presence of unauthorized drug administration by pastoralists and its adverse effect on livestock health. As one FGD participant witnessed:

> *Previously, we used to administer our traditional medicines but recently, while medicines are available in our areas, we used to buy various medicines that range from broad-spectrum to disease-specific. However, due to repeated use of antibiotics, when we*

give them our traditional medicine, they do not get cured, so we do not use our traditional medicines. [FGD-3-Male-5-Ermeede]

The FGD revealed that pastoralists are buying broad-spectrum antibiotics from pharmacies both legally or illegally and administer antibiotics like oxytetracycline without a prescription and proper consultation from health professionals. This contributes to the growing problem of antimicrobial resistance.

Impact of zoonotic diseases on social bonds

According to the focus group discussion, cattle raiding has always been linked to such values between Dassenetch and Turkana, in addition to age-set initiation rites. Furthermore, having large herds strengthens the solidarity of the pastoralists in the study areas. According to a Dassenetch FGD participant, those who lost their herds due to drought, cattle raiding or epidemics would be restocked using social customs. When poor people are affected by natural disasters it is a convention for their families restock them.

Based on these discussion points, participants were asked about the presence of zoonotic disease and its effects on social bonds. The participant from Dassenetch enlightened that the occurrence of disease in their areas shrinks the role or status of livestock including their traditional values system as well as limits their annual movement. As FGD participants stated that:

Even though I am aware of the impact of the diseases and its impact on society, I won't quarantine my child or my family member because she/he is suffering from tuberculosis [TB]. [FGD-3-Women-2-Ermeede]

When cattle become infected, we separate them from the rest of the herd to not spread the disease. Otherwise, we do not think that it has an impact on social bonds. [FGD-3-Male-4-Ermeede]

According to Hamer FGD participants, this unintentionally forces them to focus on private enclosures rather than communal lands to be used during the dry season. In other ways, due to Hamer woreda's recurring drought and disease outbreaks, private enclosures receive much attention as an option to manage rangelands. The challenge is that since land is a scarce resource, putting it under the control of a few people undermines the social fabric of the Hamer community, causing unnecessary conflict on land in the future. The Hamers were unaware of the challenge private encloses bring. They, however, discussed how a lack of grazing land was driving them to infiltrate wildlife reserves during the discussion. Almost everyone said they do not think it is a challenge for their social ties, but their answers hinted that a lack of resources pushes them to live in disease-prone areas. As private enclosures practice and management evolves, social interventions to address the subsequent challenges are expected to emerge. The FGD participants stated how the challenges pressed them to make the decision to move into Park systems.

The gathering in Kizo is for pasture, and crowding our cattle in one place exposes us to human-animal disease. We accept that being together is risky because it continues to accelerate the spread of the disease. Of course, in Kizo, cattle are exposed to diseases, mostly while drinking water since water points are few. [FGD-1-Male-2-Shanqo]

We would not take our cattle if there were available grass and water for livestock near our villages. Mago Park, predators and poisonous flies from there bite and harass making them vulnerable to zoonotic disease. The difficulty in getting pasture is what drives everyone to migrate far from our villages. [FGD-1-Male-3-Shanqo]

We should live alone in the forest, but our livestock graze and drink water; they come into contact with other herds. As a result, the overconcentration of livestock in Kizo grazing land would exacerbate disease spread. [FGD-3-Male-1-Kizo]

Zoonoses occurrences, pastoral support network system and livelihood

As the FGD participants verified, anthrax, for instance, is widespread in both woredas, with severe consequences. During the anthrax epidemic in Hamer woreda, many cattle died, and countless families confronted severe financial hardship. Essentially, many of the pastoralists have transformed into agro-pastoralists to support their livelihood. Then again, anthrax's presence, according to the FGD participants, has hampered access to milk for children's consumption. They also mentioned that the impact is not limited to household food supply but also includes milk that is sold in the market to generate income. Furthermore, the presence of disease and recurring drought has created an issue in animal production (Lumborg et al. 2021). One participant expressed his dissatisfaction and failure in the following way:

Initially, the government advised us to reduce the livestock we had due to a lack of pasture and an outbreak of disease. Alternatively, they told us to sell some cattle and save the money in cash. We were

taught to keep a few livestock for food consumption, particularly for children, and to keep a few livestock for farming. We did not pay attention to what they had been saying before because we regard cattle as a great treasure, and as a result, we lost many livestock due to disease outbreaks and drought. But now we hear the advice of the government. [FGD-2-Male-Wegnraki Lika]

In addition to the drought, in Hamer woreda, the influx of cattle at Kizo put much pressure on water sources and exposed them to further risks. People are vulnerable to the tsetse fly, rabies and sometimes-unnecessary competition as they attempt to access resources in the context of their livelihoods.

Similarly, many Dassenetch cattle were lost due to flood and disease outbreaks post-flood, and drought and the community involuntarily resorted to government support. According to FGD participants, the families, which had before relied on animal products, were hit by starvation and were not able to properly take care of their livestock. The displaced pastoralists also gathered in one cluster, and their lives and livelihoods are exposed to challenges from diseases. As the FGD participant explained it:

What's more difficult for us is that when there's a drought and animals don't have enough fodder, perceived disease prevalence rises, and livestock deaths result. [FGD-3-Male7-Ermeede]

The other participant also stated that:

When we take the drought-stricken animals to the market, the price drops, and we return home without purchasing what we need, which harms our livelihood. [FGD-3-Male-5-Ermeede]

Gender impact on livestock treatment

As the FGD participants mentioned, in most situations, women are the ones who look after sick animals while men deal with grazing issues. The vulnerability of women to zoonotic diseases was reported to be high compared to men due to their involvement in numerous activities including their engagement as primary caregivers of herders (often children). They agreed that domestic work stressors placed a heavy burden on women, who bear the responsibility of treating sick animals and humans.

A Dassenetch woman explained her burden as follows:

For example, if I don't have a husband, I am the sole person in charge of coordinating all livestock care and treatment. Therefore, women in Dassenetch are the primary caregivers and at the same time vulnerable to diseases. [FGD-3-Women-1-Ermeede]

Although men and women have different roles, the FGD participants in both woredas revealed that women contribute significantly to societal well-being and concerned about human and animal health. As a Hamer FGD participant confirmed:

The herder or the young man who keeps close to the livestock is the most vulnerable social group in our society. Women are also the next vulnerable group because they are the ones who are responsible for home activities such as making food, do the milking, and cleaning cattle camps. [FGD-1-Male-2-Shanqo]

A Dassenetch woman participant also added that:

We [the women] are the ones who are most affected and vulnerable because we are the ones who milk, clean the cattle camp, and cook food for our families. [FGD-3-Woman-Ermeede]

Food practices and preferences

Key informants claimed that, despite being aware of the dangers of eating infected and dead animals, they would not give up the practice due to its inbuilt cultural behaviour [FGD-2-women-Wegnraki Lika]. There is also an indication of using infected animal hides for mats, resulting in severe infectious diseases.

Nevertheless, the practice is different from place to place, such as Shanqo; people have been converted to Christianity and have avoided eating dead animals. The other intensifying practice is the consumption of raw milk. They consume raw milk and assume it is suitable for children and older people. Despite the general agreement that raw milk transmits diseases to humans, they consume it. Even if they know that their animals are sick, they believe that it will not cause significant harm. A Dassenetch participant explained the overall complexity as follows:

The disease primarily affects our livestock when they move for pasture. Regarding bovine tuberculosis, children become sick due to their proximity to livestock and get infected by brucellosis while consuming raw milk. [FGD-2-Male-Arikole]

Despite claiming to practice boiling, it was evident that they take raw milk from the cow or goat and drink it right away, assuming it is safer. It was a commonly observed social practice among herders during the fieldwork.

Access to animal health services

Throughout the discussion, participants remarked that they treat their sick animals unless it needs professional intervention. As explained by the FGD participants, the reason to self-administer a drug is the absence of

veterinary professionals, weak CAHWs practices and distance from nearby health facilities. The Hamer FGD participant explained the problem as follows:

> *We do not have a nearby veterinary clinic/post. Instead, the woreda expertise appears every three or four months, pretending that there is a disease outbreak and organizing a vaccine campaign. Unfortunately, we do not receive regular follow-up from the respective personnel. [FGD-1-Male-4-Shanqo]*

Another participant also added that concerning human health, we have health extension workers who follow up on our health; when it comes to veterinary service, however, no one pays attention [FGD-1-Male-6-Shanqo].

When the situation is critical, they immediately report it to CAHWs or directly notify the woreda livestock officers to get further interventions. Based on the researcher's observation, such responses and health-seeking behaviour are determined by the location of the kebele. For instance, few kebeles that are close to towns, such as Ermeede and Wegnraki Lika, preferred to use human health posts, as opposed to distant areas such as Kizo in Hamer and Seyus in Dassenetch. As the Hamer, local voluntary health assistance explained it:

> *I am Wegnyarki Lika representative in the health sector. We are instructed to report any symptoms as soon as possible, so I report them as quickly as possible. When experts receive a report on a new outbreak, they immediately arrive in the village and identify the infected individuals, take them to regional hospitals, and often to Addis Ababa. [FGD-2-Women-Wegnirak]*

The FGD participant from both woredas expressed dissatisfaction with the service they get from local CAHWs and woreda experts. A Dassenetch FGD participant explained this annoyance:

> *When we go to the woreda to apply or complain, most of the offices did not provide us with what we wanted telling us that this is not the office and that we should go to the other one. While it is simple for them to inform the appropriate body, some government personnel do not respond to our inquiries. [FGD-3-Male-4-Ermeede]*

Regarding access to medicine for livestock diseases, FGD participants discussed how difficult it is to obtain necessary drugs from government animal health posts. Even though it is available in some areas, the community encountered CAHWs unwilling to provide treatment services. The Dassenetch FGD participant during the discussion frequently complained that:

> *The CAHWs are mainly interested in selling medicine, which has brought an issue in medication usage. [FGD-2-Male-7-Arikole]*

> *Also, when we tell them there is a sick animal, they give us medicine and force us to administer it ourselves. They don't want to go to the place. [FGD-2-Male-3-Arikole]*

The CAHWs are private practitioners and may show little interest to provide service to remotely located pastoralist communities as stated by FGD-2-Male-3-Arikole above.

Uncontrolled antibiotic use

Instead of transporting sick animals to health facilities that are far away, the community prefers to buy medicine from town and administer it themselves [FGD-2-Male-Kizo]. This is a common practice in livestock treatment in both woredas, and they do not seek any advice from animal health professionals. When asked how they managed the dosage, they said they did ask the shop owner and tried it out for themselves to see whether it worked. The FGD participant underlined that:

> *We know CAHWs are the primary source of veterinary drugs and advice on proper use.*

Conversely, they believe it is better to buy and treat our animals than to buy from them because of their frequent negligence [FGD-2-Male-Arikole].

Discussion

Zoonoses are a priority concern for livestock keepers in Ethiopia (Gizaw et al. 2021). Inadequate access to water and pasture and poor animal health service delivery (Hadush 2015; Mohamed 2019) remained a challenge in pastoral areas in Ethiopia. Moreover, the coverage and quality of veterinary services are less than satisfactory across the different livestock production systems (Gizaw et al. 2021). This, therefore, limits our understanding and knowledge of animal diseases and health concerns in the study areas.

The patriarchal and hierarchal socio-cultural organization of both the Hamer and Dassenetch communities preordained the dominance of men in FGDs (Samuel 2017; Lumborg et al. 2021). Women in Hamer, however, participated actively compared to those in Dassenetch. In the Seyus cluster, for instance, women despite their availability were not able to participate as the men were anticipating a raiding mission to Turkana at the time of discussion. Their limited involvement in the discussions in Arikole and Ermeed clusters is also associated with

limited access to livestock treatment roles due to cultural taboos that consider women impure for the task.

It was noted that until recently, engaging women in both woredas to participate as CAHWs in particular and in livestock health extension in general was non-existent. It was observed that this potentially affected possibilities for deliberative exchanges particularly in Dassenetch preventing gendered viewpoints coming forward during the discussion. Perspectives from the rest of participating women were taken by giving opportunities for them to raise points and argue what men participating in the FGD presented.

Rupasinghe et al. (2022) attribute the influence of global warming and geoclimatic variations on zoonotic disease epidemiology through bringing alterations in the host, vector and pathogen dynamics and their interactions. The difficulty associated to the highly mobile nature of pastoralist communities and the lack of modern communication makes it challenging to conduct epidemiological research and disease surveillance (Alhaji et al. 2018). In the majority of cases, the disease, according to the FGD participants, is spread during the rainy season after a prolonged dry season. In addition to seasonal factors, the disease as they explained it is transmitted when they use infected animal hides for mat purposes.

In all FGD discussions on the identified zoonotic diseases, the participants did not consider zoonosis as harmful to human health as animals. They are little concerned about the human health implications and their additional risks. This supports the FGD participants' claim, which attests to the fact that the environment enables or disables the survival, reproduction and distribution of pathogens, vectors, hosts and modes of transmission.

Pastoralist communities in Ethiopia are intimately related to their animals and zoonotic infections (Hadush 2016). Rahman et al. (2020) refer to the majority of zoonoses as preventable but mention neglect in spite of them being significant public health threats in developing countries. This attests to our observation on why communities have little perception of risk and understanding of the major causes of zoonosis infections.

Pastoralists have lived with their livestock for centuries and have undeniable local knowledge to identify and treat human and livestock diseases. Throughout the discussion, the study found that pastoralists developed well-established beliefs, knowledge, skills and disease treatment practices.

Zoonosis diseases affect social bonds. In Hamer and Dassenetch pastoralists' community, cattle are the backbone of their livelihood, social prestige and symbolic importance. Their everyday interaction and aspects of their lives are interlinked with animals. Dassenetch FGD participants stated that cattle are used as wedding dowries, sustenance for families and often as a means to engage and maintain social networks. Accumulating large herds is a source of pride, and a man is wealthy if he has large herds. Cattle are also regarded as a social bonding agent during a bride's wealth as payment and compensation in cases of harm or conflict.

Social relations among pastoralist communities were affected by the recurrence of drought-induced disease outbreaks, which was the case in both Hamer and Dassenetch woredas. In 2019, for instance, anthrax killed thousands of livestock on which people depended on cattle-based alliances and social protection systems.

Pastoralists who lost their herds to floods or who faced scarcity of fodder were required to settle in a specific area in a cluster and restrict their annual movement. Drought impacted social ties through creating an environment whereby people are forced to settle in disease-prone areas and by disturbing their mobile livelihoods.

Comparably to Dassenetch, the sharp decline in herd numbers due to disease outbreaks and a loss of grazing land has reduced Hamer communal carrying values. The subsistence and support system of pastoralists in Hamer and Dassenetch woredas has been evolving due to the occurrence and severe consequences of zoonotic diseases. Attesting to this notion is the low level of awareness about zoonosis among pastoralists and health professionals in the country (Hadush 2016). The discussions conducted in both woredas suggest that people come into contact with pathogen-carrying animals in their everyday practices as they travel around a settlement for social and non-directly ecosystem-dependent livelihood purposes. In addition to having a direct impact on pastoral food security, the occurrence of zoonotic disease impacted the number of animals brought to market by pastoralists and their profit margins.

Additionally, as explained by Mulema et al. (2020), gender differences and inequalities influence exposure to perceptions and management practices for zoonotic disease risks. This influence comes through gendered roles and responsibilities embedded in social and cultural norms among different societies. The influence of gender is also evident among the Dassenetch and Hamer patriarchal societies (Samuel 2017; Lumborg et al. 2021). The socio-cultural structures and traditional practices of both societies heavily influence the gendered roles of men and women accordingly. Hence, the nature of the work prescribed for women may expose them to different health and safety-related concerns to men. The study found that women have good knowledge of the treatment and clinical symptoms of diseases. However, local norms do not allow women to use benefit from capacity-building opportunities thereby limiting them from acquiring more knowledge of animal treatment. This can be improved

through the provision of trainings to women emphasizing on the treatment of small ruminants and milking herd staying in villages where women are in control.

Despite women's treatment knowledge, during the discussion, the participants identified herdsmen and women as the most vulnerable to zoonotic pathogens due to their frequent contact with animals. Women's roles are restricted to their immediate environment, and they do not travel long distances for grazing as men do. Therefore, the management begins with cleaning their homestead or surrounding along with the cattle dungs. Aside from that, treatment activities include caring for sick people and sick animals, for example, pregnant animals including ones which abort. Both FGD participants stated throughout the discussion that women are overburdened by productive roles such as cleaning cattle camps, milking, providing traditional animal health care and food preparation. Although women are not recruited as community animal health workers (CAHWs) in the two woredas due to cultural constraints, their roles as informal caregivers for human and animal health are significant in society. As a result, women are well informed about disease symptoms and, in addition to the herder, are frequently the first to recognize a sick animal. The introduction of CAHWs in the Horn of Africa started in the 1980s following the adoption of new rural development ideas to sustain practical engagement between communities and development organizations (Leyland et al. 2014).

Food culture is identified as social behaviour in the study areas increasing perceived zoonotic prevalence, transmission and infection. According to a study on human behaviour on anthrax transmission in Uganda (Shaban et al. 2022), high levels of knowledge were inconsistent with the attitudes and practices of respondents. Hadush (2016) attributes factors such as proximity to animals, food consumption behaviour, milk and meat contamination, inadequate supply of treatment drugs, harsh environmental conditions and socioeconomic and cultural practices to pastoralists' exposure to different zoonotic diseases in Ethiopia.

Similarly, the consumption of sick and dead animals for food is a practice that put pastoralists in both Hamer and Dassenetch at risk. This practice puts consumers in contact with infected meat and contributes to the transmission of zoonotic diseases. According to the participant, such practices are not new and have been passed down from generation to generation.

The most widely acknowledged and hotly debated problems raised by FGD participants in both woredas were a lack of access to livestock health inputs and livestock health post infrastructure. The major constraints are (1) shortage of veterinary professionals, (2) lack of available medicine and (3) inadequacy of livestock health post infrastructure. Moreover, participants outlined their concerns as follows: (1) the local CAHWs every so often did not report the local concern to the woreda, (2) when diseases are reported, the CAHWs or local volunteers advise the informers to administer the drug by themselves and (3) the overall follow-up and inter-sectoral coordination and teamwork is poor.

In order to avoid further health challenges, the community buys medicine from local drug stores and administers it on their own without expert consultation or optimal doses. Such alternative social practice of purchasing medicine is commonly attributed to the challenge to access qualified personnel from veterinary medicine, but it raises the risk of drug-resistant disease. In response to a lack of drug supply and remote rangelands are unattractive to health professionals (Coppock et al. 2017). Hence, communities deal with livestock diseases using traditional or bio-medical methods based on their knowledge. Access to drugs is illegal, and the cost of the various options available and previous experience all influence the preferred method for treating livestock. Regardless of the need for additional medical research, the anti-health-seeking behaviour and drug administration revealed in the study area unavoidably increasing the spread of antimicrobial-resistant bacteria.

Conclusions

The burden from zoonotic diseases significantly threatens the livelihood, health and productivity of pastoralists and their livestock given the little health services provisioning in the pastoralist areas that are characterized by extreme forms of poverty and food insecurity. The pastoral communities in the study sites live with such a reality and are aware of the modes and risk of zoonotic infections as well as transmission from livestock to humans and vice versa. Their risk perception, however, was found to be poor. Chivalric considerations to raiding for bringing prestige to the raiding parties completely elude the association high risk of transmission has with the practice. The process impacted social bonds and pastoral support networks from exposures to infections. Herdsmen and herdswomen often move with their herd, settle in livestock camps near wildlife habitats and are active actors in raiding making them vulnerable to infection.

Moreover, it was evident from the FGD and KII responses that the perceived prevalence of zoonotic diseases was high in livestock camps away from the settlement in Hamer while for Dassenetch, the resettlement clusters created a conducive environment for transmission. Frequent contacts through the encampment of livestock in settlements and in livestock camps increased the possibility of zoonotic disease in both woredas. Increased

mobility and concentration of livestock in park systems will increase the exposure and transmission of zoonotic diseases to wildlife areas. Hence, it can be said that settlement has an influence on reduced livestock and human mobility increasing the contact time between animals and humans, and thereby higher infection. At the same time, pastoralists close to towns have an easier time accessing health services compared to those living in herd camps and away from town. The effective prevention of zoonosis and the subsequent challenges to the pastoralist communities can be addressed by applying One Health interventions and due considerations need to be given to zoonoses as a public health concern.

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Authors' contributions
ST is the principal investigator and first author of the research project. ST, DE and SM contributed to the design of the study. ST conducted the focus group discussions and key informant interviews and conducted the data analysis and the write-up. DE and SM reviewed the write-up. The three authors contributed to the revised draft and read and approved the final manuscript.

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Availability of data and materials
The transcripts of the key informant interviews and focus group discussions used during the study are available from the corresponding author upon request.

Declarations

Ethics approval and consent to participate
Ethical clearance for this research was obtained from the Institutional Research Ethics Committee at the International Livestock Research Institute, Addis Ababa, Ethiopia (ILRI-IREC2020-28).

Consent for publication
Participation in the research was voluntary, and informed consent was obtained through filling the participation information sheet. Participants were asked to either sign the sheet or listen to the information in the sheet prior to each discussion. Participants on most occasions were not able to read and write, and verbal consent was acquired. Participants were also told to withdraw from the discussions at any time during the course of the discussions.

Competing interests
The authors declare that they have no competing interests.

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