

A One Health approach to Land Tenure and Routes of Zoonotic Disease Exposure for
Pastoralists in Marsabit County, Kenya

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Abstract

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Routes of potential transmission of zoonotic diseases are unique for pastoralist herders as contact is highly reliant on the mobility of both human and livestock populations. In a One Health framework, this cross-sectional observational study examines points of higher risk through both quantitative and qualitative data analysis. Data gathered with three pastoralist communities from Marsabit County (Borana, Gabra, and Rendille) are used to illustrate how land management, climate change, and socio-economic factors can be associated with human-animal contact, which is required for the transmission of zoonotic diseases. In the quantitative study, 75 participants completed a REDCap survey, which measured human-livestock contact using self-reported recall over the last two weeks. Of these 75 participants, 22 also completed a daily diary to validate the REDCap data, assessed using Intraclass Correlation Coefficient (ICC) and agreement calculation. Questions about specific animal husbandry activities and contact with specific livestock species were analyzed for agreement. Focus group discussion (16) and transect walks (15) were also conducted in the aforementioned communities. Key informant interviews (KIs) (16) were conducted primarily with professionals and community activists

representing both public and private sectors, without restriction by ethnic group membership. We found moderate to high level of agreement (0.47-0.82) between the activities and a fair to high level of agreement (0.25- 0.74) between species using ICC analysis. Items with equal or less than fair ICC values (≤ 0.4) were found to have very low variance, with >87% or more participants entering the same answer. In these cases, agreement was high at ≥ 0.86 . These interviews highlighted points of interest per community based on the length of time that community members spent on each topic; Borana on causes of intracommunity conflict, the Rendille community on pastoralist health, and the Gabra community on water/pastureland access. Through the ICC and agreement analysis, we can estimate that participants have a high degree of recall when it comes to their interactions with their livestock and a recall survey is a viable method of data collection for further study in pastoralist communities of Marsabit County. In interviews, all community members made direct connections between the health of their community, their herds, and their lands. They saw these three factors as interdependent on each other. All participants in KIIs knew of the Community Land Act of 2016 and considered it important to the future of pastoralist communities. When asked about the future of pastoralism in the region, a slight majority in youth interviews when compared to men and women interviews, expressed the perspective that pastoralist lifestyle must adapt. No clear consensus on the future of pastoralist communities was exhibited by adult men and women interviewed. Understanding how to adapt to a rapidly changing climate is vital to building sustainable and resilient pastoralist communities in Marsabit county. Greater understanding of both the daily activities of pastoralist herds and perspectives of the interwoven relationships between the communities, livestock, and their environment can aid in creating more resilient communities in the face of climate change, conflict, and disease.

INTRODUCTION:

Pastoralism is noteworthy among occupations in that it is inextricably interwoven with the local ecosystem. For thousands of years, the pastoralists of northern Kenya have herded their livestock across their arid terrain, their movements tied directly to seasonal changes.¹ In the last century however, the pastoralist communities of Marsabit county, Kenya, have faced an increasing number of obstacles to their way of life. These challenges have come in the form of land governance policy changes, climate change, intra-ethnic conflict, and transmission of zoonotic disease.

Traditionally, pastoralist communities have viewed land as a shared resource and responsibility available to all in the community. The introduction of colonial rule changed the fundamentals of how land was divided and used through national and regional policy.¹ However, this did not mean that local communities and traditions changed their relationship with the land. These two juxtaposed mentalities have put many pastoralist communities into precarious positions with the ownership, rights, and management of their traditional pastures. As land has been privatized and conservation areas have developed, there has been an increasing separation between Indigenous land management and post-colonial/westernized-influenced land policy.¹ This growing tension has been exacerbated through additional socio-economic pressures, changes in animal husbandry practices, and climate change.

Land Tenure:

Over 9 million pastoralists live in Kenya today.² Marsabit County is the largest county in Kenya by area at almost 71,000km². It is home to a little over 400,000 people and 14 ethnic groups.^{1,3} Of these, the Borana, Gabra, and Rendille are the largest in 2022 population estimates.⁴ Herding livestock accounts for both the largest employment and source of income in the region.⁴ Five of the 14 ethnic groups of Marsabit County identify themselves as pastoralist communities.⁴ Traditional land use has changed in the last century due to changes in land use, and the population of Marsabit has grown from ~190,000 in 2000 to ~627,000 in 2024.⁵ This has added unique pressures to the region.

A 2018 study by Muhati et al. illustrates these changes by specifically looking at Marsabit forest reserve. Their research found that between 1990- 2010, there was a decrease in closed forest area (-57.7%), and open forest (-75.7%), while bare land (+82.4%) and agricultural/settlements (+87.5%) increased.⁶ The research team attributed most of this deforestation to poor land management and mass logging for fuel/coal production. Due to changes in land management and criminalizing logging between 2010 – 2017, closed forest areas (+30.8%) and scrubland (+35.1%) saw an increase. However, bare land (+15.6%) continued to increase with open forests (-430%), and grassland (-41.9%) experiencing dramatic declines.⁶ Interestingly, agriculture/settlement areas have also faced a dramatic decline (-232.7%).⁶ This study showcases that dramatic changes that the county and population have faced in the last 30 years as well as the rapid impact that land use policy changes that landscape of the region.

As more people migrated to the county from Ethiopia, Somalia, or neighboring counties and took an economic interest in the region, the pastoralists saw their traditional land diminish in size.⁷⁻¹⁰ The Community Land Act of 2016 was created to help protect community land against private individual ownership.¹¹ It gave Indigenous communities the right to claim deeds for their ancestral lands and continue with their local traditions as a community rather than individuals. It has also led to greater discussion on land management as a private or communal resource.^{1,12,13} The issues surrounding land management and community health have led to more questions about how the interactions between humans, animals, and the environment impact risk factors surrounding disease transmission.

Zoonoses:

The transmission of pathogens from a wild population of animals to humans is known as a “zoonotic spillover” or “spillover event.”¹⁴ Frequently, domestic animals are the intermediate link between wild animals and humans, acting as “bridge hosts” between wildlife and human populations or amplifiers for these events.^{3,15} Amplification of a pathogen through a bridge host can occur as both a function of the amount of contact and the amount of shedding of disease and the density of animals. This phenomenon has put occupations with direct interaction with domestic animals at the frontlines of spillover events. Pastoralists are at greater risk of zoonotic infection than other populations as they interact with their domestic herds at a higher frequency and have a broader range of responsibilities for their livestock than other animal-agriculturists.^{7,16,17} As climate change and drought put more intense pressure on both domestic and wild herds for grazable pasture and water, domestic and wild herds have increased contact as their resources dwindle.¹⁸⁻²³

The risk of zoonotic spillover is related to the degree to which individuals engage in high-risk behaviors with their livestock. These behaviors include consumption of undercooked meat, butchering practices, unpasteurized milk consumption, direct contact with sick animals, and assisting during birthing. A 2010 study in rural Ethiopia found that only 11.1% of livestock keepers had received an education about zoonoses. Of those same livestock keepers, 98.3% were aware of the risk factors of undercooked meat consumption, but only 6.3% were aware of the risk associated with working with sick animals.¹⁴ A similar study in Laikipia county, Kenya found that 90% of respondents reported drinking from the same water source as their livestock and 98% reported having eaten a sick animal in the past year.¹⁵ Understanding the frequency and cultural practices surrounding these exposures can aid in limiting their impact to both the herders and the wider community.

Although this study does not focus on specific pathogens, it is still important to understand the zoonoses that are prevalent in the region and those identified as priorities by the Kenyan government. A 2015 study by Munyua et al. reviewed resources and literature from the county, national, and international spheres to determine a rating system with which list zoonotic and vector-borne diseases that pose the highest level of danger to the Kenyan people. The burden of each disease was determined by the severity of the disease on the individual, the healthcare capacity of the community, the potential for an epidemic, potential effective interventions, and the impact on the economy of the region. Munyua et al. identified 37 diseases as high risk to the Kenyan population.²⁴ This list included both zoonotic and vector-borne diseases. Eight out of the top ten priority diseases on this list have domestic animal reservoirs which are commonly found as livestock in pastoralist herds.

Table 1 illustrates a listing of the zoonotic diseases found both on the list of greatest threats to the Kenyan people and associated with species found in the herds of the pastoralist communities of Marsabit County. The diseases are listed in order of livestock contact reported by participants in this study from most to least frequent contact. The frequency of animals per herd was taken from the REDCap survey that will be described in further detail later in this analysis.

Table 1: Zoonotic diseases and the livestock species that act as “bridge hosts” for transmission of these diseases into the human population, subset to livestock commonly kept in Marsabit. This table was created by cross referencing the top 10 zoonotic diseases reported in 2015 by Munyua et al. with a literature review of 12 other papers that examined zoonoses within Kenya and its five neighboring countries.^{14,17,24–36}

	CAMEL	CATTLE	HORSE/ DONKEY	SHEEP	GOAT
BRUCELLOSIS	X	X	X	X	X
RIFT VALLEY FEVER	X	X		X	X
ANTHRAX	X	X	X	X	X
Q FEVER		X		X	X
MYCOBACTERIUM SPPS		X			
ECHINOCOCCOSIS	X	X	X	X	X
MERS- COV	X				

Drought:

High-risk behaviors are not the only contributing aspect in the occurrence of a spillover event; climate change and land management are also key factors to this relationship. Since mid-2014, northern Kenya has experienced its worst drought in forty years. In addition, when the rains do arrive, there has been an increase in flooding as the land is too dry to immediately hold the water. This is leading to an increase in flash floods, causing harm to the delicate grasses and pasturelands.^{25–28} The most recent report produced by the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) has stated that an estimated 3.5 million people in Kenya were classified as Integrated Food Security Phase Classification (IPC) Phase 3 (Crisis) and had above acute food insecurity by September 2022.² This was a 10% increase from the same period in 2021. Marsabit County was one of seven counties identified as the most affected regions with 45% of their population classified as remaining in IPC Phase 3 (Crisis).² Of the seven counties identified as the most vulnerable, the majority relied on a pastoralist livelihood.

This climate crisis has led to the death of over 1.5 million cattle (2014-2024) due to loss of pasture and water sources in the Arid and Semi-Arid Lands of north-eastern Kenya.² Assessment Capacities Project (ACAP), an international non-profit that provides independent humanitarian assessments, created a Thematic Report from December of 2022 highlights the massive impact on this region in a single 6-month period. Between January-July 2022, a reported 273,000 livestock died due to lack of water; including 39,000 cattle, 113,000 sheep, 86,000 goats, and 35,000 camels concentrated in North Horr and Laisamis sub-counties.²⁹ After a drought event, it takes an average of 4-5 years for a pastoralist to recover their herds.¹⁰ These examples illustrate how the pastoralists of Marsabit County are faced with both an increase in sick animals as well as socio-economic pressures caused by the drought. They are forced to travel shorter distances and stay closer to viable pastureland and watering holes. This puts them and their herds in novel contact with wild populations that they would have potentially not been in contact with otherwise as wildlife faces the face decrease in resources.^{18–23} This new contact has the potential to elicit new chances for a spillover event to occur.

As resources continue to decrease due to prolonged drought, many pastoralist families must make the decision to either remain fully nomadic, become sedentary, or move into an urban setting. However, these decisions have secondary impacts that have long term effects on population health. Previous studies have shown that the move from the pastoralist lifestyle has caused an increase in malnutrition in children and mothers, as well as lower economic outcomes.^{8,30–32} A 2006 longitudinal study by Fratkin et al. in Marsabit County reveals that Rendille

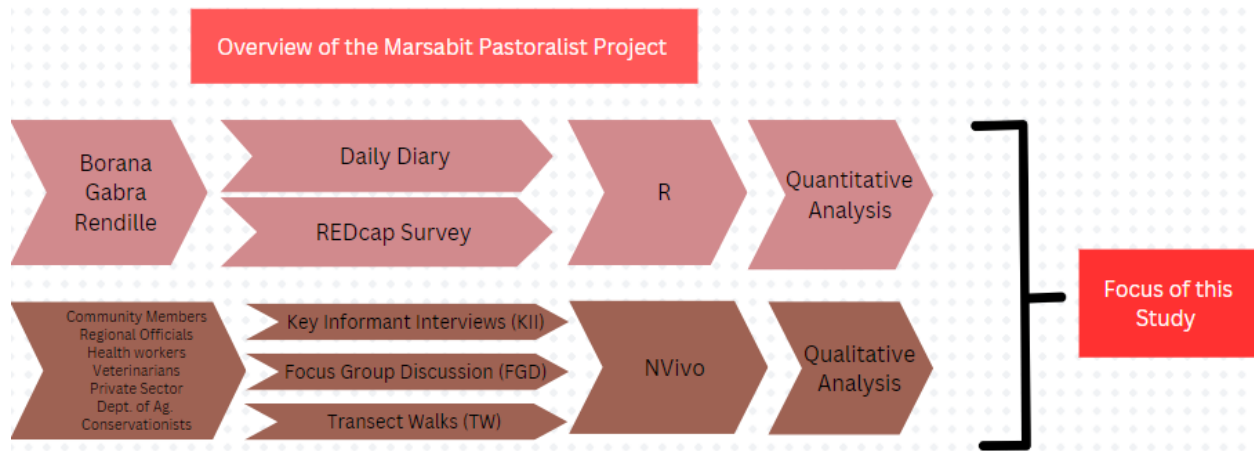
children raised in an urban setting have poorer growth outcomes when compared to their counterparts raised in pastoralist communities.³¹ As pastoralists, community members have access to a large quantity of animal products that are based on what their herds can provide. Once these community members move into an urban setting, they must now rely on what products can be bought in stores and what they can monetarily provide for their families. This causes a decrease in protein consumption leading to poor health outcomes for both mothers and children whose growth is heavily dependent on protein, iron, and calcium. All nutrients that are available in a traditional pastoralist lifestyle.

These four major challenges, land governance policy changes, climate change, conflict between the different ethnic groups, and transmission of zoonotic disease, facing the pastoralist communities of Marsabit County aggravate the human-animal-environmental relationship and have the potential to lead to more spillover events that threaten the future of pastoralism in the region.² It is important to understand the cultural, behavioral, and physical dynamics surrounding the different routes of exposure. There is a major gap in the literature surrounding the occupational zoonotic exposures of pastoralists globally, but it is even more apparent when looking at the Global South. By understanding the frequency and circumstances of these transmission exposures, programs and policies can be implemented to limit the impact. As climate pressures continue to challenge pastoralist communities, it is important to understand these challenges and their impacts when thinking about the future of pastoralist communities in the region. Approaching this problem with the One Health framework that simultaneously considers the health and well-being of humans and animals in a shared ecosystem allows a more holistic approach to the understanding of how spillover events and domestic animal amplification can be affected by land tenure, animal husbandry, and socio-economic pressures.

METHODS:

To better understand how spillover events and domestic animal amplification can be affected by land tenure, animal husbandry, and socio-economic pressures in pastoralist communities, a cross-sectional observational study was conducted looking at the occupational exposure risk of pastoralists in three ethnic groups in Marsabit County, northern Kenya: Borana, Rendille, and Gabra ethnic groups. The three communities that participated in this study were Jaldesa - a Borana community, Shuur - a Gabra community, and Songa – a Rendille community. The data collection was conducted from December 2022 – August 2023 (Figure 1).

Figure 1: Schematic of overview of the two sections of the complete Marsabit County Pastoralist Project

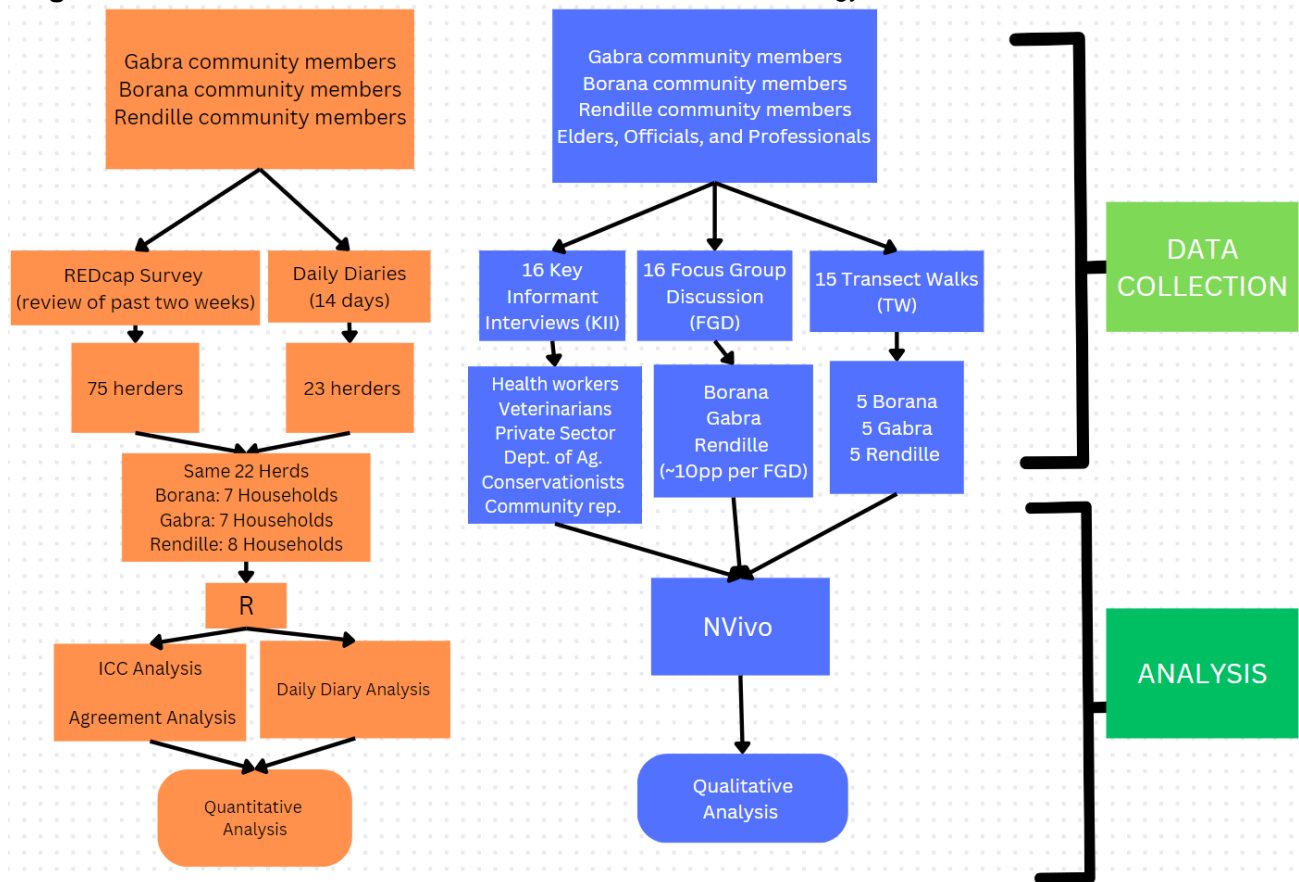


A REDCap (RC) survey was administered to capture a greater understanding of human-livestock interactions, common animal husbandry tasks, distance travelled by herds, and impacts of drought on herds. Human-animal contact reported over the last two weeks was additionally validated using a daily diary. Daily Diary (DD) had 32 questions that were completed every day for a total of fourteen (14) days to capture their contact with livestock by species, task, and herd membership. Questions were completed separately for their home herd, which remains close to their homes, and their fora herd, which travels greater distances. The DD also included a matrix asking about the source of the meat, milk, hide etc. as well as if the animal was male/female, offspring/adult, and ownership of the animal in question their own or a neighbor.

Community activists, government officials, natural resources managers, healthcare providers, veterinary providers, and community representatives were interviewed as key informants (KIs) as a data collection tool for this report. Focus group discussions (FGD) were conducted in each community, five per community: two for adult women, two for adult men, and one for youth. Adult women and adult men focus group discussions were held separately for two themes: land tenure and human-animal contact. The last type of qualitative research included transect walks (TW) with five walks per community: one for a youth, two for women, and two for men.

All data were gathered by Dr. Julianne Meisner and a primarily Kenyan-based research team. The primary author of this paper was not directly involved with the data gathering and did not travel to Marsabit County this summer. Rather, the data were collected and then analyzed through R-Studio and NVivo. The focus of this analysis was on the quantitative and qualitative sections of this study (Figure 2).

Figure 2: Schematic of both Quantitative and Qualitative methodology



Quantitative data:

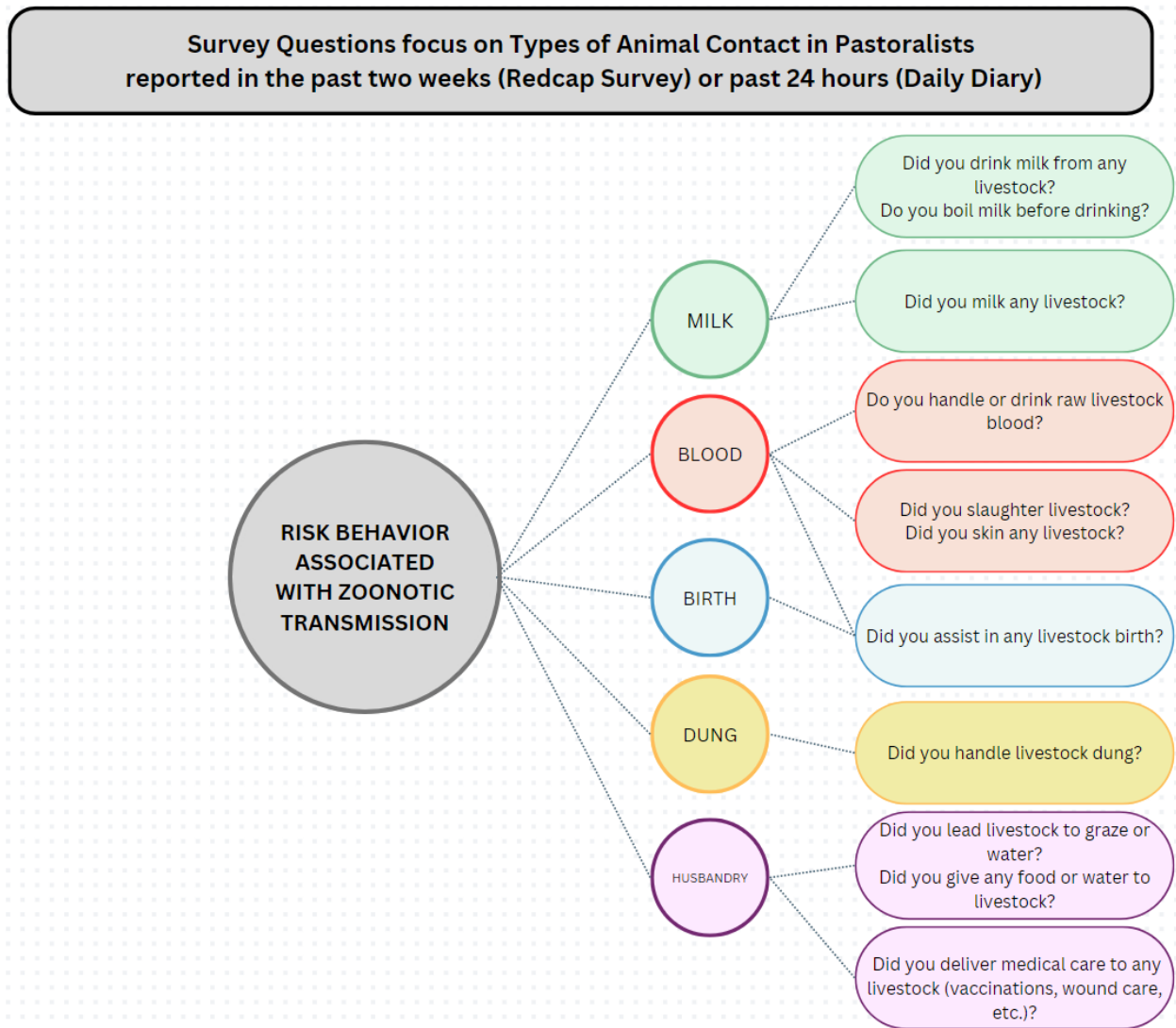
The primary aim of this thesis is to validate self-reported contact from the REDCap survey with a Daily Diary, among a subset of participants who completed the REDCap survey. These two datasets were compared against each other to determine the accuracy, recall, and precision of the data gathered. Using Intraclass Correlation Coefficient (ICC) calculation in R, overall agreement between human-animal contact reported in the REDCap survey versus the daily diaries was estimated.

The DD is a gold standard across scientific literature to gather data on daily or weekly tasks.^{33–36} However, it is also acknowledged that a daily diary creates a high burden on study participants. Due to this high burden on participants as well as the time needed for the research team, the validation sub-study was conducted.

Responses were reported as “yes”, “no”, “do not know”, “refused to answer”, and “missing.” “Missing” is defined as participants leaving an answer blank and unanswered. These are not blank due to skip-logical in the questionnaire or survey. An example of this skip-logical would be if a participant answers “no” to drinking milk. The next question is, “did the participant drink un-boiled milk?” but if their previous answer was “no” then they would not need to answer the question about un-boiled milk and therefore, it would look blank. However, the information for this question would not be considered missing but just skipped.

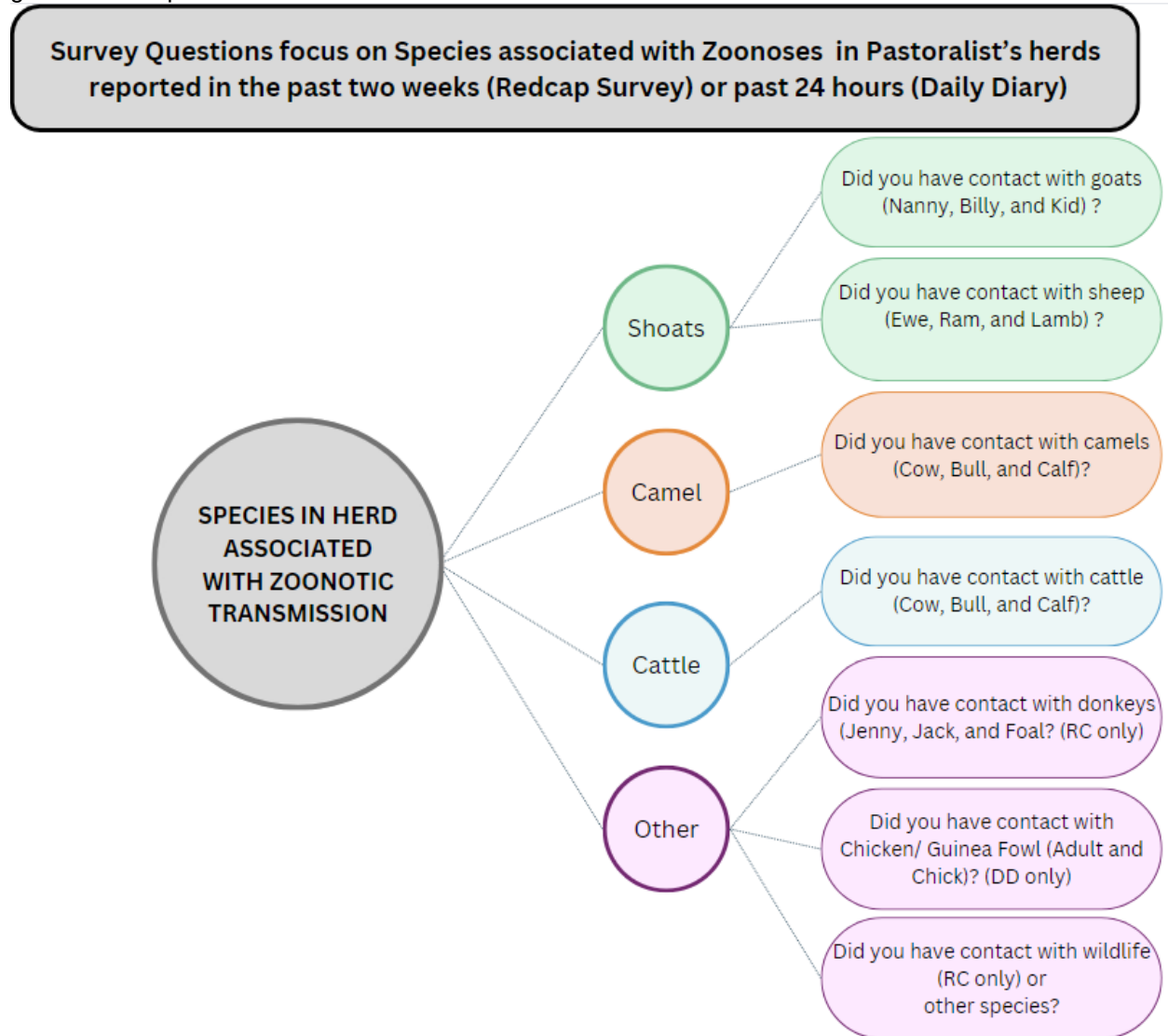
Both the DD and the RC survey focus on routes of exposure to zoonotic diseases. The primary focus is how often participants completed activities that are associated with high risk of disease transmission. Activities were defined as specific animal husbandry tasks. These activities can be divided into points of contact with the livestock including milk, blood, birth fluids, dung, and animal husbandry. Each of these five activity types provides unique exposure and associated risk for disease transmission (Figure 3).

Figure 3: Schematic of Survey Questions in both the REDCap Survey and the Daily Diary Survey examining participants' completion of activities that are associated with Zoonotic Transmission.



The secondary focus is on what species, commonly found in Marsabit pastoralist herds, the participants are in contact with more frequently. The focus of these questions was on livestock and therefore, other domestic animals commonly found around the household such as dogs and cats were excluded from these questionnaires. Each of these four broader groups of species provides unique exposure and associated risk for disease transmission (Figure 4).

Figure 4: Schematic of Survey Questions in both the REDCap Survey and the Daily Diary Survey examining participants' contact with species in their herd associated with zoonoses. *Shoats = combined goat and sheep



Intraclass Correlation Coefficient (ICC) analysis was conducted using R Studio. This validation analysis was conducted with a subset of the original population who had completed both the RC survey and the DD: a total of 22 participants. The DD asked the participants, “did you do this activity today?” or “did you interact with this species today?” while the REDCap survey asked the participants, “did you do this activity in the last two weeks” or “did you interact with this species in the last 2 weeks?”

The first step was the assessment for completeness of survey responses and percentage of responses = “No”, “Yes”, “Refused to Answer”, “Do not know”, and “missing answers” (or “missingness”) from the Daily Diary (DD) and REDCap (RC) Survey. Variables with high amounts of “missingness” were removed from further analysis.

(1) The previously aggregated species of adults, juveniles, males, and females had to be summarized into signalment groups of their common species to match the RC survey data. (2) New summary variables were created to convert 14 days of data to 2 weeks. (3) These totals were summarized across each species and then converted into a binary of 1, 0 to match the format needed for the ICC analysis. An example of this would be, “did the participant have contact with this species?”; answers could be 1 = “yes”, 0 = “no”, all “missing” answers were omitted per the ICC analysis guideline.³⁷ “Refused to answer” and “Do not know” answers were converted NA for this analysis.

ICC analyses require variance in answers between participants, otherwise improvement over expected agreement due to chance cannot be estimated. This means that this statistical test can be influenced by bias towards a singular answer. If all participants are answering the same way, then the ICC analysis will be artificially low on the scale of agreement. If all participants answer the same or close to the same, then the ICC analysis will have a value of 0.0 even if there is true agreement. To combat this, agreement was also measured, while still using the Daily Diary as the reference group or gold standard, “yes” and “no” answers separately. By using both statistical tests, agreement was measured for all activities and species of interest.

Summary variables were compiled into two separate ICC analyses. The first looked for agreement across activities that participants reported completing (Table 2). Activities (6) were concentrated on: contact/herding, consumed un-boiled milk, birth (assisting in livestock birth), feed (feeding, watering, or leading livestock to graze), slaughter (slaughtering animals, preparing meat, handling blood, etc.), dung (handling animal dung), sick (handling a sick animal), husbandry (routine care, vaccinations, healthcare, deworming, etc.), and hide (de-hiding an animal). In the RC survey, the participants were not asked broader questions such as “did you assist in livestock birth in the last 2 weeks?” Instead, the RC survey asked more specific questions such as “did you assist in a camel birth in the last 2 weeks?” In the DD, first asked the broad question of “did you assist in livestock birth today?” before asking more specific questions about the species. This meant that a summary variable was created to look at answers across multiple species in the cases that the questions were too specific in the RC survey (Table 2).

Table 2: Activity Associated with Risk of Transmission of Zoonoses used for the ICC Analysis. Illustrating where multiple questions needed to be summarized to create concordance between the two surveys.

DAILY DIARY VARIABLE (all variables pertain to activities that participants completed in 24hrs for 14 days)	REDCAP SURVEY VARIABLE (all variables pertain to activities that participants completed in the last 2 weeks)
Herd (summary question of whose herd participant was with today)	Herd (summary question asked about any milking, grazing, slaughtering, etc.)
Milk livestock (single variable)	Milk livestock (asked across 4 species – cattle, camel, shoats, and donkey)
Consumed Milk (single variable)	Consumed Milk (singular variable)
Consumed un-boiled milk (single variable)	Consumed un-boiled milk - (asked across 4 species – cattle, camel, shoats, and donkey)
Assisted in livestock birth (single variable)	Assisted in livestock birth (asked across 4 species – cattle, camel, shoats, and donkey)
Feed (single variable - feed) Grazing (summary question about leading any livestock to graze or water)	Feed (summary question about feeding, water, or lead any animal to graze)
Slaughter (slaughter animals, prepare meat, handle blood, etc.)	Slaughter (slaughter animals, prepare meat, handle blood, etc. – asked across 6 species: cattle, camel, shoats, donkey, chicken, guinea fowl, and other)

Dung (handled animal dung)	Dung (handled animal dung – asked across 6 species: cattle, camel, shoats, donkey, chicken, guinea fowl, and other)
Sick (handled sick animal)	Sick (handled sick animal – asked across 6 species: cattle, camel, shoats, donkey, chicken, guinea fowl, and other)
Husbandry (routine care, vaccinations, healthcare, deworming, etc.)	Husbandry (routine care, vaccinations, healthcare, deworming, etc. – asked across 6 species: cattle, camel, shoats, donkey, chicken, guinea fowl, and other)
Hide (de-hide an animal)	Hide (De-hide an animal – asked across 6 species: cattle, camel, shoats, donkey, chicken, guinea fowl, and other)

The second ICC analysis looked for agreement across species that participants reported having contact with (Table 3). Five species categories were looked at: Cattle, Camel, Shoaat (sheep and goats), Other (including chicken, guinea fowl, donkey, wildlife, and other), and NA (including “refused to answer”, “did not know”, and “missing”). Sheep and goats were combined into a single variable in the RC survey so that they matched the single combined variable in the DD survey. Chicken and guinea fowl were added to the “other” category as they were only asked about in the DD survey. Wildlife was also added to the “other” category as they were only asked about in the RC survey. Variables about donkey contact had a large amount of “missingness” from the RC survey and therefore, donkey variables from both surveys were added to the “other” category as well.

Table 3: Species that Participants reported contact with in both the REDCap Survey and the Daily Diary used for the Intraclass Correlation Coefficient (ICC) Analysis. Illustrating where multiple questions needed to be summarized in order to create concordance between the two surveys.

REDCAP SURVEY VARIABLES	DAILY DIARY VARIABLES
Cattle (combination of adult and juvenile variables)	Cattle (combination of herd/female and male/adult and offspring variables)
Shoat (combination of adult and offspring variables) Sheep Goat	Shoat (combination of herd/female and male/adult and offspring variables) -> this variable was a combination of Sheep and Goat from the start of the diary
Camel (combination of adult and offspring variables)	Camel (combination of herd/female and male/adult and offspring variables)
Other (combination of adult and offspring variables) <ul style="list-style-type: none"> • Wild Animal • Donkey 	Other (combination of herd/female and male/adult and offspring variables) <ul style="list-style-type: none"> • Chicken • Guinea Fowl • Donkey

Each activity and species corresponding variables were measured for agreement using Intraclass Correlation Coefficient (ICC) . The analysis was scaled from “poor” level of agreement through “almost perfect” agreement (Table 4) using the well-established ICC value scale.^{38,39} All values were compiled into a matrix for ease of interpretation as shown in results.

Table 4: Scale of Intraclass Correlation Coefficient (ICC) levels of Agreement³⁷

Value of ICC	Strength of Agreement
<0	Poor
0.01 – 0.20	Slight
0.21 – 0.40	Fair
0.41 – 0.60	Moderate
0.61 – 0.80	Substantial
0.81 – 0.99	Almost Perfect

Qualitative data:

The secondary aim of this study was to analyze data from the key informant interviews, focus group discussions, and transect walks, which were transcribed and translated from local languages (Borana, Oromo, and Rendille languages) as well as the national language of Kiswahili into English. The data were collected, transcribed in Kenya, and later analyzed using NVivo 12 software by the author of this paper at the University of Washington. The dataset was then divided into five (5) primary themes with twenty-eight codes and seventy-five subcodes. The report gives verbatim quotations from respondents to validate the data.

Codes were assigned to the data set through a mixture of inductive and deductive coding. The interviews were read through initially to create a codebook with the aid of themes pulled from the quantitative surveys (deductive method). Further, codes were added to the codebook in the process of coding as major themes were subdivided into specific categories and other new codes were generated (inductive method). The primary code was completed by the primary author and then reread and corroborated by a secondary researcher.

RESULTS:

Quantitative data:

The RC Survey was completed by 60 community members across all three communities, of these 22 participants (29.3%) also completed the DD survey. Jaldesa, the Borana community, had 7 (31%) participants, Songa, the Rendille community, had 7 (31%) participants, and Shuur, the Gabra community, had 8 (36.4%) participants. Two participants from the Jaldesa Community decided not to respond to the age and gender questions; therefore, they are not represented in the demographic information. In total, participants ranged between 6 - 65 years old with the largest age group 16-30 (40%). The second largest age group was 0-15 (25%) with 5 participants completing 14 (63%) were self-identified as male and 6 (27%) as female. 2 (9%) of participants chose not to respond to this part of the questionnaire.

The Jaldesa Community had 4 male participants (57%), 1 female participant (14%), and 2 participants that declined to answer demographic questions (29%). The majority of their participants were between the ages of 0-15 with 2 participants (29%) refusing to answer these demographic questions. The Shuur Community had 4 male participants (50%), and 4 female participants (50%). They had the largest age range with at least one participant in each group. 4 participants were under the age of 30-years old (50%) and 4 participants were over the age of 31-years old (50%). The Songa Community had 6 male participants (86%) and 1 female participant (14%). The majority of participants (5) were between the ages of 16-30 years old (72%).

Table 5: Demographic characteristics of participants of both the Daily Diary and REDCap Survey from the Rendille, Borana, and Gabra Communities.

COMMUNITY	JALDESA	SHUUR	SONGA	TOTAL
Total Number of Participants n=22 (%)	7 (31.8%)	8 (36.4%)	7 (31.8%)	22 (100%)
Age				
0 -15	2 (29%)	2 (29%)	1 (14%)	5 (23%)
16-30	1 (14%)	2 (29%)	5 (72%)	8 (36%)
31-45	1 (14%)	1 (14%)	-	2 (9%)
46-60	-	1 (14%)	1 (14%)	2 (9%)
>60	1 (14%)	2 (29%)	-	3 (14%)
Missing	2 (29%)	-	-	2 (9%)
Sex				
Male	4 (57%)	4 (50%)	6 (86%)	14 (64%)
Female	1 (14%)	4 (50%)	1 (14%)	6 (27%)
Missing	2 (29%)	-	-	2 (9%)

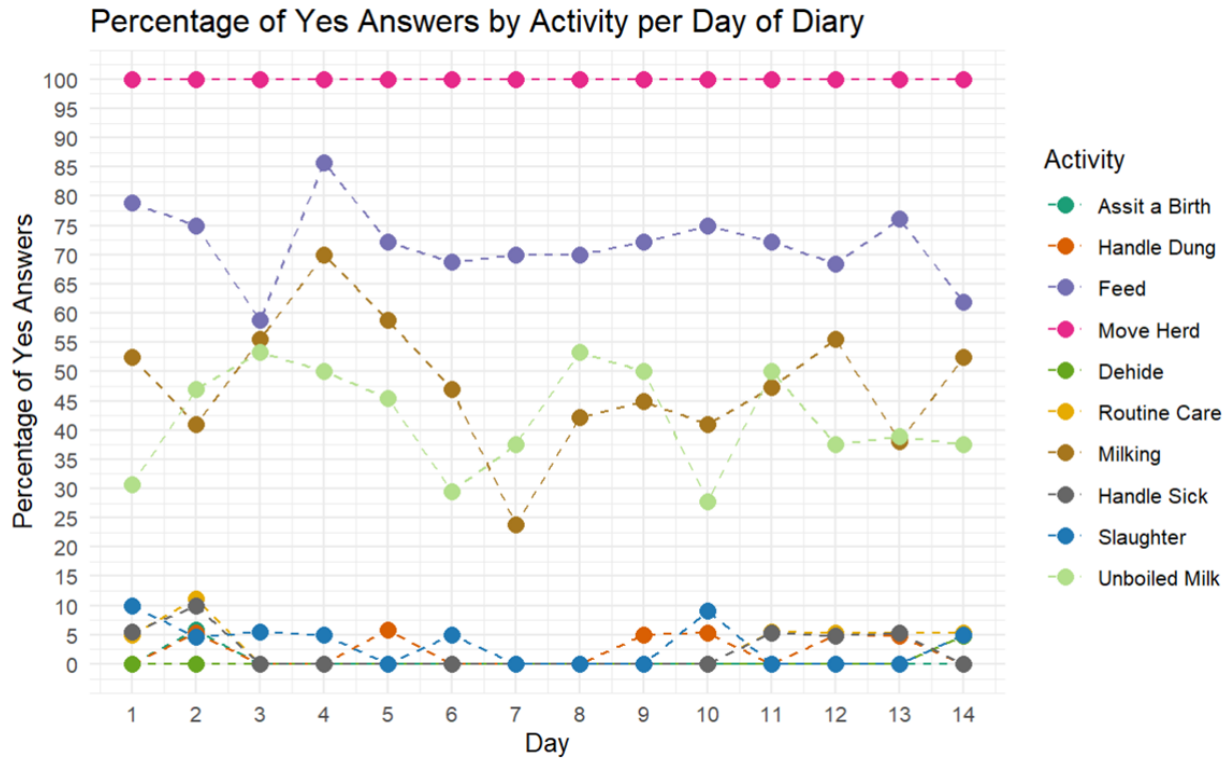
Daily Diary :

The DD was completed by 23 participants. Of the total number of responses to the DD, 2.17% of these responses were missing or unanswered. These were answers that were left blank and were not “Refused to Answer” or “Do not Know” responses. Of the total number of responses to the DD, 5.44% of responses were “Refused to Answer” and although an option, no participants responded with “Do not know.” In contrast, 14.79% of RC survey participants responses were “Refused to Answer” (Table 5).

In the figures below, “Yes”, “Refused to Answer”, and “Missing” responses were examined across each of the 14 days of the DD survey by both activity that participants completed and ethnic community that participants self-identified as belonging to (note: all participants self-identified with ethnic groups in the RC survey results as expected, on the basis of community membership).

Herding was reported as the highest number of “Yes” responses with 100% across all 14 days of the DD survey showing that this was an everyday task. The second highest reported activity was feeding with a peak of 85% and a trough of 59%, indicating that over half of the participants performed this task every day, reflecting a close relationship between the two activities, as well as showing the variation in the completion of these tasks. In other words, this is a task for some participants but not others. For those who did complete these tasks, it is still not an everyday occurrence. Consumption of un-boiled milk and milking livestock fluctuated between ~70% - 24%. The remaining six activities had responses of “Yes’ between 0% - 11% through a 14-day DD survey. Activities of slaughtering livestock, routine care, handling sick livestock, and handling dung being the most diverse in number of responses. These were infrequent tasks for the majority of the participants. Notably, “yes” answers did not increase or decrease throughout the two-week time period nor was there another visible pattern to these responses (Figure 5).

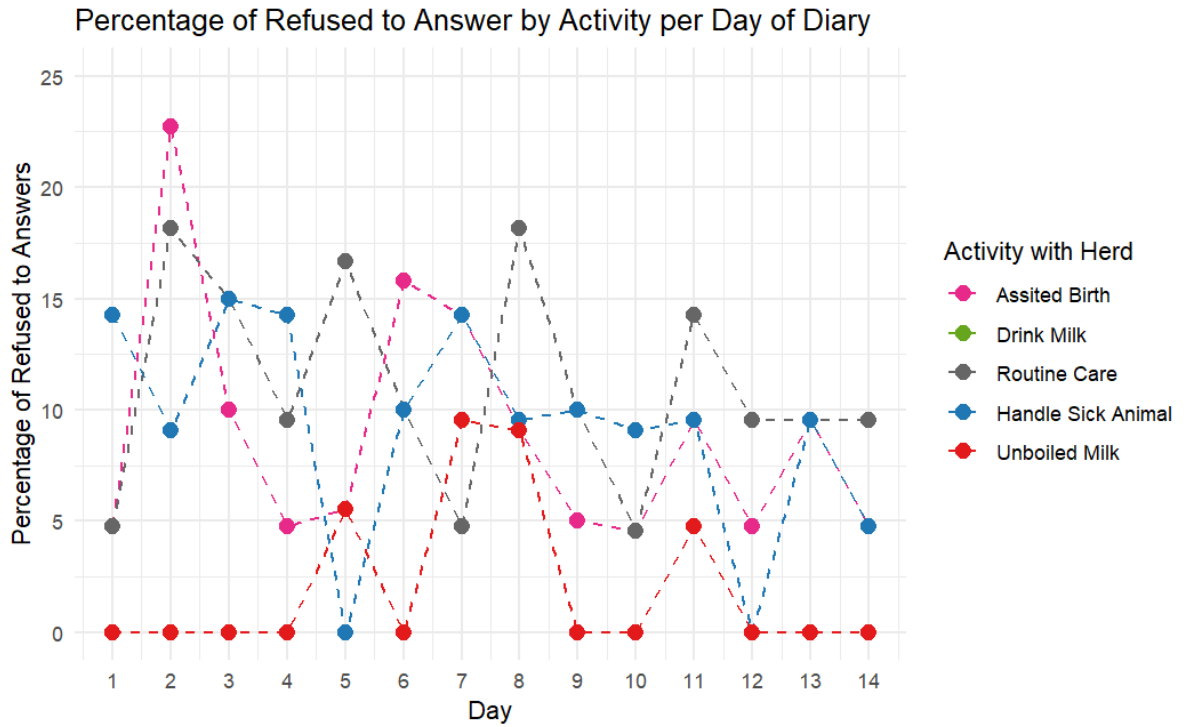
Figure 5: Percentages of Responses = “Yes” of Participants of the Daily Diary for each day over the course of the 14-day collection period by type of Activity performed with contact with livestock.



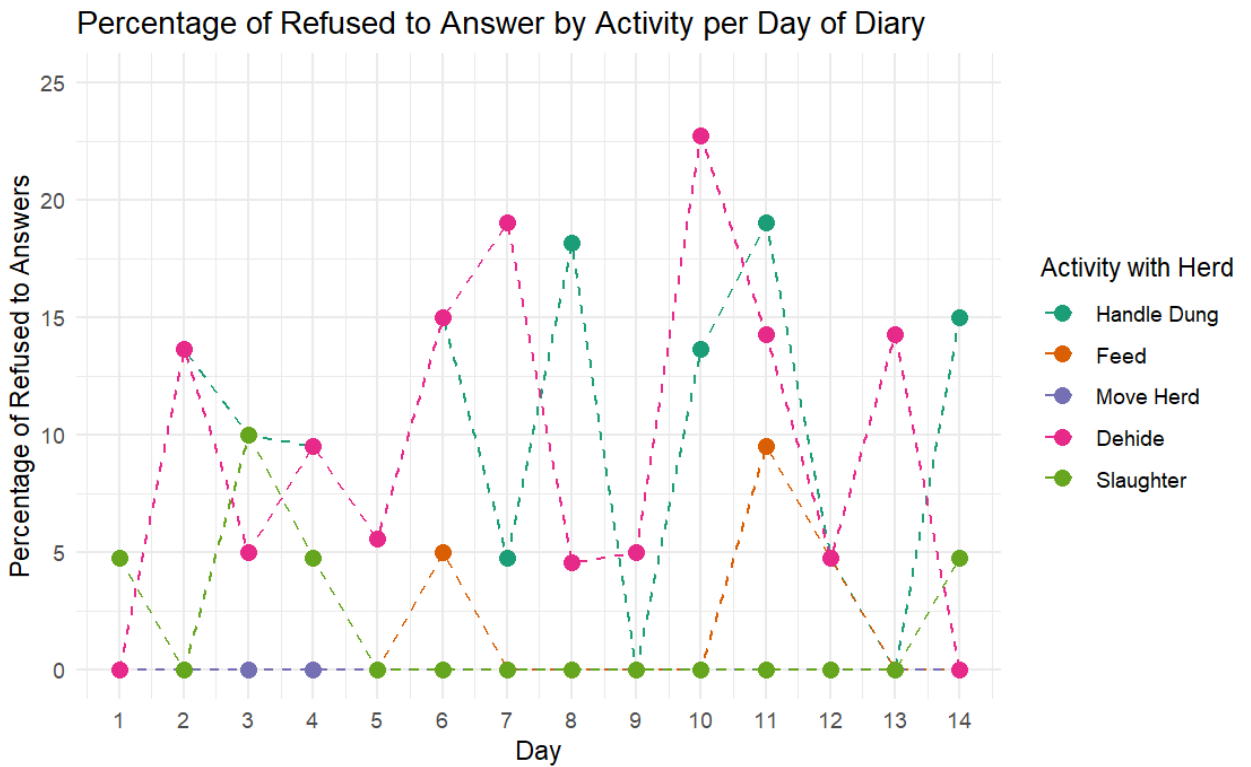
To better visualize the trends in activities over the course of the 14-day questionnaire, we have divided Figure 6 into two panels, each presenting the same information for different activities. In Figure 6A, we present “Assisted Birth”, “Drink Milk”, “Routine Care”, “Handle Sick Animal, and Drank Un-boiled Milk.” The activity of assisting in livestock birth had the highest percentage of “Refused to Answer” (~23%). The lowest percentages reported for this activity (~5%) did not reach 0% through the DD period. Un-boiled milk had the lowest percentage of “Refused to Answer” remaining at 0% for 10 of the 14 days. In Figure 6B, we present “Handle Dung”, “Feed”, “Move Herd”, “De-hide”, and “Slaughter.” De-hiding livestock had the largest difference in percentage peaking (~23%) and dropping to 0% on first and last day of the DD. The activity of handling livestock dung had the second highest percentage of “Refused to Answer” (~19%). The lowest percentages reported for this activity (0%) for 3 days. Feeding livestock dung and Slaughtering livestock had similar peaks (~10%) and remained below ~5% for all other days of the DD survey. Herding livestock had the lowest percentage of “Refused to Answer” remaining at 0% for all days of the DD survey. Notably, “Refused to Answer” did not increase or decrease through the two-week period nor was there another visible pattern to these responses (Figure 6).

Figure 6: Percentages of Responses = “Refused to Answer” of Participants of the Daily Diary for each day over the course of the 14-day collection period by 5 types of Activity performed with contact with livestock. These four activities represent similar trends to all other activities. (A) Assisted in Livestock Birth, Drink Milk, Routine Care/Husbandry, Handle Sick Animals, and Drink un-boiled milk. (B) Handle Dung, Feed Livestock, Herd Livestock, De-hide Livestock, and Slaughter Livestock.

A:



B:

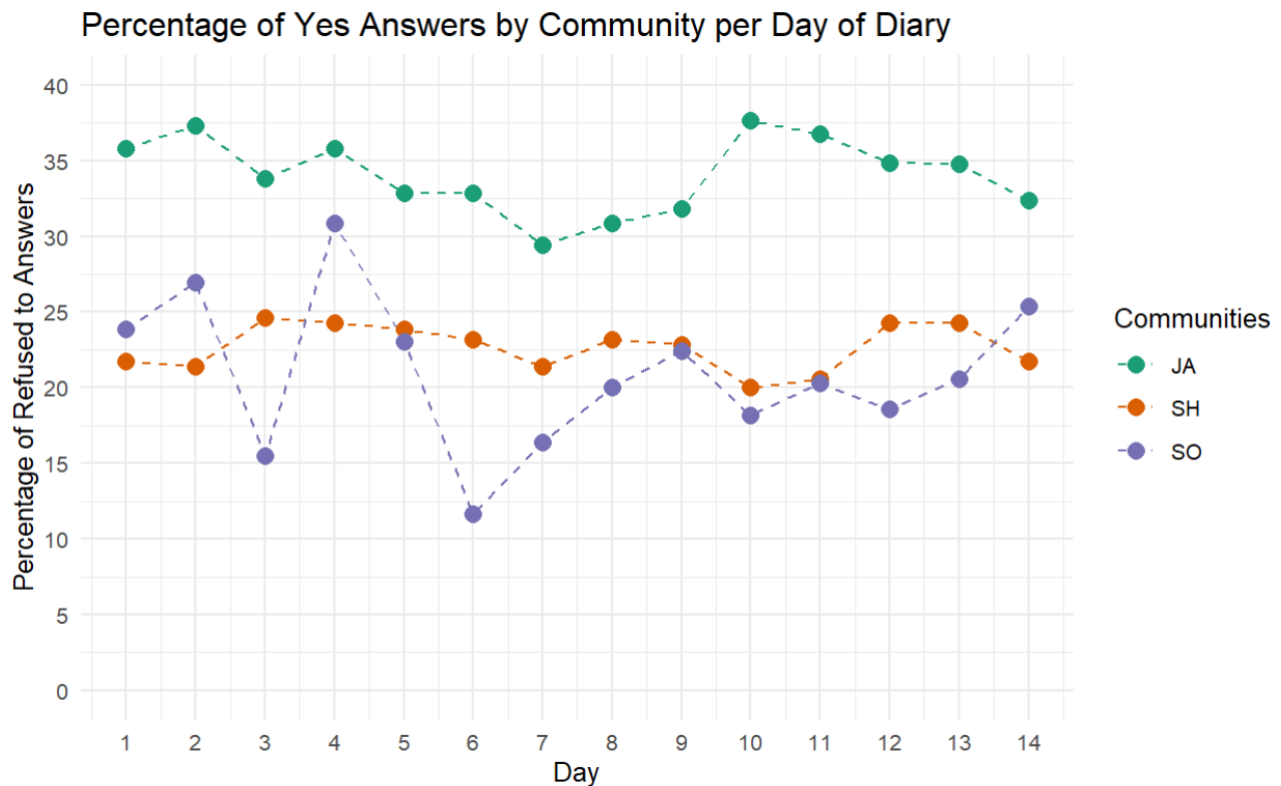


When looking at the percentage of “missing” responses or unanswered questions per day of the Daily Diary , we did not see an increase in missing towards the end of the 14-day period. Assisting a livestock birth, handling sick livestock, and handling dung all peaked throughout the two-week

period (~5%) without a visible pattern. All other activities reported 0% “Refused to Answer” throughout the 14 days. Therefore, the percentage of “missing” responses is not represented by a figure.

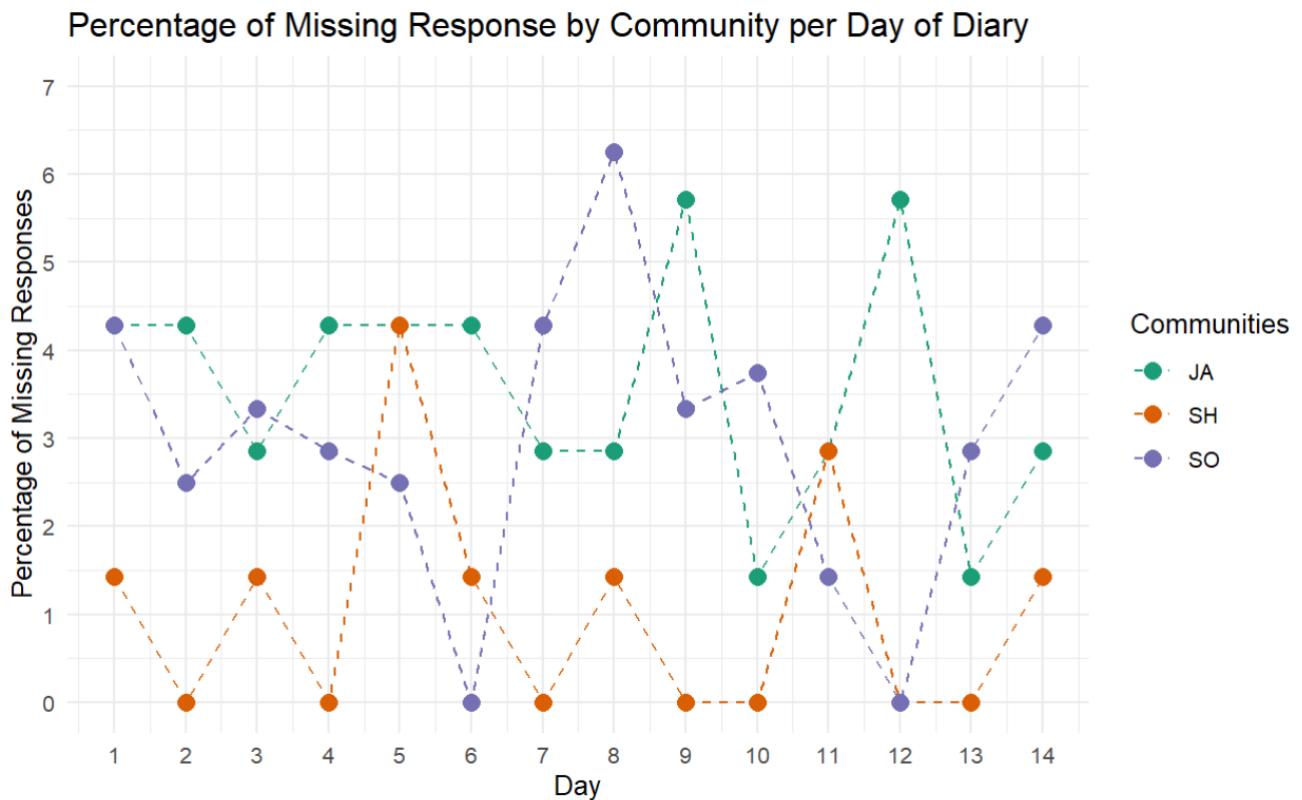
The Jaldesa Community averaged the highest percentage of yes answers to the DD over the entire 14 days with between 30%-40% answering yes to all activities. The Songa Community reported the lowest number of “yes” responses (12%) for any of the three communities. The Shuur Community was the most consistent in their responses with between 20%- 25% responding yes throughout the 14-day period. Notably, “yes” responses did not increase or decrease for any singular community through the two-week period nor was there another visible pattern to these responses (Figure 7).

Figure 7: Percentages of Responses = “Yes” of Participants of the Daily Diary for each day over the course of the 14-day collection period by the Rendille, Borana, and Gabra Communities. Note: JA = Jaldesa community, SH = Shuur Community, and SO = Songa Community



Although they did report 0% for two days, the Songa Community reported the largest percentage of “missingness” in the DD survey when compared to the other two communities (~6%). Jaldesa Community reported their peak of ~5.5% and a low point of ~1.5%. Shuur Community maintained the lowest percentage of reported “missingness” with their peak of ~4.5% and 7 days at 0%. One community did not illustrate a large trend of “missingness” when compared to the other communities. Nor did “missingness” increase over the course of the 14-days (Figure 8).

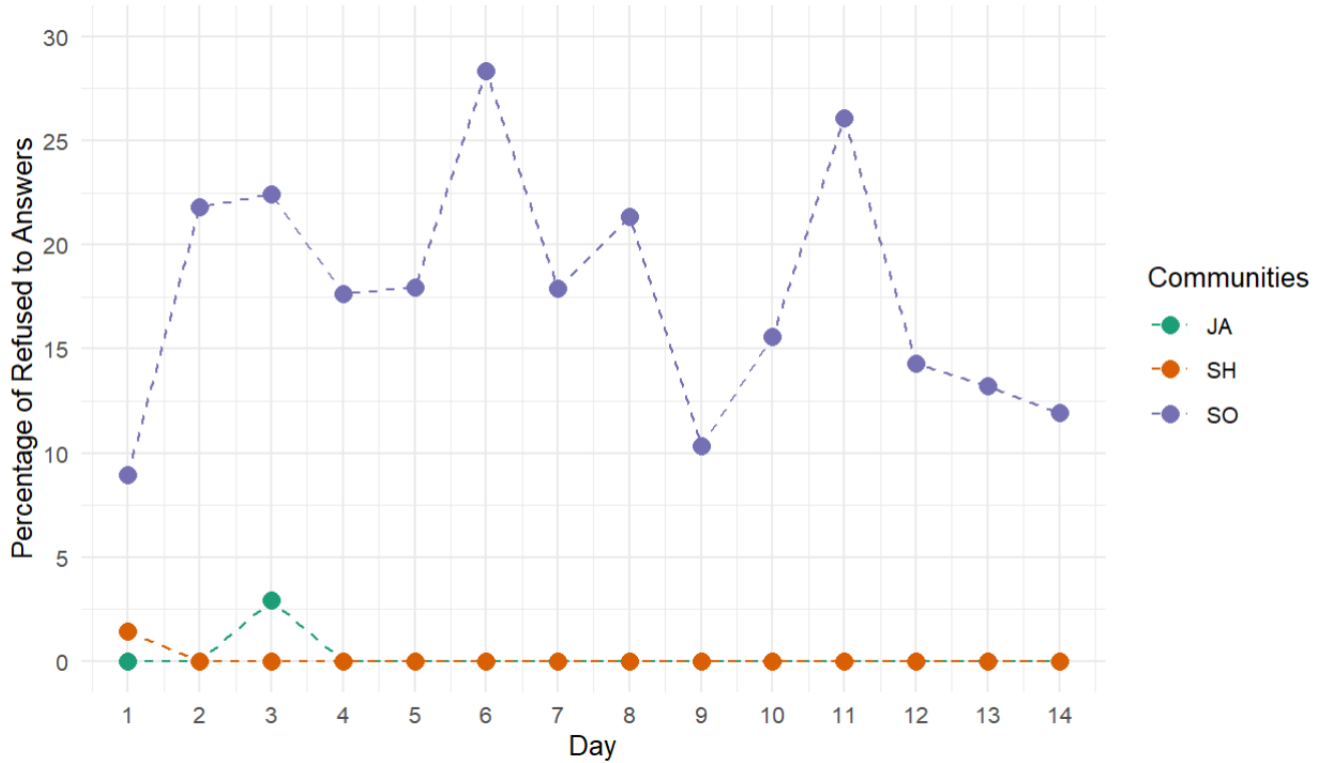
Figure 8: Percentages of Responses = “NA” of Participants of the Daily Diary for each day over the course of the 14-day collection period by the Rendille, Borana, and Gabra Communities. Note: JA = Jaldesa community, SH = Shuur Community, and SO = Songa Community



The Songa Community reported the largest percentage that “Refused to Answer” in the DD when compared to the other two communities at ~28%. For this community, the lowest percentage of “Refused to Answer” was ~9%. Jaldesa Community had their peak “Refused to Answer” responses to the DD at ~3%. Shuur Community had the lower percentage of “Refused to Answer” with their peak of ~2%. Both Jaldesa Community and Shuur Community stayed below 4% throughout the 14-day period. The Songa Community maintained >9% increase in “Refused to Answer” when compared to the other two communities. Notably, “Refused to Answer” did not increase or decrease through the two-week period nor was there another visible pattern to these responses (Figure 9).

Figure 9: Percentages of Responses = “Refused to Answer” of Participants of the Daily Diary for each day over the course of the 14-day collection period by the Borana, Gabra, and Rendille Communities.

Percentage of Refused to Answer by Community per Day of Diary

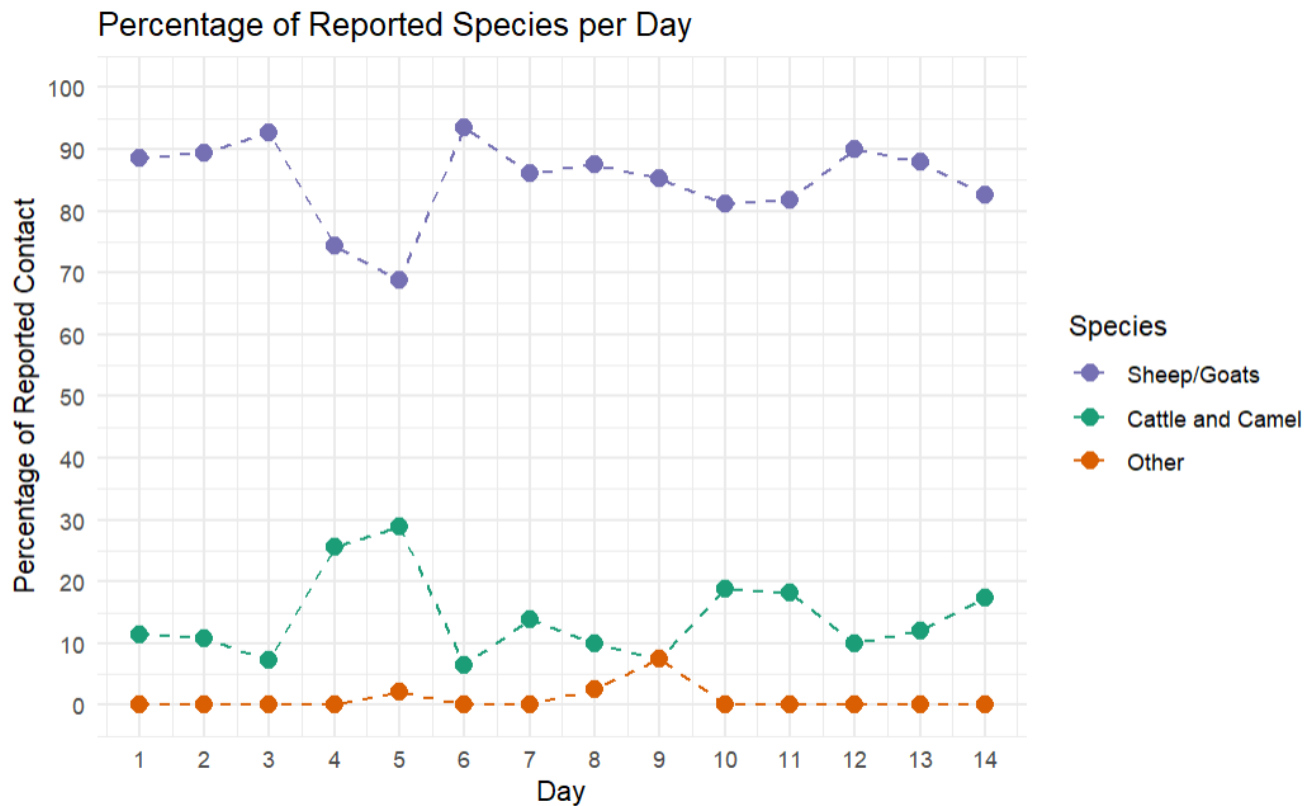


Note: JA = Jaldesa community, SH = Shuur Community, and SO = Songa Community

Contact with a total of 575 individual animals was reported over the entirety of the 14-day DD survey. All participants reported having contact with a species either Sheep/Goats, Cattle, Camel, or Other on every day of the survey. Therefore, the category of “None” was removed from the table above (Figure 10).

Sheep/Goats as a combined category had the highest percentage of reported contact with the participants varying between ~70% - ~90% throughout the two weeks. Remaining at a high and constant amount of contact between sheep/goats and pastoralists. Although examined separately, Camel and Cattle were reported to have the same rate throughout the 14-day period between 6.5% - 29%. Contact with other species was only reported three times throughout the 14-day period (2.2% - 7.4%). The percentage of contact by species remained relatively constant throughout the 14-day period indicating stable herd population. There was no sudden increases or decreases in percentage that were sustained for the rest of the DD. (Figure 10).

Figure 10: Percentages of Species Contact by Participants of the Daily Diary for each day over the course of the 14-day collection period by the Rendille, Borana, and Gabra Communities.



Intraclass Correlation Coefficient (ICC):

The lowest calculated ICC value was 0.47 (95% CI: 0.076 – 0.74) for three variables: feeding livestock, drinking unboiled/unpasteurized milk, and drinking milk (Figure 11). This designates moderate agreement between the DD and RC surveys, indicating a moderate level of consistency reporting on feeding livestock between the DD and RC surveys (Table 4).

The next level of ICC values was calculated at 0.65 (95% CI: 0.33– 0.84) for two variables: handling sick animals and husbandry/routine care of livestock, and 0.74 (95% CI: 0.47 – 0.88) for handling livestock dung (Figure 11). This designates substantial agreement between raters, indicating a high level of consistency between reporting on feeding livestock between the DD and RC surveys (Table 4).

The highest calculated ICC value was 0.82 (95% CI: 0.63 – 0.92) for slaughtering livestock (Figure 11). This designates almost perfect agreement between raters, indicating the highest level of consistency between reporting on feeding livestock between the DD and RC surveys (Table 4).

The assessment of herding livestock, assisting in livestock birth, and milking livestock was omitted from Figure 12 due to the high prevalence of either “yes” or “no” answers.^{37,38,40} This was an issue for the ICC analysis as variance was too low to estimate agreement beyond that due to chance. ICC calculation works best when working with high variation between raters. As a result, the inter-rater agreement for variables referring to herding livestock was not able to be calculated using Intraclass Correlation Coefficient statistic. The questions on herding livestock, handling livestock hide, assisting in livestock birth, and milking livestock all had prevalence >87% of all their answers

towards a singular “yes” or “no” answer. This large prevalence of singular answers given by all participants across both RC survey and DD was a problem for ICC assuming that there is a normal variance and distribution of answers. The positive of agreement in the DD and RC surveys was 95% for two variables: herding livestock and handling livestock hide. The agreement was calculated to be 86% for milking livestock. Indicating high level of consistency towards “yes” answers between reporting on feeding livestock between the DD and RC surveys.

Assisting in livestock birth has a large prevalence of “no” answers given by participants 90% negative agreement. Indicating elevated level of consistency towards “no” answers between reporting on feeding livestock between the DD and RC surveys. In addition, illustrating that this was not a common activity to complete in the duration of either survey.

Although ICC values were produced for the feeding livestock, consumption of un-boiledmilk, and consumption of milk, they all had >62% agreement when “no” and “yes” answers were calculated separately. Consumption of un-boiled milk did report 100% agreement when calculated separately. This high level of prevalence towards “yes” or “no” answers reflected in the artificially low ICC values.

Further, the RC Survey contained a question about undercooked, raw meat, or blood consumption that did not have a corresponding question with the DD questionnaire; it was removed from this analysis.

Figure 11: A) Intraclass Correlation Coefficient (ICC) results of responses to questions about activities involving contact with animals between the Daily Diary survey and the REDCap Survey. B) Looking at Agreement separately when there is <13% variation in between “yes” and “no” answers. Activity variables were created through combining multiple variables that referred to the same activity by different species in DD survey – such as multiple questions relating to each species that was milked, what milk was consumed, or (Table 2). Feed and grazing questions were combined in the RC survey as it was a combined variable in the DD survey. Questions about undercooked meat were excluded from this analysis as this activity was only represented in the RC survey (Table 2).

A)



*Note: “dmilk” = drinking milk, “unbm” = drinking un-boiledmilk, “milk” = milking livestock, “husband” = husbandry/routine care.

B)

Activity	Agreement
Herd	0.95
De-hide	0.95
Milking	0.86
Assisting in Livestock Birth	0.90

*Note: ICC = 0.0 due to lack of variation in participants answers. For each question, $\geq 87\%$ of participants answered with the same responds. Herd = positive agreement, De-hide = negative agreement, Milking = positive agreement, and Assisting in Livestock Birth = negative agreement.

The lowest calculated ICC value was 0.25 (95% CI: -0.18 – 0.60) for two species: Camels and Shoats (Table 12). This designates fair agreement between raters due to chance, indicating the fair level of consistency between reporting on feeding livestock between the DD and RC surveys (Table 4). Further analysis revealed that Camel 0.87 agreement (negative agreement) and the Shoat reported 0.72 agreement (positive agreement) when “yes” and “no” answers were calculated separately. This indicates a high prevalence of either “yes” or “no” answers. This high prevalence and low variance produced artificially low ICC values.

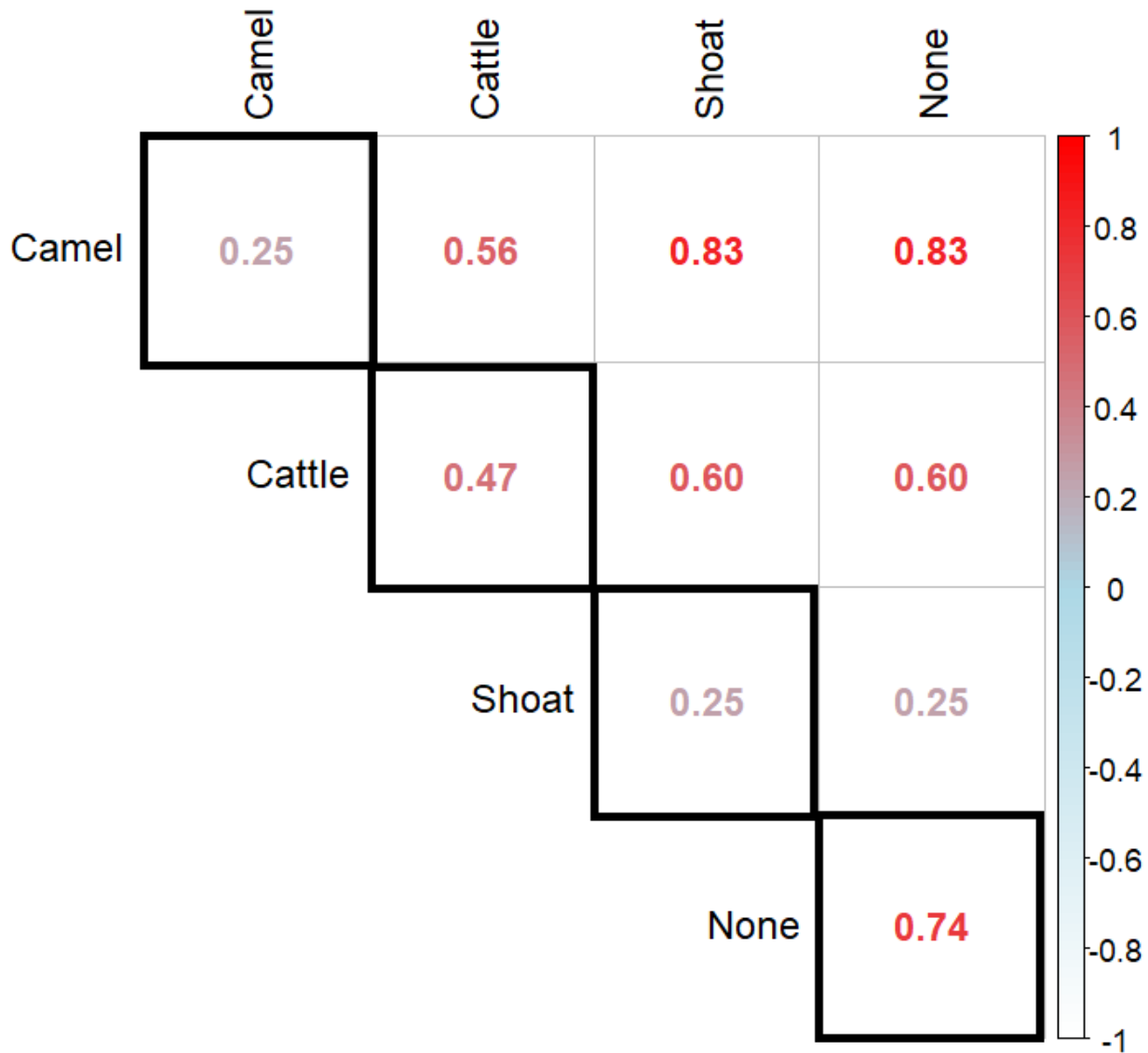
The calculated ICC value 0.47 (95% CI: 0.076 – 0.74) for Cattle, designates moderate agreement between raters due to chance, indicating a moderate level of consistency between reporting on feeding livestock between the DD and RC surveys (Table 4).

The highest calculated ICC was value 0.74 (95% CI: 0.47 – 0.88) for no contact with any livestock, designates substantial agreement between raters due to chance. Indicating a high level of consistency between reporting on feeding livestock between the DD and RC surveys (Table 4).

The inter-rater agreement for variables referring to contact with other animals was not able to be calculated using Intraclass Correlation Coefficient (ICC) statistic.^{37,38,40} The questions on camels, shoats, and other animal contact all had prevalence $>87\%$ of their answers towards a singular “yes” or “no” answer. This large prevalence of singular answers given by all participants across both RC survey and DD was a problem for ICC assuming that there is a normal variance and distribution of answers. In the Other animal category, this was due to the large prevalence of “no” answers given by participants. Other category had 95% of answers given in the DD and RC surveys as “no” answers and was calculated to have a 0.95 agreement value. This indicates an almost perfect level of consistency towards “no” answers between reporting on other animal contact between the DD and RC surveys as well as infrequent contact with other species.

Figure 12: A. Intraclass Correlation Coefficient results of responses to questions about contact with different species between the Daily Diary survey and the REDCap Survey. B. Looking at Agreement separately when there is $\leq 13\%$ variation in between “yes” and “no” answers. Shoat is the combination of goat and sheep variables for the RC survey, Shoat was already combined in questions for the DD survey. Other is a combination of the donkey, wildlife, and other variables for the RC survey; it is the combination of the chicken, guinea fowl, donkey, and other variables for the DD survey (Table 3).

A)



*Note: “Shoat” = combination of sheep and goats. “Other” is not included in this analysis due to 95% of the answers = “no”

B)

Species	Agreement
Camel	0.87
Shoat	0.72
Other	0.95

*Note: ICC = 0.0 due to lack of variation in participants answers. For each question, $\geq 87\%$ of participants answered with the same responds. Camel = negative agreement, Shoat = positive agreement, and Other = agreement

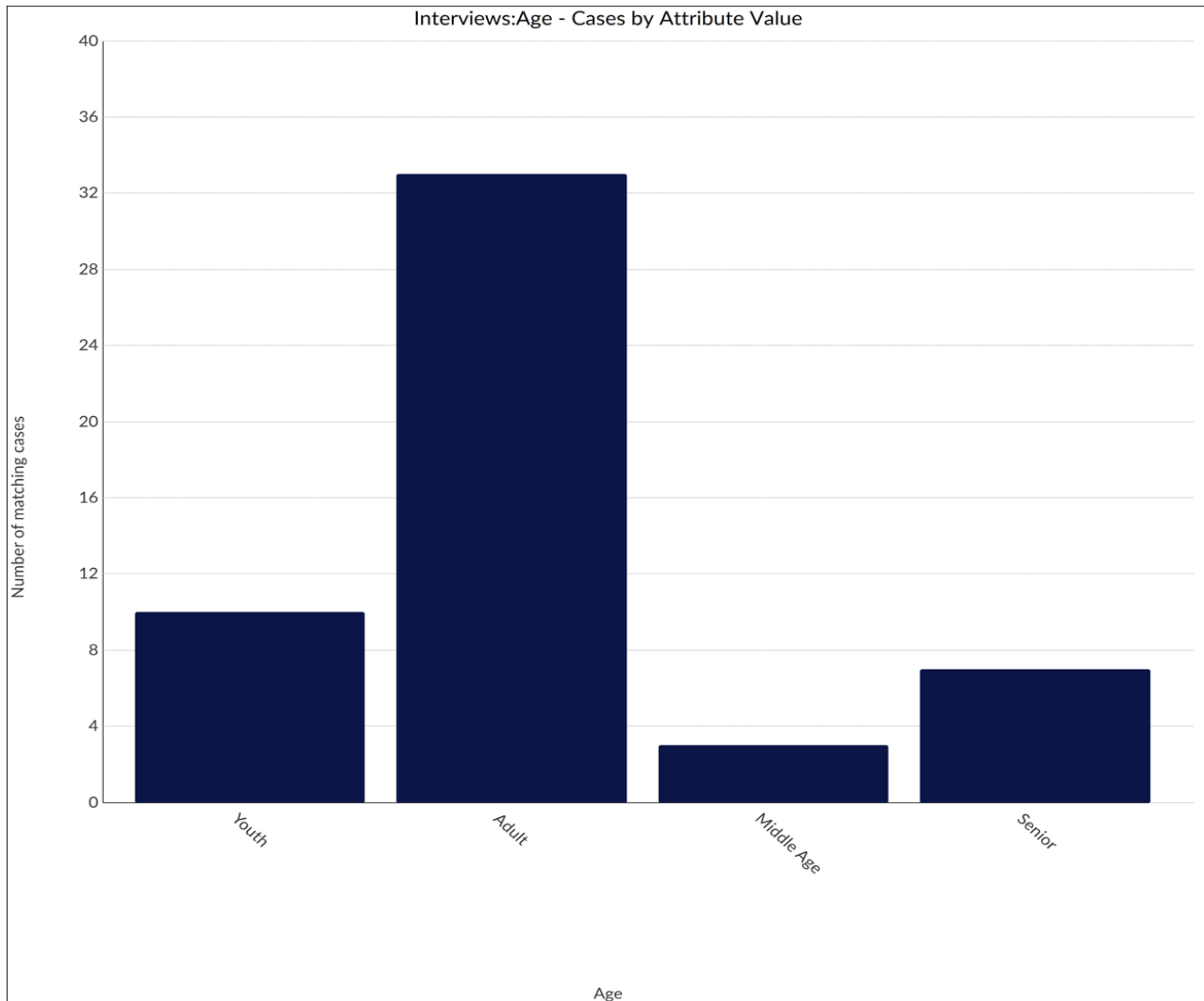
Qualitative:

A total of 16 Focus Group Discussions (FGD), 15 Transect Walks (TW), and 16 Key Informant Interviews (KII) were completed for this qualitative study. Of the TWs and KIIs, 16 interviews were with male participants (52%), 12 interviews were with female participants (39%), and 3 interview participants did not specify their sex (9%). Each of the FGDs comprised about 10 individuals of the same age group and a mixture of male and female.

Participants of all interview types were asked if they self-identified as Gabra, Borana, Rendille, or another community. All FGDs and TWs were conducted in Gabra, Borana, and Rendille communities. For the KIIs, 1 participant identified as a Gabra community member and two identified as Borana community members, but the rest were from other ethnic communities.

Participants of all interview types were asked to self-indicate their age groups: Youth (0-17), Adult (18-40), Middle Age (40-60), and Senior (60+). Additional consent was acquired from all parents or guardians for any participant under the age of 18-years old. In the cases of the FGD, these groups were initially gathered by their self-identified ages before discussion began. Most participants fell into the adult age group with a total of 28 (62%) interviews being with adults. 9 (19%) interviews were conducted with Youth, 6 (13%) interviews with Seniors, and 2 (6%) interviews with the middle age group (Figure 13).

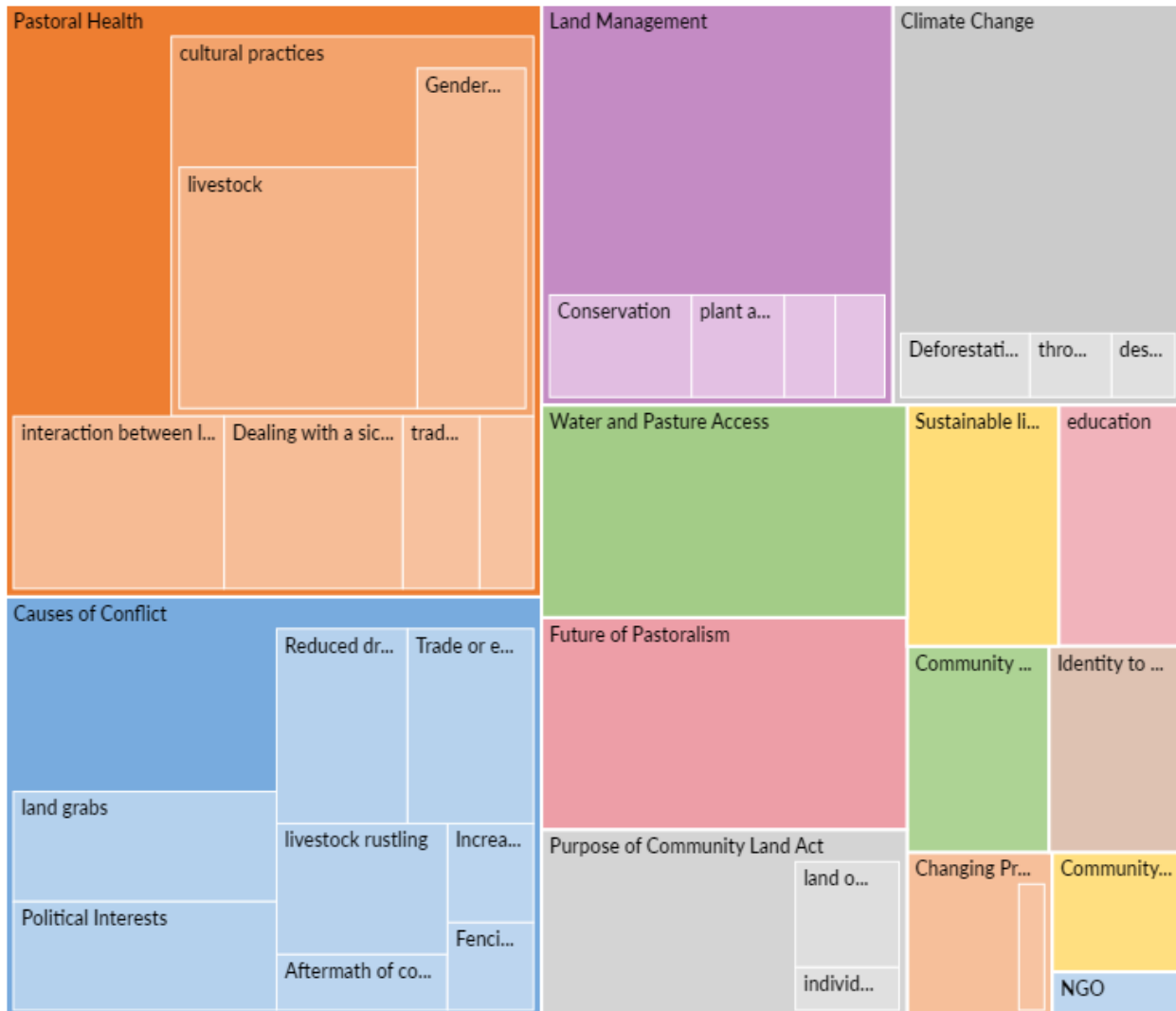
Figure 13: Distribution of participants of all FGD, TW, and KIIs across Gabra, Borana, Rendille, and other communities. Distribution of participants of all FGD, TW, and KIIs across age groups = Youth (0-17), Adult (18-40), Middle Age (40-60), and Senior (60+).



Focus Group Discussions and Transect Walks:

FGDs were conducted through guided discussion comprising of about 10 individuals of the same age group and sex. The discussions were each conducted over the course of an hour with participants dictating how long each topic was discussed. At some points, the interviewer assisted in moving the conversation along or asking more detailed questions. Participants spent a larger amount of time discussing topics of “Pastoralist Health” and “Causes of Conflict” in Marsabit County. Both topics combined covered close to 50% of the interview time given. “Land Management” and “Climate Change” were the second highest topic of discussion together with almost 20% of interview time being taken by these subjects. “Water and Pasture Access”, “Future of Pastoralism”, and “Purpose of the Community Land Act” combining to equal another 20% of the interview time. The rest of the interview time was taken up by multiple other topics such as education, sustainability, community, and identity to the land (Figure 14).

Figure 14: Distribution of topics covered by the FGDs, and TWs participants. The larger boxes illustrate the broad topics covered throughout the interviews. The brighter the color and the larger the size of the boxes indicates the longer amount of time participants spent on the specific topics.



*(1)Other than brightness of the shade of color, colors do not have any other significance. (2)Some subsets for topics were cut off due to formatting of this figure. (3) Under Pastoral Health, Gender roles in livestock care, Interaction between livestock herds, Dealing with sick livestock, and Trading/gifting livestock between communities. (4) Under Land management, Plant agriculture is cut off. (5) Under Causes of conflict, Reduced pastureland due to drought, Trade or economic pressure, Increasing population, Fencing of land, and Aftermath of colonialism are cut off. (6) Under Climate change, Deforestation, Understanding through elders, and Desertification. (7) Under Purpose of the Community Land Act, Land ownership and Individual land purchasing are cut off. (8) Sustainable livelihood, Education, Identity tied to land, Community engagement, Changing Production system are also cut off.

When discussing the subsets under “pastoralist health,” the adult age category spent more time discussing pastoralist health and had a higher diversity of topics covered in discussion than the other age categories. The youth age category had the next largest time spent on this topic with the second most diverse topics touched upon. The middle-aged participants did not discuss soil health in their discussion of pastoralist health. The senior aged participants did not discuss “soil health,” “trading livestock,” and “dealing with sick animals.” Most of their discussion primarily focused on “cultural practices.”

When discussing the subsets under “pastoralist health,” Borana spent more time discussing pastoralist health than the other communities. Gabra had the largest diversity of sub-topics than the other communities. Rendille and the other category had a similar amount of time spent on this topic and the same amount of diversity within those sub-topics.

Rendille (Middle-Aged Man) – “Animals graze from land pasture. (What) they get there defines their health and also the water they get from the land defines their health... also animals’ health depend on pasture and water they get from that land... Animals and human health is so important because when animals health is good also human will have good health since people do take milk and meat from animals so human and animals health is so important.”

Discussions surrounding pastoralist community health fluctuated smoothly between topics of animal health, intra-community conflict, and environmental health. Conservation surrounding pasture health frequently turned into discussions about conflict, drought, and the importance of maintaining herd health.

KII (adult man – veterinary officer) – “I think for climate change, you know, when there is no grass to pasture, obviously this will affect the animals, because the body condition deteriorates and for the wildlife, I think basically you have seen most of the elephants were dying. I think you have seen there was one of the big, tusked elephants which died. A lot of wildebeest are dying, so I think because of climate change, these animals lack things to eat. In fact, it also increases human-animal conflict because when this animals in our area when there is nothing to eat in the forest, they come and try to destroy the trees we have in the area because we have the trees like the fruit trees like the mangoes, and bananas and the vegetable because we do a bit of irrigation. So, it also creates the issue of human wildlife conflict. When they are there, they also cause human injuries, deaths in two instances, just last week in Karare, there were two people killed by the elephant. Now from the other side of livestock its all the same...”

When discussing the subsets under “pastoralist health,” FGDs spent more time discussing pastoralist health than the other interview types and less diverse topics than other interview types. TWs had the most diverse topics than other interview types. KIIs spent the least amount of time on this topic (Figure 14).

Discussing the subsets under “pastoralist health,” the adult age category spent more time discussing pastoralist health and had a higher diversity of topics covered in discussion than the other age categories. The youth age category had the next largest time spent on this topic with the second most diverse topics touched upon. The middle-aged participants did not discuss soil health in their discussion of pastoralist health. The senior aged participants did not discuss “soil health,” “trading livestock,” and “dealing with sick animals.” Most of their discussion primarily focused on “cultural practices” or celebrations such as births or weddings, religious events, and handicraft making that dealt directly with livestock.

When discussing the subsets under “pastoralist health,” Borana spent more time discussing pastoralist health than the other communities. Gabra had the largest diversity of sub-topics than the other communities. Rendille and the other category had a similar amount of time spent on this topic and the same amount of diversity within those sub-topics.

Rendille (adult woman) – “Animals graze from land pasture. (What) they get there defines their health and also the water they get from the land defines their health... also animals’ health depend on pasture and water they get from that land... Animals and human health is so important because when animals health is good also human will have good health since people do take milk and meat from animals so human and animals health is so important.”

“Pastoralist Health” was subset divided into more specific themes during the process of coding. These themes included “cultural practices”, “livestock”, “gender roles in livestock management”, “interactions between herds”, trading/gifting livestock”, “dealing with a sick animal,” and “soil health.” “Soil health” was cross coded under board topics such as “climate change” and “land management” as well. Most of the discussion under this umbrella topic covered boarder topics of “Pastoralist Health” and “cultural practices.”

Gabra (middle-aged man) – “Our food comes from our animals which feed on grass that are on our land, so when there’s no grass, there would be no health due to lack of food from the animals”

“Causes of Conflict” was subset divided into more specific themes during the process of coding pulling forward participants beliefs surrounding the root causes of conflict in the county. Participants fell into 5 major categories; “land grabs”, “reduced viable land due to drought”, “political interests”, “trade or economic pressures”, and “fencing over land”. Participants’ opinions were evenly distributed on where they believed conflict started between these categories.

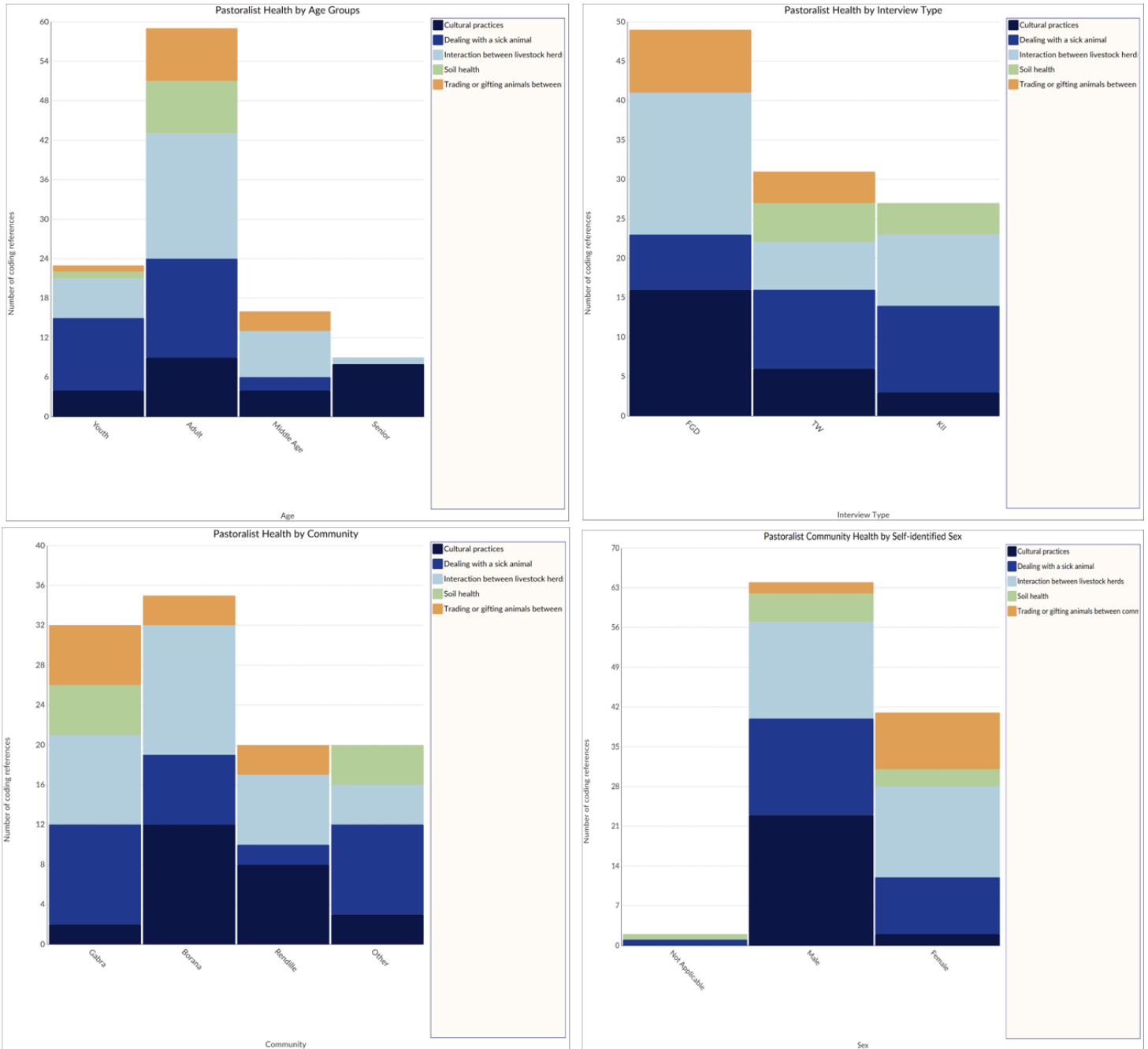
Borana (Youth) – “We don’t steal from each other, but when they steal from us is when we steal from them also... Let me tell you... the main issue for conflict is water... grass... let’s say our is drought season, and another place has pastures...so when we take to their place, they take our animals, so that means I went to take my cattle to have grass, and then they were taken away... yes, because if we had grass of our own, we would graze them here.. all to have water and plant grass...everyone to settle (where they are pastureland and water).”

Rendille Communities and subdivided by sex of participants who completed the FGDs and the TWs interviews. The Borana community spent a larger amount of time during the interviews discussing “causes of conflict” when compared to the Gabra and Rendille communities. In the Gabra community, most of the discussion on this topic was by the female participants. 70% of the Gabra community were male participants (Figure 15). Most participants who spoke about causes of conflict in the county were male. There are many reasons why other participants are less willing to discuss the intracommunity conflict during the time of these interviews, including power imbalances between the genders or interviewer and participants, mistrust surrounding sensitive topics, or fear of repercussions for speaking out about the causes behind conflict in the region. Those who on this topic spoke about a diversity of reasons behind the continued unrest, but most spoke about increasing communication between the communities as a way towards a more peaceful future. A small number experienced their belief that conflict would in a way be a part of Marsabit County and that there was no way to end it.

Rendille (senior men) – “here are times when animals’ diseases (participant coughing) break out at once but not all the time...Wild animals, human and domestic animals may have good health at once so the diseases are nor there all the time... Wild animals may transmit diseases to domestic animals which in turn might transmit to human being.”

The Rendille community spent a larger amount of time during the interviews discussing “pastoralist health” when compared to the Gabra and Borana communities. Their participants who were a majority male focused on the dependency of their community on livestock and other animals to determine the health of their community. Many community members spoke about the interconnective nature of disease and animal health between domestic and wildlife (Figure 15).

Figure 15: Distribution of topics under “pastoralist health” covered by age categories; youth, adult, middle age, and senior. The second graph is the distribution based on community categories; Gabra, Borana, Rendille, and Other. KIIs participants were the only ones to fall into the Other category. The bottom left graph is distributed by the FGDs, TWs, and KIIs participants. The bottom left graph is distributed by self-identified sex of the participants.



The Gabra community spent a larger amount of time during the interviews discussing “water and pasture access” when compared to the Rendille and Borana communities. In the Gabra community, most of the discussion on this topic was by the female participants. This was true for the Borana community as well. Female participants were focused on the lack of water and pasture

for not only how it impacts their livestock, but furthermore how it impacts the education of their children. One participant made direct ties between the water and the ability to gain an education,

Gabra (adult women) – “Most of the animals are gone and we only hope almighty to give us rain so as the remaining one to survive and if not, it will be the end of it... We have educated many before but now due to lack of animal which is the source of income has made us not to do so but if we get support leave alone the children, even the older me will be ready to go back to school because we have seen important of education... What we plead most is (for) the government to stand with us during these hard times. You have heard our animals are gone, our children are at home due to lack of fees, and we plead the government not to chase them away and also give us support in terms of relief food”

This participant emphasizes that she knows the importance of education and its importance to the future of her community. However, funding for education is a large barrier to sending children to school. Water, pasture, livestock, and education are seen as an interconnected system. Livestock is dying due to the lack of water and pastureland, which in turn is severely impacting families' incomes. Without income, the youth are not able to attend school. The Gabra women emphasized the importance of education multiple times in their interviews. They want to see their children go to school but do not see a way to keep their youth in school if their income continues to feel the impacts of the drought.

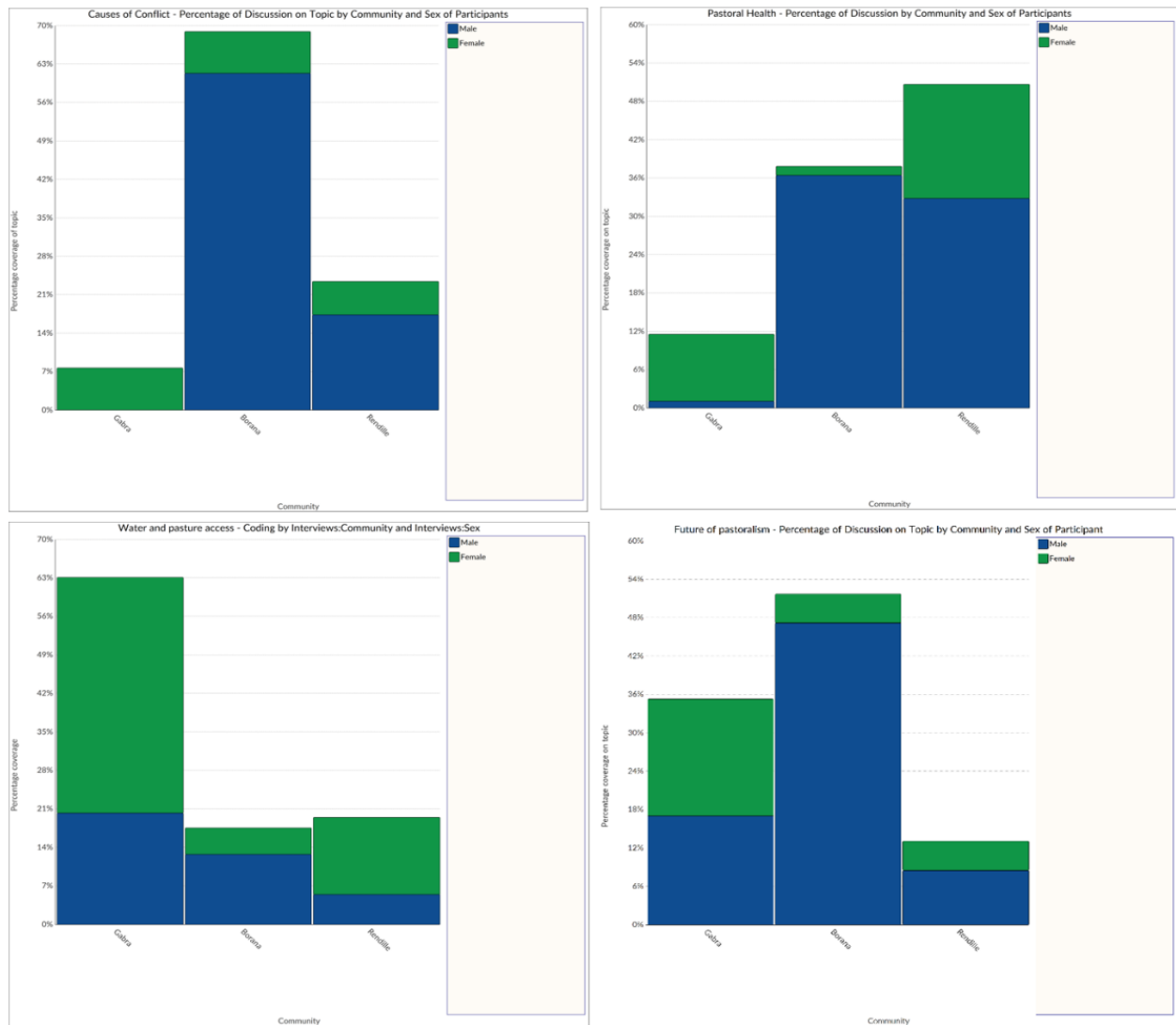
The Borana community spent a larger amount of time during the interviews discussing “future of pastoralism” when compared to the Gabra and Rendille communities. In the Borana and Rendille communities, most of the discussion on this topic was by the male participants. In the Gabra community, most of the discussion on this topic had an even distribution of male and female participants (Figure 15).

The Borana community spent a larger amount of time during the interviews discussing “causes of conflict” when compared to the Gabra and Rendille communities. In the Gabra community, most of the discussion on this topic was by the female participants. Seventy percent of the Gabra community were male participants (Figure 16). Most participants who spoke about causes of conflict in the county were male. They spoke about a diversity of reasons behind the continued unrest, but most spoke about increasing communication between the communities as a way towards a more peaceful future. A small number expressed their belief that conflict would always be a part of Marsabit County and that there was no way to end it.

Rendille (adult men) – “here are times when animals' diseases (participant coughing) break out at once but not all the time...Wild animals, human and domestic animals may have good health at once so the diseases are nor there all the time... Wild animals may transmit diseases to domestic animals which in turn might transmit to human being.”

The Rendille community spent a larger amount of time during the interviews discussing “pastoralist health” when compared to the Gabra and Borana communities. Their participants who were a majority male focused on the dependency of their community on livestock and other animals to determine the health of their community. Many community members spoke about the interconnective nature of disease and animal health between domestic and wildlife (Figure 16).

Figure 16: Distribution of responses to questions about “Causes of conflict”, “Pastoralist health”, “water and pasture access”, and the “future of pastoralism” across the Gabra, Borana, and Rendille Communities and subdivided by sex of participants who completed the FGDs and the TWs interviews.



The youth were asked about what they saw for the future of pastoralists in the region. The Borana youth FGDs spent the most time on this subject. They stated,

Borana (two youth in the same interview) – “ (1)I also love pastoralism...For me, I want to be a veterinary doctor... yes...

(2) for me, I don't want for now... I don't want. In the past, I used to love it so much, but now because of climate changes, it's so much loss maybe doing business...for now, I don't want, but if it rains, I will continue with pastoralism.”

There were mixed responses on where they saw the future of pastoralist communities. Unfortunately, due to the lack of verbatim translations, the transcribes are missing nuance when looking at participants feels surrounding the pastoralist lifestyle. Many other quotes are similar to

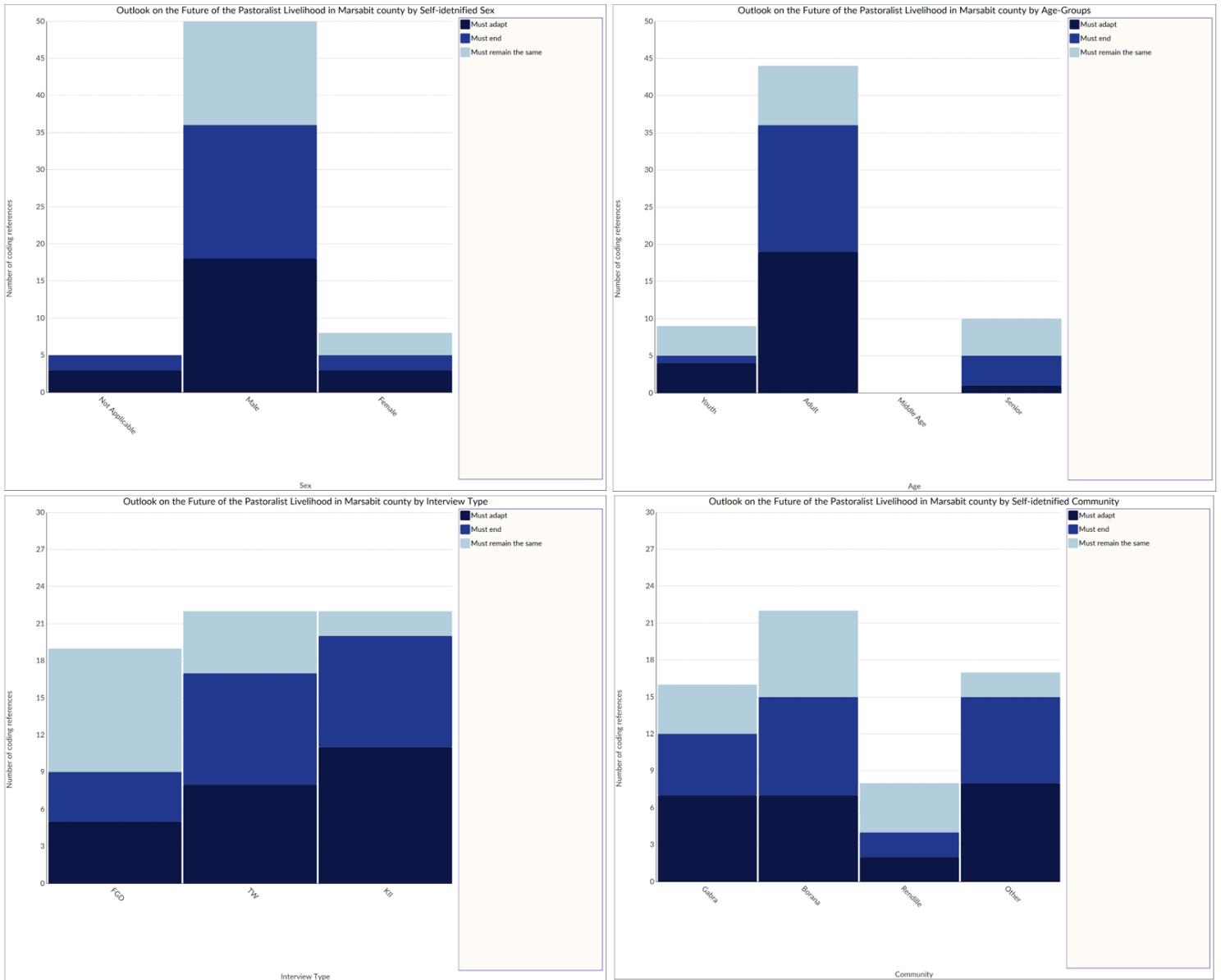
the quotation above. Participants are stating that they love pastoralism. However, this cannot fully illustrate the picture of what they love nor can be give greater meaning to these quotes. The translator only chooses to dictate that they all expressed love for their ancestral livelihood. Testimony from the interviewers who were presented for the FGDs indicate that more nuanced parts of the conversation are missing from these translations. However, there was a mixed response from asking if there would still be a future in this work (Figure 17a).

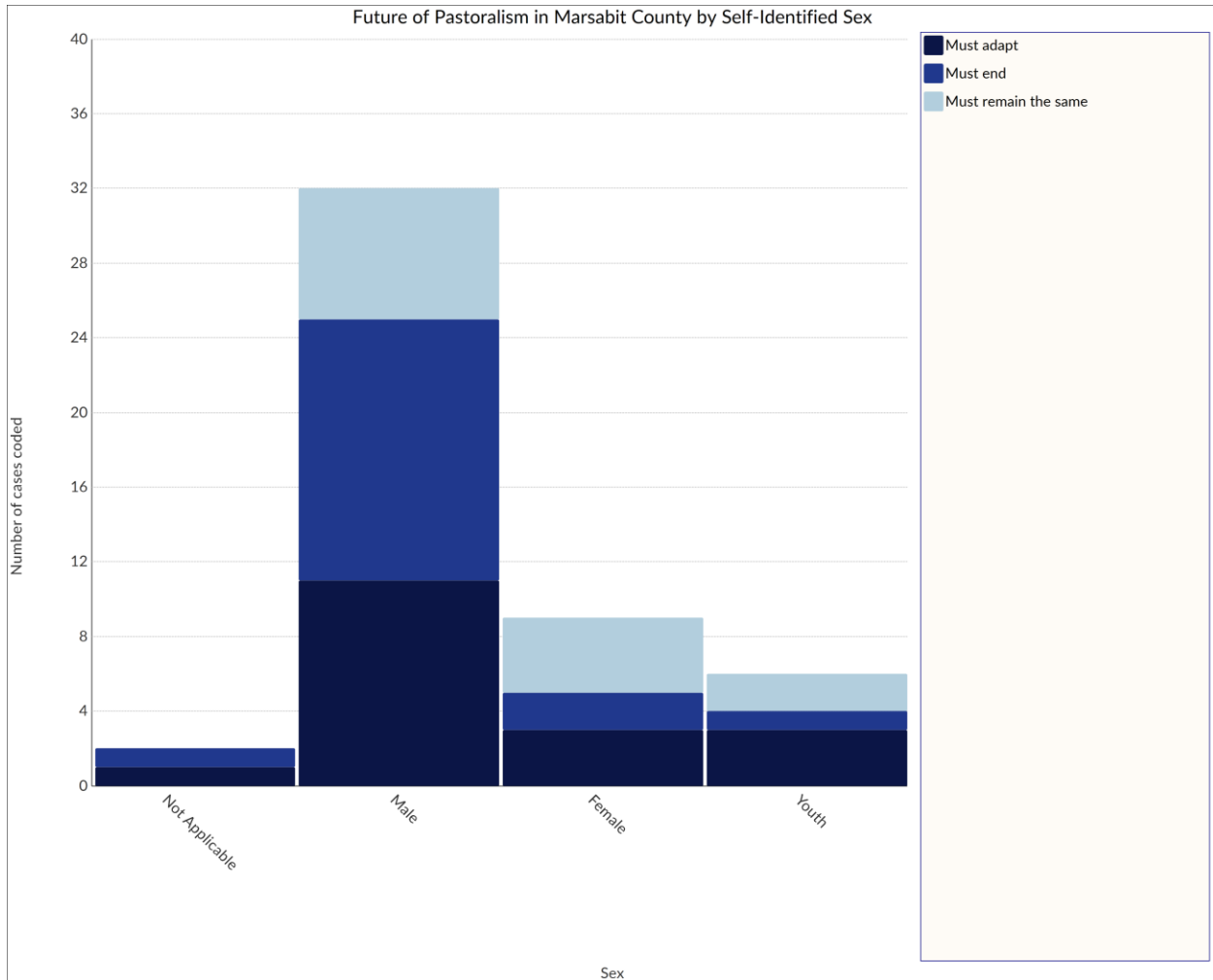
Rendille (Youth) - I want to change from being a pastoralist but keep a small number that is manageable at home without movement.

There was a slight majority of participants looking to adapt the pastoralist lifestyle in the youth interviews when compared to the men and women participants (Figure 17b). The youth interviews were a mixture of both girls and boys and therefore, further analysis based on the future was not possible. However, the youth were willing and eager to discuss future plans. Interviews with men held a large discussion on the future. However, these numbers are not significant when compared to women and youth as men were the majority group in all three interview types. Looking at the portions of “must remain the same”, “must end”, or “must adapt” opinions for both men and women there is not a clear majority of which opinion is the most dominant (Figure 17b).

Figure 17: Distribution of responses to questions about “future of pastoralism” across the “must remain the same”, “must end”, or “must adapt” opinions, A) subdivided by sex, communities, age-groups, interview types of participants who completed the FGDs and the TWs interviews. B) Distribution of opinions on “the future of pastoralism” between by sex. Youth is separate as FGDs with youth did not specify sex of individuals and were a mixture of both male and female participants.

A.



B.

KII (adult man – nursing/disease surveillance) – “Future of pastoralists: no more drastic changes, let them be. No more CLA, pastoralism best way to utilize rangelands.”

All participants were asked about their beliefs regarding the future of pastoralist communities, whether they believed that a “pastoralist lifestyle must remain the same” or that “pastoralist lifestyle must end” in the future, and where they saw themselves in that future (asked to pastoralist community members only). Their answers fell into three categories, “pastoralist lifestyle must remain the same,” “pastoralist lifestyle must end,” and “must adapt.” The majority of participants answer fell into the “must adapt” category with TWs and KIIs spending more time on this topic than FDGs. Interestingly the Middle-aged participants did not spend any time on this category and male participants spent more time on this topic than female participants.

Gabra (adult woman) – “Most of the animals are gone and we only hope almighty to give us rain so as the remaining one to survive and if not, it will be the end of it.”

There were mixed reactions between each of the three interview types. With a more even mix between three categories; “pastoralist lifestyle must remain the same outlooks,” “pastoralist lifestyle must end outlooks,” and “must adapt”.

Rendille (Senior Men) – “There is a lot of changes in boundaries, in this area three communities that are; Gabra, Borana, Rendille live together, and now from colonial time there is a lot of changes in boundary and the government could not come and put proper boundaries, and now it has resulted to a lot of issues, conflicts... Therefore, our big problem is the boundary, because we are pushed, they (the colonial government) have made a new map... the way we said that someone without a land comes with title deeds, the maps have incorrect details, maybe saying that [name of a place] is on this side while we are know it is on the other side, all this is because of boundaries.”

Discussion around adapting for future success focused mostly on conflict solutions, land management, and education. All three communities were quick to identify where the challenges facing their community stemmed from and called for more discussion around solutions and creative land management. Most of the “pastoralist lifestyle must end” outlooks stemmed from the perspective that there were no solutions to these challenges and there were no discussions around problem solving.

KII (adult man – green energy private sector) – “The era of pastoralist is fading. The sooner it comes to reality the better... pastoralists are now missing how to go to the pasture simply on the ground that they someone when they're young, they are on the pastoralist, they grew up. Now, they will marry they will become students. Now that student will not go to that animal, they will go to school.”

Most of the KII participants, who had a “pastoralist lifestyle must end” outlook on the future of pastoralist communities, believed the end of this livelihood was the unavoidable consequence of education and climate change. They expressed their belief that pastoralism had to end for the county to move forward either with the education of the people or the change in management of the land. Some expressed that this “fading” of pastoralism has been happening for a long time and will slowly continue.

Borana (adult men) – “The greatest changes we have seen is...first the trees have decreased to nothing, people have cut down trees, they are using charcoal, burning of the charcoal also brings so much heat/warmth, trees continue to be extinct. Also, people have lost so much wealth because of climate change. This has led people to depend on charcoal burning; therefore, so much harm is there. This is one of the changes. People used to plant crops, now without the rain, therefore people depend on the government which was not there before... Maize was taken to Wajir, Mandera, and sides of Garissa. When you walk road heading Isiolo I believe you've seen a big food store/barns, it was built because of Borana farmers. Now it has become like a story. Rain is now not seen, and the more rain fails to rain, the more trouble approaches because one keeps losing wealth as more hunger strikes, a very hot sun, now people cut down trees to keep up with life. There have been very big changes.”

For Borana, Gabra, and Rendille community members, “pastoralist lifestyle must end” outlooks were rooted in the lack of solutions around drought, livestock death, and lack of land communal land management. Community members told of their own experiences with livestock death and family members moving to more urban areas. They saw the end of their pastoralist lifestyles not as a choice but as a survival decision. One that they or their children would have no choice but to

leave due to the pastoralist livelihood being destroyed by higher force such as climate, drought, or God.

Borana (adult man) – “So, there is like kitchen garden, buying animal feeds, and were now trying to educate our children, we are going through hardships to educate our children, that we can go hungry for them to be in school. And when they are done and get jobs, they come back to help the parents, so that is one way of coping with change. Our livelihood depended on livestock but because of climate change, we had to diversify (our) livelihood.”

Key Informant Interviews:

Each of the 16 KII interview participants spent 60 – 80 minutes with the interviewing team. The majority of these interviews were conducted in Kiswahili and later translated into English. KIIs participants spent the greatest amount of time discussing topics of “Causes of Conflict” in Marsabit county. “Land management” and “Purpose of Community Land Act” were the next largest topics covered during these interviews. The three topics combined took up close to 50% of the interview time given. “Pastoralist health”, “water and pasture access”, “future of pastoralism”, and “climate change” have an equal amount of weight in these interviews. The rest of the interview time was taken up by multiple other topics such as education, sustainability, community, and identity to the land (Figure 18). This is a large change in time spent on different topics when compared to the TWs, and FGDs community interviews.

A large focus of the KIIs was the Purpose of the Community Land Act (2016). These interviews spent a much larger amount of time on this topic compared to the TWs, and FGDs community interviews. Many members of the Borana, Gabra, and Rendille communities who participated in these interviews stated that they did not know what the Community Land Act was but were interested in learning more. The participants of the KIIs were already familiar with the 2016 Act and were happy to share their perspective on the Act itself and the challenges that community face when trying to apply for a land grant under this Act,

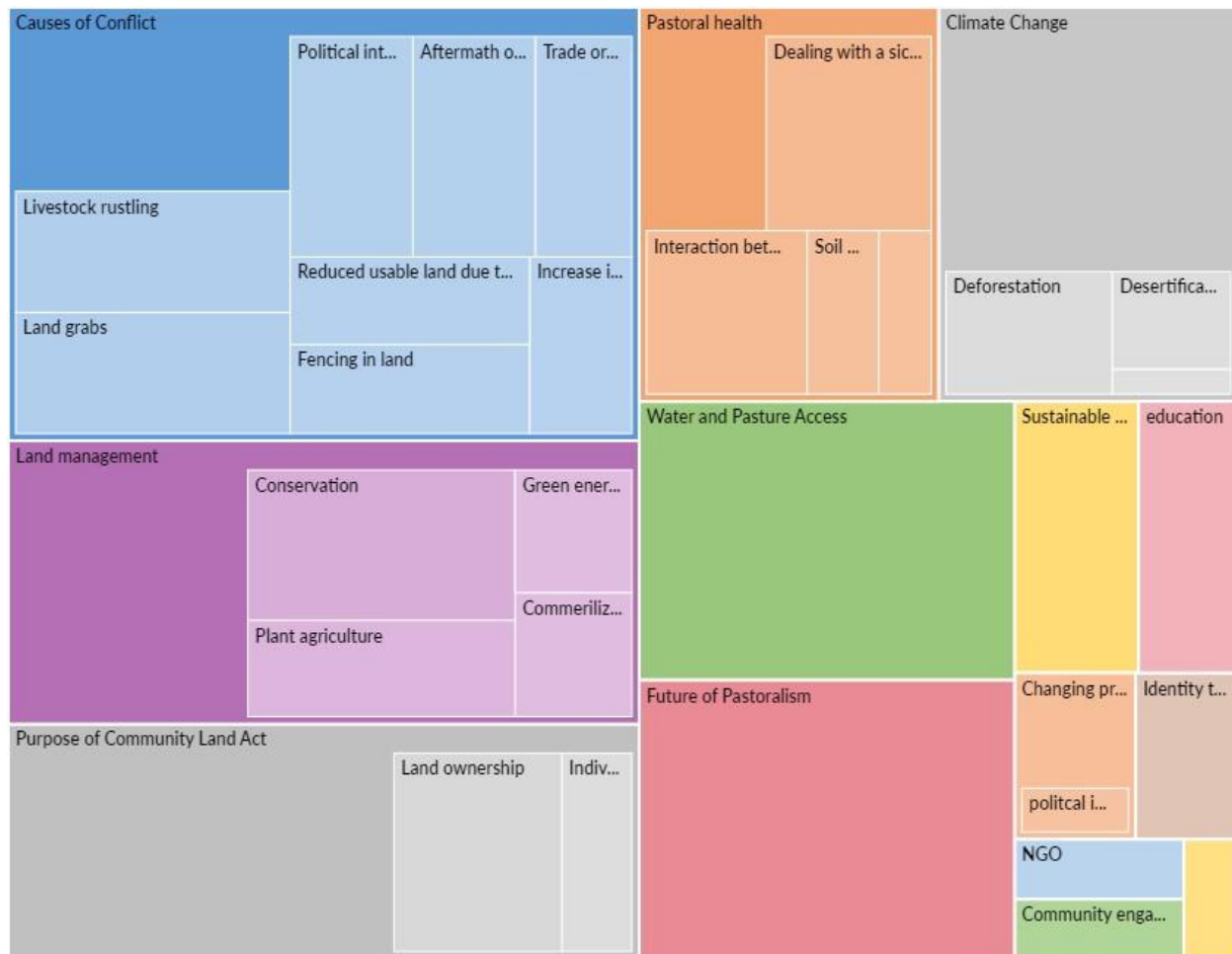
KII (adult man – veterinary officer) – “I think when we started the county, governments were telling our people to register as community land, but this process was not picked, for almost two three years, ... I don't know if it's the issue of funding or what, but we're thinking, if maybe, if we're proposing, if we can help through the conservancy for people to register through their own land. That was pure thinking, maybe in 2023 but there is no land which has been registered as a community, ... now the problem, is you know there is no awareness (of the Community Land Act), you know if you create more awareness to this people, that it is important for you to... we need to really push in this 2023 and make sure this community land is registered...I think the individual land tittle is also good for those people who have settled and have their own pieces of land. The individual title is good as well as the community title because this community title will safeguard our community land. It will safeguard because you know when you have that community title, means that area will be secured.”

The majority of KIIs see the Community Land Act as a good step in the right direction. However, they are all quick to outline challenges that communities face when trying to implement this legislation. No KII participants talked about the lack of awareness about this law in Marsabit pastoralist communities despite many community members in the FGD and TWs interviews stating that they did not know that this law exists and what impact it could have on their communities.

KII (adult man – natural management) – “So in terms of challenges... One of the main (challenges) with law is that this is just one law that’s supposed to take care of all this. What we have in the rangelands and in that case adopting the law to the context of the specificities you know is of a challenge to the pastoralists...the law defines what a community is in terms of people of the same kind of ethnic cultural social ecological ... is defined as a community, but then it (the definition of community under the law) goes way beyond and says that this community is able to sit down and make decisions on the land. When we talk about this sitting down there and you know at the back of people’s mind that it is small enough for people ... like sixty five percent or the two thirds should be able to sit down and design (the plan for the land). Even with initiating the registration itself, that’s a requirement that they have to sit down and decide that yes, we are a community called this and that is our land and these are our members and we want to register... one big challenge that came about is the land that people talk about as land is so expansive that the practicalities of people coming together to sit down is impossible but that’s what the law says, you know that’s one of the issues . The other bit is that a lot of effort was placed at the community themselves, the communities are the ones to initiate the claim, you know, and in that sense, they have to understand the law and they have to produce the documents that are required by to be able to come and ascertain and register their land. ... So, they (local government leaders) were supposed to provide awareness and education to the (community members)... so another challenge you know having that awareness to know what is the duty, the responsibilities that they are supposed to undertake is other challenge and then the system was linked in the sense that there are some responsibilities of the community itself such as initiating the , identifying themselves , giving a name, coming up with those required documents is a primary of the community but the on the other hand besides educating them on the law, they (local government leaders) have to prepare them because it’s a new law , requires new offices that are to receive this applications and the documents from the community.”

Despite these challenges outlined above, KII participants expressed that it was important that the pastoralist communities were informed of this Act and understood how to apply for land under their community names (Figure 18). Many KII participants voiced their concerns that communities were not using this Act to their benefit and offered solutions to this issue,

Figure 18: Distribution of topics covered by the KIIs participants. The larger boxes illustrate the board topics covered throughout the interviews. The brighter the color and the larger the size of the boxes the longer participants spent on the specific topics.



*(1)Other than brightness of the shade of color, colors do not have any other significance. (2)Some subsets for topics were cut off due to formatting of this figure. (3) Under Pastoral Health, Gender roles in livestock care, Interaction between livestock herds, Dealing with sick livestock, and Trading/gifting livestock between communities. (4) Under Land management, Green energy and Commercialization is cut off. (5) Under Causes of Conflict, Reduced pastureland due to drought, Trade or Economic Pressure, Increasing population, Fencing of land, and Aftermath of colonialism are cut off. (6) Under Climate Change, Deforestation, Understanding through Elders, and Desertification. (7) Under the Purpose of the Community Land Act, Land ownership and Individual land purchasing are cut off. (8) Sustainable livelihood, Education, Identity tied to land, Community engagement, Changing Production system are also cut off.

KII (3) – “Pastoralists should be incentivized by the government leaders on the role of having a few animals due to the scarcity of land. Climate change has a lot of impacts even on the government and pastoralists should be informed about these effects. They (pastoralist communities) should understand the role of pasture production, tree planting and mixed farming practices.”

The KII participant (3) expressed the need for the Community Land Act to be enacted and “incentivized” by the government was not only a matter of land management, but also has ties to climate change, community health, and the future of the region. This participant saw the Community Land Act to improve education around land management, increase community resilience in the face of Climate Change, and increase/diversify the economy of the county.

DISCUSSION:

Quantitative:

In our quantitative analysis, we found that there were no spikes or trends in “Refused to Answer”, “Yes”, and “Missing” responses were consistent across the 14 days of the DD, indicating that there was no evidence of survey exhaustion. Although the Songa community (Rendille) had an increased number of “Refused to Answer” when compared to the other two communities. The ICC and agreement analysis revealed a moderate to higher level of agreement between all activities and species examined between the DD and RC survey, indicating that participants had a high degree of recall when remembering both the animal husbandry tasks that they completed and the species that they interacted with in the past two weeks.

We used the DD to validate two-week animal contact recall in the RC survey. Participants reported that in some cases the DD survey took them up to 3 hours per day to complete the DD and others reported requiring aid from their children for the DD. These reports illustrated the burden that the DD presented to participants. Despite this, community members showed high commitment to completing the questionnaire. The number of “Refused to Answer”, “Yes”, and “Missing” responses were consistent across the 14 days. There was no spike in any of these responses towards the end of the week, which would indicate survey exhaustion. Survey exhaustion is a participant response when participants grow tired or disinterested in completing a survey. This often indicates that a survey is too long or has created too great a burden on participants. This can be shown by responses to questionnaires with increased or decreased responses across all participants towards the end of the questionnaire time-period.

The Songa community (Rendille) had an increased number of “Refused to Answer” when compared to the other two communities. These numbers were consistent across all days of the DD. This indicates that this was not a case of survey exhaustion. The Songa community was the first community to complete the DD and the first time that the research team explained the project to a community. This increase in “Refused to Answer” could be attributed to confusion in instructions for completing the DD. The research team was able to improve their methods of instruction when working with the next community. An additional questionnaire could be implemented with the Songa community to confirm this theory and refine the questions for future surveys.

ICC analysis revealed a moderate or higher level of agreement between all activities examined between the DD and RC survey. The activities of feeding livestock, un-boiled milk, and drinking milk had the lowest levels of agreement for the activities examined. These low levels of agreement were mostly due to low variance in responses, leading to an artificially low ICC value.

ICC requires variance in participants’ answers. If most participants’ answers are the same, then the ICC value will be artificially low. This was true for the activities of Herd, De-hide, Milking, and Assist in Livestock Birth. When positive and negative agreements were looked at separately this activity all had almost perfect agreement.

The high to almost perfect level of agreement between the true surveys illustrates that participants had a high level of recall when thinking back on activities that they completed in the last two weeks. However, this does not mean that participants did not experience any recall bias. Recall bias is when participants might systematically misremember specific events in their past to either over or under report a specific detail. There is not a large amount of evidence in the case of this study. The activity with the largest risk of recall bias was questions about the consumption of un-boiled milk. This is due to the cultural practices of drinking un-boiled camels’ milk at odds with the national health programming that teaches about boiling milk before consumption.³⁰ Many participants reported similarly in their interviews. However, in both the DD and RC survey, participants reported readily and there was not an increase in “Refused to Answer” or “missing”

answers when compared to other questions. However, positive agreement to this question does not mean that recall bias is not present. Participants, who drink both un- and boiled milk, might be more conscious of drinking un-boiled milk due to their national health programs. Therefore, they might over report drinking un-boiled milk as once every two weeks when it is once a month.

In the RC survey, there was a question about consumption of blood, raw, and undercooked meat that did have a high degree of “Refused to Answer” or “missing” answers. However, this question was not asked in the DD, and faces similar contradictions between cultural practices and health programming. Therefore, further study would be needed to determine if this question is at risk for recall bias.

Overall, there were lower levels of agreement between the DD survey and RC survey when looking at variables surrounding animal species that herders had contact with during the allotted time frame. This could be due to the confusion that many participants expressed when looking at the question set up in the DD. The questions about species asked the question in the form of a matrix so that it was asking what species, age, sex, and owner of the animal in the same set of checkboxes. This created confusion for the participants. For example, a large amount of people would say that they milked livestock and then left the matrix empty. Therefore, we had information about the activity but not about the animal contact. In the next matrix, the participant might fill out only part of the matrix before giving up again. This gave the false answer to no contact with camels. However, in the RC survey, they asked about the numbers of animals, and they asked about them each in a separate question. The clarity of the questions meant that participants were about to respond in more detail.

Despite this, once the matrix of species, age, sex, and owner in the DD were collapsed into just species, a comparison between surveys illustrated moderate to almost perfect level of agreement. This again illustrated that the pastoralist participants had a high level of recall when reporting on their contact with species. Unlike specific activities, reporting on species did not have as high a risk for recall bias.

The category of “Other” species was the most variable comparison due to its wide coverage of animals. The DD asked specific questions about chicken, guinea fowl, and other, while the RC survey asked specific questions about donkey, wildlife, and other. In this analysis, all were put under the umbrella of “Other.” This meant that participants were remembering different events for each of these questions optionally leading to a lower agreement between the two questionnaires.

The high levels of sheep and goats in the participants’ herders reflect other information gathered from the interviews. Goats and Sheep have a greater resistance to drought and the dry season. More herders have been turning to goats, especially due to their higher resilience in the face of climate change. However, goats are a double-edged sword in many ways. Unlike other ungulates, goats consume grass and other forage from their leaves to their roots. Most other ungulates consume only the leafy greens and leave the root systems behind. This allows goats to gain a larger amount of water from the roots of the plants and therefore, survive much harsher dry seasons than cattle and other ungulates. However, in multiple studies, this is shown also as a contributing factor to desertification.⁴¹⁻⁴³ With the root systems removed as well, there is little way for the forage of the pasturelands to regrow in the absence of the livestock.

Herding, feeding livestock, milking livestock, drinking milk, and drinking un-boiled milk were the most frequent activities completed during the DD survey. All other activities were completed by <15% of the participants per day of the DD survey. This illustrates which activities are more frequently completed and therefore, which pathways are more likely to be the route of disease transmission. When moving forward with the rest of this study, the research team can focus on these activities as origins for potential spillover events.

Qualitative:

In the FGDs and TWs qualitative analysis, we found that the Borana community members spent the most time discussing intracommunity conflict, the Gabra community spent the most time discussing water/pasture access, the Rendille community spent the most time speaking about pastoralist community health and the KII participants spent the most time on climate change. Community members expressed mixed views on the future of pastoralism in the region with the youth interviews having a slight majority towards “the pastoralist lifestyle must adapt.” The KIIs interviews revealed no clearer census on the future of pastoralism.

The community members who participated in the FGDs and TWs interviews saw their environment as the largest impactor on their livestock and their ability to herd. Participants from all three communities reported that their health, herds, and intracommunity conflict was based on the current climate. When questioned about climate change, every participant could see that their region’s climate was changing and could tell stories of the changes through their own experience or through stories that their relatives told. Every participant expressed their concerns about climate change and how they could stop its effects. Many reported turning to prayer or the government for answers. Still others expressed a hopelessness around how their own actions or the direct actions of their community could change the climate that they face. In the face of climate change, many community members reported an increase in the severity of the region’s droughts.

The Borana community members spent the most time discussing intracommunity conflict, the Gabra community spent the most time discussing water/pasture access, the Rendille community spent the most time speaking about pastoralist community health and the KII participants spent the most time on climate change. The amount of time spent by each community on each topic could illustrate which topic they find to be the most pressing for their community or organization. However, this could also indicate possible discomfort with specific topics, taboo subjects, or more general disinterest. Each of these topics blended into a discussion of land tenure and the impacts all of these topics will have on the future of pastoralist communities in Marsabit county.

The pastoralist communities of Marsabit County have historically been semi-nomadic or fully nomadic. However, in the last major drought (2024-2024), communities have started to become more sedentary. Community members have reported that they have limited the travel for both their fora (roaming herd) and home herds preferring to start closer to their homes and known pastureland.

They have seen deforestation as a major contributing factor to the desertification of their lands. As communities have settled and began to grow, more land needs to be cleared for agricultural use and timber is needed for infrastructure. However, they also see these developments as drivers of changes to their environment. Themes that ran through many of the TW interviews independent of what community was being interviewed, was deforestation as being the root cause of climate change in the region and their need to settle in one place or move into a larger community was due to the climate and the drought that had decimated their herds. For many diversifying their livelihoods into both agriculture and livestock was the safer option for their families.

Options for families that are moving to a more sedentary lifestyle have two options. Families can either turn to more plant agricultural and a smaller herd or move to a city such as Marsabit Town or Nairobi.⁴⁴⁻⁴⁶ Turning to plant agriculture heavily depends on the amount of viable land available to cultivate while moving to an urban center depends on available housing and job opportunities. The decision to settle gives way to need challenges around nutrition, food security, and economic security.^{8,31,44,45} Many community members find their families caught between their herders

perishing of drought and their livestock no longer about to support their families and the desire to remain as pastoralists. Therefore, all options are not taken lightly by community members.

Those who stated that the pastoralist lifestyle should adapt and change to meet the needs of the community in the face of climate change and other challenges had a slight majority in youth interviews. These participants advocated for smaller herds and diversifying their livelihood. Some spoke about having an additional job such as a veterinarian while still herding their livestock. Others spoke about adding plant agriculture to their pastureland to provide additional income. These sentiments were shared by many other men and some women as well but were dominant in the youth interviews.

The individuals with these perspectives did not want to move into cities and did not want to end their pastoralist livelihoods. However, they see climate change and the desertification of their lands as the greatest threat to their communities. They expressed the need for change to build a sustainable and resilient community. They formulated that these major changes needed to be around deforestation, land ownership, intracommunity conflict, and livestock management. These participants saw deforestation as a major driver of climate change in the region. Something that could decrease but only if communities decided as a whole to pressure their forests. They saw conflict as a symptom of climate change rather than a nature way of life in Marsabit. Ending conflict would be closely tied to land and livestock management. They saw the need to decrease herd size to accommodate a lack of pastureland and water access. And they saw that an increase in the community land ownership to work towards these goals.

The participants who either advocated for the end of the pastoralist lifestyle or that this lifestyle must remain the same did not elaborate on what this would mean in more specific detail for the most part. One elaborated stating that pastoralism must end as it is harmful to the land. While another participant asked for government assistance to continue living in their homes. Both participants expressed that both options of remaining the same or ending the pastoralist lifestyles were attached to feelings of sadness and desperation.

For those who fell into “the pastoralist lifestyle must end”, many participants expressed their sadness over being forced to leave their land, the mass deaths of their animals, and the deforestation of their lands. And that families would be forced to move to cities or that educated children would not wish to return. They saw that outside forces would be the end of the pastoralist lifestyle. There was a sense of despair and inevitability in the way in which they spoke about the end of pastoralism in Marsabit.

For those who fell into “pastoralist lifestyle must remain the same,” many participants expressed their love of the pastoralist lifestyle, their love for their animals, and their positive opinion on how the pastoralist lifestyle impacted their land. There was a need for the lifestyles to continue for the benefit of the communities as well as the land.

Participants in the KII interview were mostly from other communities outside of the Borana, Gabra, and Rendille. Many of these participants expressed their concerns over climate change and its impact on the region’s communities. Many expressed saw changes as a result of community land management in Marsabit county. There were a mixed number of opinions on if pastoralist land management has positive or negative effects on climate change in the region.

KIIs participants did not spend a lot of time on the subject of livestock. They did not discuss in depth the impacts of livestock on pastoralist health. In comparison, community members in the FGDs and TWs spent a large amount of time describing livestock health and impacts on their communities. In many instances, when asked about community health FGD and TW participants

immediately began the discussion with comments about livestock health and what they can see in their herd. They saw no separation between community and herd health.

KIIs were conducted primarily with people from other communities, however, one participant self-identified as Borana, and two others as Gabra community members. While many participants of the FGDs and TWs did not know about the Community Land Act of 2016, all those who participated in the KIIs knew of the Act and considered it important to the future of pastoralist communities. Many saw this as a challenge that the pastoralist communities and governmental agencies would need to overcome in order to pastoralism to continue in Marsabit and throughout Kenya.

Due to the mixed response of all participants and the width of their views, it is still that there is no consensus of what the future of pastoralist communities in Marsabit County looks like. However, there is clear agreement that the future health of pastoralist communities is closely tied to their livestock, their land, and their region's climate.

Limitations:

For the survey validation, there were a few items in REDCap that did not directly correspond to items in the Daily Diary . A prime example of this is that in the DD survey participants are asked about their daily contact with chicken, guinea fowl, and other animals, while in the RC survey, participants are asked about to contact with donkeys, wildlife, and other animals. Due to the lack of exact reflection of questions and variables across the DD and the RC surveys, multiple variables were combined to create equivalent variables for ICC analysis. This could have led to an artificially inflated level of disagreement between the two surveys.

ICC analysis looks primarily at "Yes" and "No" answers.³⁷ The analysis ignores the "missing" answers. Participants were given the option of "refuse to answer." Although observing the number of "refuse to answer " is important when looking at sensitive topics and helps to indicate what activities are more sensitive or how communities respond to the two surveys, it limits ICC analysis to finding levels of agreement. In the cases where positive or agreement was over 85% of the answers were "yes" or "no", the ICC calculation would produce a false 0.0 value.^{38,40} Many other statistical analysis such as ICC, Cohen's Kappa, and Fliess Kappa relay on a high level of variance between raters to produce a level of agreement. This is because all these tests are estimating agreement beyond that due to chance, and with low variance, almost all answers can be attributed to chance, providing very little room for agreement beyond chance. Looking at the absolute value of positive and agreement can help to understand what is happening; however, it cannot give us the whole picture. Unfortunately, sample size would not correct this unless participants are from a large pool of ethnic backgrounds and questions were more specific to cultural practices that are not common across all communities.

The Songa community was the first community in which qualitative and quantitative data was collected. This means that the research team was still in the process of being trained and therefore less experienced than when working with the other two communities. In addition, the drought ended during the last days of the quantitative data collection period with the Songa community (after all qualitative data were collected from all three communities). The ending of the drought could have effect data collection from the other two communities meaning that activity levels were different with human-animal interactions, and stress levels were decreased for both surveys and interviews.

For the qualitative analysis, the greatest limitation was the lack of verbatim translations from local languages and Kiswahili into English. The translation company was initially paid for verbatim transcribes of all FGDs, TWs, and KIIs. However, when the interviewing team later inspected

them, it was discovered that the transcripts were not verbatim and lacked nuance and details that were expected. Unfortunately, due to lack of communication from the translation company and time constraints with this thesis, this analysis was completed with obtaining retranslations of the interviews. This left an incomplete view of the feelings behind many of the statements made during the interviews. Further analysis would require retranslation of interviews verbatim.

Further, limitations to the qualitative analysis could be participant hesitation about discussing specific topics. This could be due to cultural norms on what topics are taboo, positionality of the interviewers and interview/participant power dynamics, as well as discussion of potentially sensitive or illegal topics. The youth FGDs had coed participation, gender dynamics could have been at play even at those in the younger age group. Participants might not have felt fully comfortable expressing all their views due to these factors. Smaller groups and separated gender discussions might be a help in this regard for future studies.

Ethics:

All participants under the age of 18 years required additional consent from their parents or guardians to participate in this study. There was no conflict between funding and communities involved in this study. No further conflict of interests was identified by the research team.

CONCLUSION:

In conclusion, the quantitative portion of this study was testing the methodology needed to continue to study human-animal contact in pastoralist communities of Marsabit County. In a pilot study, it is important first to establish the correct methods that is accurate and does not cause undue burden to participants. Using both ICC analysis and separate agreement calculations, we can see that that was a moderate to high level of agreement between the DD and RC surveys across all 22 participants indicating that pastoralists have a high level of recall for the activities that they have completed and to a slightly lesser extent the species with which they interact. As a pilot study, this is a solid foundation for further research to build upon. We can estimate that participants have a high degree of recall when it comes to their interactions with their livestock. A REDCap survey would be able to be used in the future of this project to accurately report pastoralist contact with their livestock. The research team would be able to control when these surveys take place and make sure that the survey period does not overlap with times of cultural importance where increased contact with livestock would occur such as slaughtering or de-hiding.

An additional REDCap survey to compare times of high activities and cultural importance to the average time-period would add a level of cultural significance and detail to the future of this study and lend a greater understanding to the human-animal-environment bond in pastoralist communities.

The qualitative portion of this study, aided in solidifying that further research is needed in this region for a greater understanding of how human-animal, human-human, and human-environmental interactions are impacting community health. The topics that community members spent the most time on showed where community concerns could be, what challenges are the greatest per community, and what are the perspective on the future of pastoralist livelihood. FGDs and TWs were conducted in Borana, Gabra, and Rendille communities. The Borana community members expressed the most interest in discussing causes of conflict, while the Rendille community was more interested in discussing pastoralist health, and the Gabra community was more interested in water/pasture access. Both the Borana and Gabra community members spent more time discussing the future of pastoralist community than the Rendille community members. The amount of time spent on each point of discussion illustrated the different points of interest for each community. All community members made direct connections between the health of their

community, their herds, and their lands. They saw these three factors as interdependent on each other.

KIIs were conducted primarily by officials and activists who were not necessarily from Borana, Gabra, or Rendille communities, however, one participant self-identified as Borana, and two others as Gabra community members. Although KII participants did not make direct reference to the interdependency of community health, livestock health, and climate, they did make broad connections between pastoralist community health and land management. While a large number of the participants of the FGDs and TWs did not know about the Community Land Act of 2016, all those who participated in the KIIs knew of the Act and considered it important to the future of pastoralist communities. Many saw the lack of awareness and access to using this Act as a challenge to be overcome by pastoralist communities and local governments in order to secure a bright future for continuation of pastoralism in Marsabit county.

Due to the mixed responses of all participants and the variability of their views, the adult men and women interviews did not show a consensus about the future of pastoralist communities in Marsabit County. However, there was a slight majority in the youth interviews that the pastoralist lifestyle must adapt to remain resilient in the future. There is clear agreement that the future health of pastoralist communities is closely tied to their livestock, their land, and their regions' climate.

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