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HUMAN AND ANIMAL FAECES MANAGEMENT IN SELECTED KEBELLES OF KILTE AWLAELO HEALTH AND DEMOGRAPHIC SURVEY SITE (HDSS): KNOWLEDGE, ATTITUDE AND PRACTICE OF HOUSEHOLDS

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Mekelle, Ethiopia

DECLARATIONS

This is to certify that this thesis entitled "***Determinants of Human and Animal Faeces Management in Selected Kebeles of Kilte-Awlaelo Health and Demographic Survey Site (HDSS) of Tigray Region, Ethiopia***" submitted in partial fulfillment of the requirements for the award of the degree of Master in Zoonoses and Food Safety, by Dr. Syum Guesh, is an authentic work carried out by me under my supervisors. The matter embodied in this thesis has not been submitted earlier for an award of any degree or diploma or publication.

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LIST OF ABBREVIATIONS AND ACRONYMS

ETB	Ethiopian Birr
HDSS	Health and Demographic Site Survey
KAP	Knowledge, Attitude, and Practice
ILRI	International Livestock Research Institute
LMICs	Low- and Middle-Income Countries
MDGs	Millenium Development Goals
OHWASH	One health water sanitation and hygiene
SDGs	Sustainable Development Goals
THRI	Tigray Health Research Institute
UK	United Kingdom
UNICEF	United Nations International Children's Emergency Fund
WASH	Water, Animals, Sanitation and Hygiene
WaSH	Water, Sanitation and Hygiene
WHO	World Health Organization

ABSTRACT

A community-based cross-sectional study was conducted in Kilte-Awlaelo Health and Demographic Survey Site from randomly selected 351 households. The study aimed to investigate the knowledge, attitude, and practices of residents regarding faeces management. A structured questionnaire was prepared, translated from English into Tigrigna, and pretested. Animal manure is mainly collected by adult women (74.7%, 260) and female children (58.9%, 207). Usually, animal faeces are collected by Spade (89.7%, 315) and bare hand picking (40.5%, 142). The 321 (91.5%) respondents indicated that the cattle faeces are stored either as store in a heap (42.5%, 149) or underground in a deep hole/compost (49.3%, 173) or in a biogas digester pit (2%, 7). Collected faeces is used as fertilizer (304, 86.6%) or dung cake making (291, 82.9%). Open defecation was exercised by 75.21% (264) whereas 12.54% (44) had pit latrines without slabs. Mothers of the household disposed of their child stools in garbage 107 (71.33%). Feco-oral practice with animal faeces in children was reported by 94 households. Respondents wash their hands after toilet (350, 99.72%), after changing the baby's sanitary materials (341, 97.15%), before handling food/eating (350, 99.72%), after handling animal manure (344, 98.01%), after touching animals (342, 97.44%), and after handling raw food 348 (99.15%). Of the respondents, 342 (99.44%) and 309 (88.03%) agreed both human and animal faeces contain germs that could make people sick respectively. Drying animal faeces to dry before touching them (303, 86.32%), and making compost (309, 88.03) can reduce the spread of germs to people. The sources of water for the household's overall consumption were standpipe (90.03%, 316), and piped water into dwelling/yard/plot 24 (6.84%). About 197 (56.13%) used streams/rivers as sources of drinking. In conclusion, these findings emphasize the importance of public education on livestock waste management, and improved WaSH interventions; and call up on the importance of considering the management of animal excreta in the ongoing global WaSH program of 2030.

Keywords: *Faeces, Mothers, Animals, KAP, WaSH, Kilte-Awlaelo HDSS*

CHAPTER I: INTRODUCTION AND STATEMENT OF THE PROBLEM

1.1. Background

Faeces are a major source of virulent and antimicrobial-resistant pathogens to the environment and life on earth (Hassell *et al*., 2019). Zoonotic *Escherichia coli, Salmonella spp., Campylobacter spp.,* and *Cryptosporidium sp*p. are common and important public health challenges transmitted feco-orally (Islam *et al*., 2007). The ways in which animal and human faeces are managed are important determinants of pathogen transmission from animals to the environment and humans (Hutchison *et al*., 2005).

Faeces management is a crucial aspect of public health and environmental sustainability. Both human and animal faeces contain harmful pathogens that can cause diseases and pollute the environment if not properly managed. Improper disposal of faeces can lead to the contamination of water sources, soil, and air, which can have serious consequences for human and animal health. Effective faeces management involves the safe collection, treatment, and disposal of fecal matter to prevent the spread of diseases and protect the environment (Hutchison *et al.*, 2005).

The use of improved sanitation facilities can help to prevent diseases that are transmitted through faeces. On the other hand, globally, in 2010, 2.5 billion people were still living without improved sanitation and 15% of the population still practiced open defecation. In sub-Saharan Africa, in 2010, 45% of the population used either shared or unimproved facilities, and 25% practiced open defecation. Unless the speed of movement of change in the sanitation sector is accelerated, the Sustainable Development Goal (SDGs) sanitation target may not be achieved until 2026 (WHO, 2017).

Efforts to end open defecation and provide universal access to safe drinking water, sanitation, and hygiene (WaSH) by 2030 are being enacted through the Sustainable Development Goals (Prendergast *et al*., 2019). However, current achievements particularly in developing countries, such as Ethiopia are low.

Poor management of animal faeces and poor understanding of zoonotic pathogens from manure are very common problems in Ethiopia. The Government is giving due attention only to biosolids (human faeces) and sewage, however, is arguably neglecting the important public health risks from animal faeces. Hence, policymakers remain largely unaware of the extent of the problem due to improper management of animal waste. This project took a One Health approach and determined the challenges of not properly managing both human and animal faeces and recommended potential solutions that could contribute to the success of the SDGs agenda in good health and wellbeing (SDG 3), clean water, and sanitation (SDG 6).

This study, on integrated surveillance of human and animal faeces management practices and its determinants in urban and rural households in the Kilte-Awlaelo Health and Demographic Survey site (HDSS) of Ethiopia, is a One Health project that can contribute to a sustainable solution to sanitation, that is, to include an animal in the WaSH into Water, Animals, Sanitation, and Hygiene (WASH). The final aim is to inform WASH-type interventions to reduce human exposure to zoonotic pathogen threats associated with human and animal faeces.

1.2. Statement of the problem

In general, most people of the world particularly those living in the developing countries are suffering from infectious diseases. People of the developing countries are facing many problems and challenges including a lack of quality water and facilities that are used for their sanitation and hygiene purposes which expose them to huge highly pathogenic diseases. Not only this, but also their level of awareness, practice habits, the knowledge they have, and also their attitude towards the threat of diseases (Getachew, 2019).

Most of the households in urban community have high coverage of latrines but the habit of use of latrines with a clean facility is very low (Samuel *et al.*, 2021). Farmers most of the time consider the faeces of child and animals to be less threat to their health.

Due to this perception, those who are eating and drinking after improper handling of animal or child faeces without proper washing of their hands are infected by many pathogenic microorganisms that could be potentially prevented through proper washing, sanitation, and hygiene (Tesfaye *et al*., 2018).

Management of faeces produced by humans and animals is a problem in many Low- and Middle-Income Countries (LMICs), with 80 % of fecal load coming from livestock globally. Direct or indirect contact with animals or fecally contaminated environments can cause human and animal infections (Howie, 2003, Silvestro *et al*., 2004). In Ethiopia, 60% of the disease burden is due to poor sanitation and diarrhea among fewer than five children account for 15% of the total deaths (FDRE, MOH, 2005).

1.3. Rationale of the study

To combat health threats due to fecal-borne pathogens, the WHO introduced a Water, Sanitation, and Hygiene (WaSH) program. The Ethiopian government introduced a health extension program and community-led total sanitation and hygiene programs. However, low success has been observed, associated with under-recognition of exposure to animals and their faeces in WASH and challenges for implementation of proper waste management. Handling of child faeces and animal faeces is considered like they cannot transmit fecal-borne pathogens. To prevent fecal-to-oral disease transmission mothers especially those who handle animal and baby faeces have to develop sanitation, wash after handling of animal products, and hygiene practices (Tesfaye *et al.*, 2018).

Interventions around Water, Sanitation, and Hygiene (WaSH) are key for infectious disease control. Efforts to end open defecation and provide universal access to safe drinking water, sanitation, and hygiene by 2030 are represented in the Sustainable Development Goals. However, results indicate that the impact of conventional rural WaSH approaches in LMICs on child diarrhea and child growth is low (Prendergast et al., 2019). This could be due to extensive exposure to animals and their faeces, currently an under-recognized threat to human health (Prendergast *et al*., 2019).

Even if the Ethiopian government's interventional programs, (introduction of health extension programs and community-led total sanitation and hygiene programs) have brought some change in latrine utilization (WHO, 2019b) the burden of infectious disease is still prevalent in the country. In Kilte-Awlaelo HDSS sites of Tigray Regional State in the Northern Ethiopia, so far, there are no studies on the management practices around human and animal faeces, the challenges this may bring, and the impact on public health.

1.4. Objectives

General objective

- To determine on human and animal faeces management practices in urban and rural *Kebele*s of Kilte-Awlaelo HDSS in the way to inform One Health-WASH type interventions to reduce human exposure to the zoonotic bacterial threat associated with human and animal faeces.

Specific objective

- Identify the knowledge, attitude and practices of residents regarding how human and animal faeces are managed in the HDSS sites, and
- Identify the socioeconomic determinants of residents associated with the management of human and animal faeces.

1.5. Significance and Outcome of the Study

Breaking of the bridge from feco-oral way of transmitting zoonotic diseases are one important to give emphasis to all concerned bodies. Households are also responsible to protecting themselves from those highly pathogenic organisms by developing knowledge, attitudes, and related skills that how washing, sanitation, and hygiene are the first steps to preventing the greatest threat. The outcomes of this study could provide a practical recommendation for the inclusion of animals in the existing global Water, Sanitation, and Hygiene (WaSH) program into Water, Animals, Sanitation and Hygiene (WASH).

CHAPTER II: LITERATURE REVIEW

2.1. Latrine Utilization and Coverage

Globally, two billion people still do not have basic sanitation facilities such as private toilets or improved latrines. Three billion people still lacked basic hand washing facilities at home: 1.6 billion had limited facilities lacking soap or water, and 1.4 billion had no facilities (WHO, 2019b). A study found that students in South Africa's Vhembe District know about safe hygiene practices but don't always apply them due to poor school sanitation. Field visits showed a lack of understanding and proper conduct. Issues with sanitation and hygiene facilities included insufficient access to clean water, proper sanitation services, soap, and women's amenities. The authors recommend educating students, providing clean water and facilities, and encouraging proper hygiene (Sibiya and Gumbo, 2013).

Mothers under the age of 20 years old, households without point-of-use water treatment methods, inadequate sanitation, unsafe disposal of child faeces, improper management of solid waste, improper management of liquid waste, and hand washing practices with fewer occasions (one to two critical times) are risk factors significantly associated with infant death from diarrhea. Infant deaths from diarrhea are more likely to occur in households with inappropriate handling of liquid waste and infrequent hand washing. To lower the baby mortality rate from diarrhea in Ethiopia, interventions should be taken to consider these risk factors, especially during the infantile period (Mebrahtom *et al.*, 2022).

Currently, 97% of Brazilian schools have restrooms, 95% of them have water that is fit for human consumption, 78% have better sanitary facilities, and 70% collect solid waste. Within WASH domains, schools are more in need of changes in the sanitation infrastructure and solid waste management. As for the comparison of WASH in schools and the peri-COVID-19 pandemic, 170,422 schools were analyzed. Mixed changes in the variables, with both improvements and deterioration, were observed in schools in all regions of the country (Poague *et al*., 2023).

For drinking water, 31.4% of rural households used tube wells or boreholes, while 56.8% of those used public taps. In metropolitan areas, 25.6% of people used bottled water, and 54.4% used water from tanker trucks. Regarding sanitation, 25.2% of households lacked a toilet and 72.7% used the flush/pour technique. Water, sanitation, and hygiene practices are associated with a population's socioeconomic status and place of residence. (Muniyapillai *et al*., 2022).

2.2. Human and Animal Faeces Management

Many groups around the world encounter structural and environmental obstacles when attempting to get adequate water, sanitation, and hygiene (WaSH) services. Animal waste that is not properly managed can have negative effects on the environment and on public health. Animal inclusive Water Sanitation and Hygiene (A-WaSH) techniques must be used to reduce human exposure to animal waste in order to improve public health in families who raise livestock, but they have received little attention up to this point (Sentamu *et al*., 2023).

Many populations face structural and environmental barriers to accessing safe water, sanitation, and hygiene services, including 20 million pastoralists in Ethiopia. A Pastoralist Community WASH Risk Assessment was conducted to identify WASH interventions that can mostly alleviate public health risks, within the population's structural and environmental living constraints (Whitley *et al*., 2019).

Locals from rural Tigray in northern Ethiopia usually displayed poor behavior, a negative attitude, and a lack of understanding of WaSH. It is essential to reenergize the health extension activities in basic healthcare facilities in order to improve knowledge, attitude, and practice about WASH (Berhe *et al*., 2020).

As poor handling of human and animal waste can result in the spread of diseases and environmental damage, faeces management is a crucial component of public health. Designing efficient interventions and policies requires an understanding of the elements that affect people's awareness of and attitudes toward excrement control (Malomo *et al*., 2018). The determinant factors of human and animal faeces management, with a focus on assessing knowledge and attitudes, are crucial for understanding the complexities of sanitation practices and improving public health. Locals from rural Tigray in northern Ethiopia usually displayed poor behavior, a negative attitude, and a lack of understanding of WASH. It is essential to reenergize the health extension activities in basic healthcare facilities in order to improve knowledge, attitude, and practice about WASH *(Manisha et al*., 2023)

Water treatment is not common in the study region. A formal education, collecting water more than three times a day, and collecting water by dipping were all signs of household water treatment methods. Therefore, household water treatment should be encouraged, especially among those without formal education, and more research should be conducted on the behavioral factors driving household water treatment *(*Aydamo *et al*., 2023)

Homeless individuals struggle to access WASH services, which makes it challenging to maintain basic hygiene. Due to limited access to facilities, they often resort to using buckets for defecation and practicing open defecation. Clean drinking water is scarce, and they must rely on bottled water or public taps for this purpose. Additionally, due to the lack of access to water and soap, hand hygiene is a major challenge for unhoused individuals (Avelar Portillo *et al*., 2023).

Communication about the risks of developing diseases due to lack of clean water and good hygiene helps to raise awareness of the consequences of poor hygiene practices on health. This participatory approach allows people to analyze their own health conditions and find solutions together. Access to safe water and basic sanitation at home should not be a privilege but a priority. These are basic health services and it is the responsibility of all countries to ensure that everyone has access to them (Oduoye *et al.,* 2023).

The study identified a correlation between water, sanitation, and hygiene (WASH) practices and childhood diarrhea. It was found that households with stagnant or sewage near their houses and those with poor waste management practices were more likely to have a higher prevalence of diarrhea. The results highlight the importance of proper waste management and regular use of footwear in preventing childhood diarrhea (Giri *et al*., 2022).

2.3. Knowledge of Disease Transmission

According to the World Health Organization (WHO), the main preventive measures against infectious diseases like diarrheal disease are ensuring access to safe drinking water, improving sanitation facilities, and promoting good hygienic practices (WHO, 2019a). Unimproved drinking water sources, limited drinking water service, open defecation practice, unimproved sanitation service, limited sanitation service, no hygiene service, and limited hygiene service were significantly associated with diarrheal disease (Girmay *et al*., 2023).

Enhancing WaSH (water, sanitation, and hygiene) is vital in bridging the health gap between urban and rural regions. While China's National Essential Public Health Program launched in 2009 is a positive move towards fundamental healthcare, adopting a multi-faceted approach that gives priority to socioeconomic factors such as environmental sanitation may prove imperative (Lin and Feng, 2023).

Though expensive, improved water was accessible. There were not many household methods for making water safer to drink. The primary types of restrooms in informal settlements are pit latrines that are often overcrowded. Residents are required to pay for the cleaning and emptying of cesspits, leading to contamination of drainage canals due to waste disposal problems. Garbage collection services were inadequate and unsustainable, exacerbating flooding and causing waste to enter homes (Dickson-Gomez *et al*., 2023).

More children need access to safe and clean water, as only a small percentage use available surface water. It is unacceptable that nearly 60% of children are living in homes without access to toilets.

Only one in ten families have basic and private toilets, which is a grave concern. This issue must be addressed urgently to ensure that every child has access to safe and hygienic sanitation facilities. Almost half of all children come from households that lack personal hygiene facilities (Gaffan *et al.*, 2023). According to (Gupta *et al*., 2023) findings highlight the need for interventions to improve water, sanitation, and hygiene (WaSH) conditions in urban slums to ensure access to clean water, improved sanitation facilities, and better living conditions for slum dwellers.

The study conducted in Dhaka, Bangladesh found that food plates and cutting knives in low-income households had the highest average *E. coli* contamination, while drinking vessel surfaces and latrine doorknobs had the lowest contamination. To estimate the true pathogen exposure, there is a need to measure an individual's pathogen exposure as close to the mouth. The proposals are to introduce the "personal domain" as the point of consumption to assess WaSH interventions, which can help observe and quantify different pathogen exposure routes. Insights into potential transmission routes, such as the risk of contamination from serving freshly cooked rice on newly washed food plates or drinking pre-treated/boiled water from newly washed glasses (Jensen *et al*., 2023).

According to (Kim *et al*., 2023) basic WaSH techniques like hygiene and water treatment can effectively protect against *typhoid fever*. These estimates differ significantly from previous values. Implementing on-farm biosecurity and WaSH programs in agricultural settings that utilize animals can effectively reduce infections and antibiotic resistance (Jimenez *et al*., 2023). Childhood diarrhea in Senegal is caused by a lack of access to clean water, sanitation, and hygiene facilities. However, there has been a positive improvement of 18.1% in water services and 19.1% in sanitation services (Daffe *et al*., 2022).

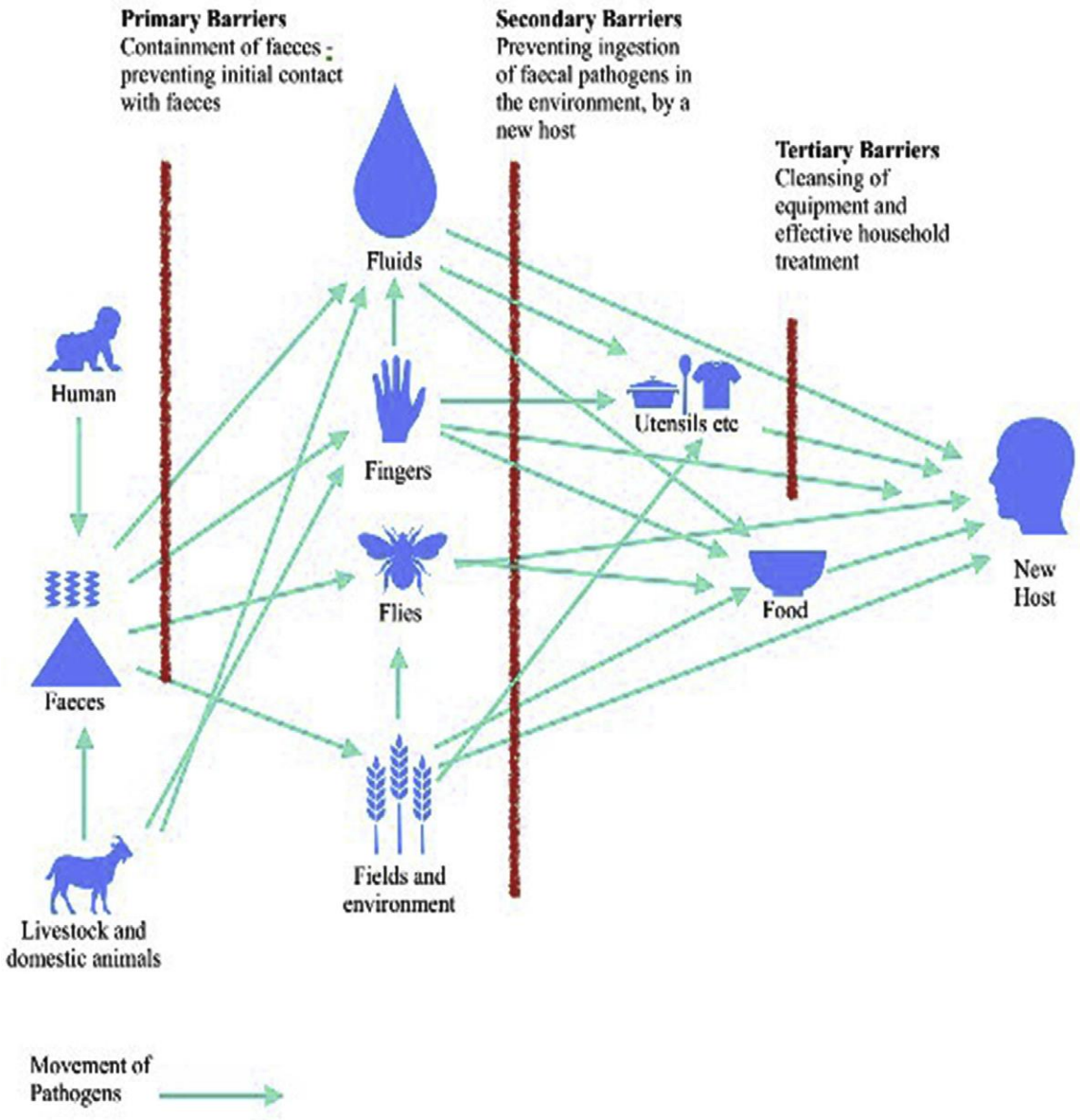

Figure 1: F-diagram demonstrating possible transmission routes for fecal pathogens.

Adopted from (Whitley *et al.*, 2019)

CHAPTER III: MATERIALS AND METHODS

3.1. Study Area

The district of Kilte-Awlaelo is found in the eastern zone of Tigray, north Ethiopia which consists of 18 kebeles. Geographically the district is located between 39° 30′ to 39° 45′ E and 13° 45′ to 14° 00′ N which is 825 km far away from the capital city of Ethiopia, Addis Ababa. The territories of the districts, on the north, are surrounded by Hawzien and Sease Tsadamba, Atsbi Womberta in the east, south with Mekelle (Enderta), and in the west by Douga Tambien (Teklay, 2015). The study was conducted in the Kilte-Awlaelo Health and Demographic Survey Site (HDSS) of Mekelle University. From the 8 rural kebeles and 1 urban kebele of the HDSS, considering the security threat of the region during the data collection phases of the project (bloody war in the region; November 2020-2022), a purposive selection of Agazi (urban kebele) and Adi-Kisanded and Negash (rural kebeles) was made.

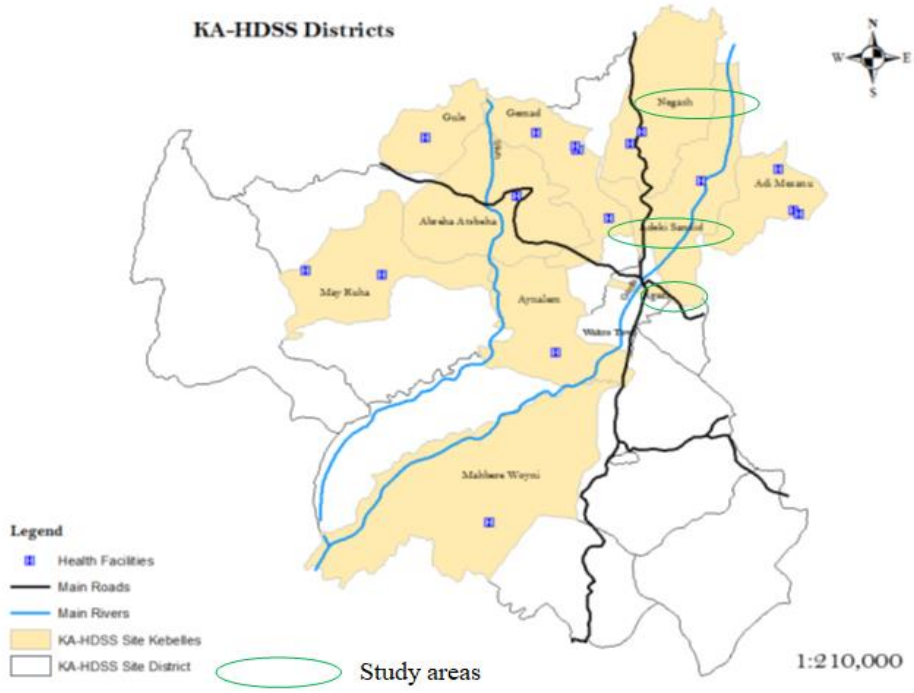

Figure 2: Map of the study area

Adopted from **(**Abera *et al*., 2020**)**

3.2. Study Population

The study populations were randomly selected mothers or adult females owning livestock living in households found in the selected kebeles of the HDSS.

Inclusion Criteria:

- Mother or adult female living in the household; AND
- Household owns livestock (cattle)

Exclusion criteria:

- Having large scale farm (livestock number >60)

Thus, the mothers' age must be greater or equal to eighteen. They must own livestock less than 60 (NB: the households are eligible if they have up to 20 animals of each species, e.g., 18 sheep, 18 goats, and 2 cows are eligible but if any of the ruminant species is above 20, they are not eligible). A household must own cattle to be considered as a study subject but not must have sheep and goats.

3.3. Study Design and Sampling Technique

3.3.1. Study Design

A community-based cross-sectional study was utilized among the three purposively selected kebeles and randomly selected households in the study area. The samples were collected proportionally based on the number of mothers or adult women living in the study area who own livestock.

3.3.2. Sampling Technique

The study was conducted only in three *Kebeles* namely Negash, Adi-Kisanded, and Agazi respectively with human population of 6776; 6544; and 12822. The sample size was determined based on the following assumptions: unknown knowledge and attitude (50%, desired precision (5%), and 95%confidence level (Thrusfield, 2007). Accordingly, the estimated sample size for the Questionnaire survey was 385 households (https://epitools.ausvet.com.au/prevalencess). In each kebele, the sample size was

allocated proportionally to the number of households per Kebele. In each selected kebele the households were also selected randomly.

Accordingly, the proportionate calculated number of the respondents from each Kebele was 109, 239, and 36 respectively.

3.4. Data Collection

A structured questionnaire (Annex 1) that targets on management of waste (faeces of animal or human) and factors affecting it (physical environment, socio-economic, knowledge, and attitude) was prepared, pretested, and translated from English into Tigrigna. Moreover, a "Consent for Participation" (Annex 2) and "Participant Information Sheet" (Annex 3) were prepared. Ethical approvals were obtained as described below. The questionnaire was translated into the Kobo Collect survey data system by a skilled person from ILRI Nairobi. The MSc candidate had been trained in ILRI Addis Ababa, about the Kobo Collect tool uploaded on a Tablet and the interview scenario. After explaining the project objectives, a willing mother or adult female from a randomly selected household was included in the study. Self-reporting practices were complemented with an observation of animal and human living places as well as disposal sites for animal faeces and latrines.

3.5. Data analysis

Data was translated into an Excel sheet. Descriptive statistical analysis was done to describe the study population and identify determinants of proper management of both human and animal faeces. STATA was used to analyze the result.

3.6. Ethical consideration

The project activities have no impact on animal welfare, environment, and safety of participants. Ethical clearance for conducting this research was obtained from Tigray Health Research Institute (THRI/4032/0909/12), ILRI Nairobi (LRI-IREC2020-16) and University of Liverpool, UK (7838) (Annex 4). The information of all participants was kept confidential. The participant names were not mentioned in any documents of this

study. Information from the participants was kept strictly confidential. Their participation was voluntary and they were not obliged to answer any question they did not wish to answer. They were allowed to drop out of the study any time they wanted.

CHAPTER IV: RESULTS

4.1. Demography and Socioeconomic Characteristics of the Population

A total of 351 respondents participated in this study. The age category of the respondents was 18-40, 41-65, and 66-82 years respectively in 40.4% (142), 50.7% (178), and 8.8% (31) of the households. Of the respondents, 47.8% (168/351) cannot read, 48.2% (169/351) attended various levels of pre-university level of education, and only 4% (14/351) attended college-level education. The households, that had at least 1 child with an age of less than 5 years, were 42.7% (150) whereas 12% (42) of the households had a family member with an age of at least 61 years.

The main sources of income of the households were crop farming (74.1%, 260), Crop-livestock mixed farming (13.1%, 46), and livestock farming (6.3%, 22). The most common types of fuel sources for domestic cooking were firewood, charcoal, and dry dung cake. Only 2.6% (9/351) were used biogas (Table 1). Of the respondents, 150 (42.73%) had babies under five years of age and 146 (41.59%) of were older than 61 and above. Where both those under five years and above sixty years who will be highly susceptible to environmental diseases (Table 1).

Table 1. Socioeconomic characteristics of respondents

Variable	Category	Frequency	%
Age category	0-5 years	150	42.73
	6-18 years	286	81.48
	19-60 years	340	96.86
	Above 60 years	146	41.59
Highest level of education of respondent (n=351)	Basic (adult) education	13	3.7
	Cannot read and write (illiterate)	168	47.9
	College and above	14	4.0
	Primary	101	28.8
	Secondary	55	15.7
Household's main income(n=351)	Crop farming	260	74.07
	Crop-livestock mixed farming	46	13.10
	Government employment	3	0.90
	Livestock farming	22	6.27
	Non-farming self-employment	9	2.56
	Non-governmental employment	9	2.56
	Pension	1	0.28
	House rent	1	0.28
Type of fuel used for domestic cooking (n=351, multiple option)	Electricity	28	8.0
	Gas cylinder	0	0.0
	Kerosine	3	0.9
	Dung cake	322	91.7
	Biogas	9	2.6
	Firewood/straw	342	97.4
	Charcoal	323	92.0

4.2. Animal Farming Characteristics

Animals rearing characteristics of the households include donkeys (73.8%, 259), working oxen (73.5%, 258), chicken (70.9%, 249), sheep (54.7%, 192), and goats (30.8%, 108). Most of the respondents indicated that animals stay outside the residential compound during day time but inside the residential compound during the night time. Most households clean the compound daily (Table 2).

Table 2. Animal rearing characteristics of selected kebeles in Kilte-Awlaelo HDSS

Variable	Category	Frequency	Percentage
Which type of livestock owned the household	Dairy cattle	287	81.77
	Donkeys	259	73.79
	Working oxen	258	73.5
	Chicken	249	70.94
	Sheep	192	54.7
	Goat	108	30.77
	Beef cattle	9	2.56
Where do keep the cattle During the day time (n=333)?	Outside residential compound	280	84.08
	Inside residential compound	48	14.41
	Inside and outside residential compound	5	1.5
Where do keep the cattle during the night time (n=333)?	Inside residential compound	328	98.5
	Outside residential compound	5	1.5
How frequently are the livestock sleeping areas cleaned?	Daily	263	74.93
	2-3 times a week	36	10.26
	Two times per day	20	5.7
	Once a week	16	4.56
	Three times per day	12	3.42
	Four times per day	4	1.14

Variable	Category	Frequency	Percentage
What is the source of drinking water for the livestock?	Stream/river	197	56.13
	Tap water	82	23.36
	Pond	76	21.65
	Borehole	15	4.27
	Harvested rainwater	5	1.42

4.3. Animal Faeces Management Practice

Animal manure is collected by adult women (74.7%, 260) and female children (58.9%, 207). More over adult males (47.8%, 168) and male children (60.1%, 211) may do the cleaning job of the compound. Manure is collected by spade (89.7%, 315) and hand (40.5%, 142). The 321(91.5%) respondents indicated that the cattle faeces are stored either as store in a heap (42.5%, 149) or underground in a deep hole/compost (49.3%, 173) or in a biogas digester pit (2%, 7) or fill into another container (1). While animal faeces is stored, 311 (88.6%) of the respondents indicated that they don't add any chemical, while 10 (2.8%) respondents claimed that they add either of Effective Microorganisms, Diazinone, top organic fertilizer, Ash, or Antiweed. The majority of the respondents (304, 86.6%) indicated that they use cattle manure as a fertilizer. Before it is spread onto agricultural fields, it has to be stored for months. The 291 (82.9%) respondents have a practice of dung cake making. As reported by 273 (77.8%) of the respondents, dung was made on a daily basis but up to 5 days reported. Runoffs are managed directly to enter the toilet, flow through canal tubes outside the compound, or mixed with dry faeces.

Of the respondents, 222 (63.2%) reported that they collect faeces of small ruminants as well. It is collected by spade (217, 61.8%). Most indicated that small ruminant faeces collection is made once per day (164, 46.7%), 3 times a week (37), once a week (15), and more than once a day (6). 222 (63.2%) respondents have claimed that they store small

ruminant faeces. The storage methods were underground in a deep hole/compost (133, 38%), stored in heap (87), and in a biogas digester pit (3). Of the respondents 61.3% (215) indicated that they use small ruminants' faeces as a fertilizer.

4.4. Water, Sanitation, and Hygiene (WaSH) Practice

The sources of water for the household's overall consumption were standpipe (90.03%, 316) and piped water into the dwelling/yard/plot 24 (6.84%). About 197 (56.13%) used streams/rivers as sources of drinking. Open defecation was exercised by 75.21% (264) and whereas 12.54% (44) had pit latrines without slabs. After defecation, 87.18% (306) reported that they washed their hands but 3 (0.85%) did not want to say anything. Hand washing with soap was reported only by 62 of the respondents. Mother of the household disposed of their child's stools in the garbage 107 (71.33%). Faeco-oral practice with animal faeces was reported by 94 respondents.

Table 3. WaSH practices in selected kebeles of Kilte-Awlaelo HDSS

Variable	Category	Frequency	%
What is the main source of drinking water in this household (n=351)?	Piped water into dwelling/yard/plot	24	6.84
	Protected spring	1	0.28
	Public tap/standpipe	316	90.03
	Tanker-truck	4	1.14
	Unprotected spring	6	1.71
What is the main source of water used by your household for other purposes (n=351)	Piped water into dwelling or yard or plot	27	7.69
	Protected spring	1	0.28
	Public tap/standpipe	313	89.17
	Tanker-truck	4	1.14
	Unprotected spring	6	1.71
What kind of toilet facility do members of your household usually use (n=351)?	Flush/pour to piped sewer system*	1	0.28
	Flush/pour to septic tank*	18	5.13
	No facilities or bush or field^	264	75.21
	Temporary toilet	1	0.28
	Pit latrine with slab*	10	2.85
	Pit latrine without slab/open pit^	44	12.54
	Ventilated improved pit latrine (VIP)*	13	3.7
	No	72	82.76

Variable	Category	Frequency	%
Do you share this toilet facility with other households (n=87)?	Yes	15	17.24
Have you ever noticed this toilet facility leaking in to the environment (n=87)?	No	86	98.85
	Yes	1	1.15
Do you usually wash your hands after using the toilet facility/field (n=351)?	No	42	11.97
	Prefer not to say	3	0.85
	Yes	306	87.18
Do you use soap/ash when you wash your hands (n=306)?	No	44	14.38
	Yes	262	85.62
The last time [the youngest child] passed stools, what was done to dispose (n=150)	Buried	12	8
	Child used toilet/latrine	2	1.33
	Left in the open	4	2.67
	Defecate outside	1	0.67
	Temporary toilet for kids only	1	0.67
	Put/rinsed into drain or ditch	1	0.67
	Put/rinsed into toilet or latrine	22	14.67
	Thrown into garbage	107	71.33
Where do you usually put your baby when you are doing chores (n=150)?	Clean area for playing (e.g. play pen)	66	44
	Not applicable (no baby)	3	2
	On the ground	80	53.33
	The father will serve as navy temporarily	1	0.67
Have you ever seen your baby put manure/chicken faeces in their mouth (n=147)?	No	53	36.05
	Yes	94	63.95

4.5. WaSH Knowledge and Attitude

All the participants of this study revealed that hand washing could prevent them from getting sick. Respondents indicated that they wash their hands after toilet 350 (99.72%), after changing baby's diaper 341 (97.15%), before handling food/eating 350 (99.72%), after handling animal manure 344 (98.01%), after touching animals 342 (97.44%), after handling raw food 348 (99.15%). Of the respondents, 342 (99.44%) and 309 (88.03%) agree both human and animal faeces contain germs that could make people sick respectively. Households indicated that letting the animal faeces to dry before touching it

(303, 86.32%), and making compost (309, 88.03) can reduce the spread of germs to people, respectively.

The attitude and perception of all the participants disagreed when the baby was eating soil is good 336 (95.73%) and the other 10 (2.85%) agreed eating soil is good especially since babies are getting an opportunity to adapt to the environment. Of the respondents, 321 (91.45%) likely got sick when they were handling animal manure. Almost all of the respondents agreed that wearing protective clothing likely prevent disease transmission from animal faeces to human. Respondents agreed that it was very important to wash hands after handling animal manure 350 (99.72%), and hand washing was not difficult after handling animal manure 350 (99.72%) and totally animal faeces management was not difficult 333 (94.87%).

Table 4: Knowledge and awareness about WaSH

Variable	Category	Frequency	Percent
Washing my hands can prevent me from getting sick (n=351)	Agree	351	100
	Disagree	0	0
	I am not sure	0	0
I wash my hand after going to toilet (n=351)	No	1	0.28
	Yes	350	99.72
After changing baby's nappy (n=351)	No	10	2.85
	Yes	341	97.15
I wash my hands before handling food/eating(n=351)	No	1	0.28
	Yes	350	99.72
I wash my hand after handling animal manure (n=351)	No	7	1.99
	Yes	344	98.01
I was my hand after touching animals (n=351)	No	9	2.56
	Yes	342	97.44
I wash my hand after handling raw food (n=351)	No	3	0.85
	Yes	348	99.15
Human faeces contain germs that can make people sick (n=351)	Agree	342	97.44
	Disagree	1	0.28
	Don't know	8	2.28
Animal manure contain germs that can make people sick	Agree	309	88.03
	Disagree	24	6.84
	Don't know	18	5.13
Letting manure dry before touching it can reduce the chance of me getting sick (n=351)	Agree	303	86.32
	Disagree	29	8.26
	Don't know	19	5.41

Variable	Category	Frequency	Percent
Making compost can reduce germs in manure from spreading to people (n=351)	Agree	309	88.03
	Disagree	8	2.28
	Don't know	34	9.69
It is good for babies to eat soil (n=351)	Agree	10	2.85
	Disagree	336	95.73
	Not sure	5	1.42
How likely do you think you are to get sick after handling animal manure? (n=351)	Likely	321	91.45
	Not likely	23	6.55
	Not sure	7	1.99
How important is it to wear protective clothing when handling animal manure? (n=351)	Important	350	99.72
	Not sure	1	0.28
How difficult is it to wear protective clothing when handling animal manure? (n=351)	Difficult	24	6.84
	Not difficult	326	92.88
	Not sure	1	0.28
How important is it to wash hands after handling animal manure? (n=351)	Important	350	99.72
	Not sure	1	0.28
How difficult is it to wash hands after handling animal manure? (n=351)	Not difficult	350	99.72
	Not sure	1	0.28
How difficult is it for you to manage animal faeces? (n=351)	Difficult	18	5.13
	Not difficult	333	94.87

CHAPTER V: DISCUSSIONS

A community-based cross-sectional study conducted in Kilte-Awlaelo HDSS aimed to determine the knowledge, attitude, and practices of residents in faeces management. Among the 351 respondents, 47.9% were unable to read and write (illiterate). Improving access to education and promoting literacy can have numerous benefits, including better understanding and adoption of proper faeces management practices, and empower individuals to make informed decisions regarding sanitation and hygiene, ultimately contributing to improved public health outcomes (Sangalang *et al.*, 2022, Sibiya and Gumbo, 2013, Sullivan *et al.*, 2023).

The fact that most participants owned livestock and kept them within residential compounds at night suggests that there may be specific practices in place to ensure the safety and well-being of the animals. The presence of livestock in residential areas has implications for public health and hygiene, as it can lead to the spread of diseases and contamination of the environment (Ercumen *et al*., 2017). The finding that most households clean their compounds daily suggests a strong emphasis on hygiene and cleanliness. This could have positive implications for the overall health and well-being of both humans and animals, and also consider the interconnection between the health of people, animals, and our shared environments, as it helps to minimize the risk of disease transmission and maintain a clean-living environment (Prendergast *et al*., 2019).

In the study area, animal faeces are daily collected either to be stored underground for compost-making or a heap for dung making but few use it in a biogas digester pit. Compost making offers benefits such as decomposition and nutrient recycling, which can be advantageous for agricultural purposes. Additionally, burying the faeces helps control odor and reduces the risk of contamination. Storing in a heap allows for natural decomposition and can be a suitable option for those who do not have access to underground storage facilities or composting systems (Hutchison *et al*., 2005). On the other hand, the low use of biogas digester pits can be attributed to the fact that this method requires more specialized knowledge, infrastructure, and investment.

Biogas production from cattle faeces can be an effective way to generate renewable energy, but it may not be widely adopted due to the associated costs and technical requirements (Tesfaye *et al*., 2018).

The result that the majority of households (90.03%) relied on standpipe as their source of water for overall consumption is significant. A similar study on rural residents in the Tigray region, Northern Ethiopia showed that 89.9% used hand pumps as a source of drinking water (Berhe *et al*., 2020). A small percentage of households (6.84%) had piped water directly into their house yard. Having piped water can offer several advantages, including easy access to clean water for drinking, cooking, and other household activities. On the other hand, the fact that a significant percentage of respondents (56.13%) relied on stream or river water as their source of drinking water is a concern. Drinking water from streams or rivers can pose various health risks, including exposure to contaminants such as bacteria, parasites, and pollutants. Implementing water treatment methods, such as filtration or disinfection, can help improve the quality of water from these sources and reduce the risk of waterborne diseases (Anderson *et al*., 2022, Asgedom *et al*., 2023).

Most of the households (75.21%) in the study area practiced open defecation; only 12.54% had pit latrines without a slab. This low latrine use in rural areas of the region was reported by (Ajemu *et al*., 2020). Hence, there were signs of defecation on the latrine or odor and visible faeces on the ground which was in agreement to (Tesfaye *et al*., 2018). Pit latrines without a slab may still pose health risks as they can allow flies and other vectors to come into contact with faeces and potentially spread diseases (Whitley *et al*., 2019).

The finding that a significant percentage of mothers (71.33%) disposed of their child's stools in the garbage was positive. A similar study conducted by (Sentamu *et al*., 2023) made an intervention involving the development or use of a play yard to segregate children from animal faeces. Proper disposal of child stools is crucial to prevent the spread of diseases, especially in households with young children who are more susceptible to infections. The use of appropriate methods, such as burying or using a sanitary pit, can further improve sanitation practices.

Contact with animal faeces can introduce pathogens into the human body, leading to various diseases (Ercumen *et al*., 2017, Penakalapati *et al*., 2017). A considerable number of respondents (94) in this study reported children's experience in feco-oral practices with animal faeces. This calls upon to educate individuals about the risks associated with such practices and promote proper hygiene measures, including hand washing, to prevent disease transmission.

The study finding indicated that there was a high level of awareness and understanding of the role of hand hygiene in preventing disease transmission. However, it is worth noting that while all participants recognized the importance of hand washing, this does not necessarily mean that they always practice good hand hygiene. Factors such as access to clean water and soap, cultural practices, and individual habits can all influence hand hygiene behavior. Majority of respondents agreed that both human and animal faeces contain germs that could make people sick. Households indicated they wash their hands after using the toilet (99.72%), changing a baby's local sanitary cloths (97.15%), after handling animal manure (99.72%) and before handling food or eating (99.72%). The study conducted in rural residents of Tigray, Northern Ethiopia (Berhe et al., 2020) agrees with the current study.

On the other hand, only few of them (62) had access to use soap. It is worth noting that a small percentage of participants (0.85%) did not provide any information about their hand washing practices. This may indicate a lack of awareness or inconsistent adherence to hand hygiene practices among some individuals. On the other hand, personal experience of the researchers and physical observation to the households indicated that the hand hygiene was low. This reduced WaSH had been exacerbated by the bloody war resulted in high prevalence of diarrheal diseases (25.5%) among children (Asgedom *et al*., 2023)

When findings in this study are compared; the hand hygiene compliance rates of 87.18% *(Berhe et al., 2020)* and 85.62% (Samuel *et al.*, 2021) and hand washing with soap compliance rate of respectively 37% and 38.2% suggest that the WaSH intervention implemented in their study sites was more effective in promoting hand hygiene compliance. In Sub-Saharan Africa, *Campylobacter, non-typhoidal Salmonella (NTS),*

Lassa virus, Cryptosporidium, and *Toxoplasma gondii* (all transmitted by animal hosts, except Lassa virus, which is spread through the faeces of rats) are the major pathogens that cause close to one million deaths annually (Delahoy *et al*., 2018). Hand hygiene or hand wash is one of the basic components of any infection control program (Widmer, 2000).

A significant percentage of respondents (86.32%) indicated that letting animal faeces dry before touching it can reduce the spread of germs to people is noteworthy. Allowing faeces to dry can help inactivate certain pathogens, making them less likely to cause illness. This practice can be particularly relevant in agricultural settings where there may be regular contact with animal faeces. Similarly, the finding that a majority of respondents (88.03%) indicated that making compost from animal faeces can reduce the spread of germs to people. Proper composting processes, such as maintaining the right temperature and moisture levels, can help break down pathogens and reduce their viability. This practice can be beneficial in recycling nutrients from animal waste while minimizing the risk of disease transmission. Composting and drying of manure decrease the number of viable pathogens (Pell, 1997). However, it is important to note that while these practices can help reduce the spread of germs, they may not eliminate all pathogens entirely. It is crucial to combine these practices with proper hand hygiene, such as washing hands thoroughly with soap and water, to further minimize the risk of disease transmission.

The Global Goals of the United Nations' 2030 Agenda for Sustainable Development sets out a One-Health approach to poverty, inequalities, health and the environment, in contrast with the siloed structure of the previous Millennium Development Goals (MDGs), whose agenda ended in 2015. This study provided evidence on the importance of including animals in the existing WaSH program.

The inclusion of animals in global Water, Sanitation, and Hygiene (WaSH) programs has been recommended by Matilla *et al*. (2018) and Prendergast *et al*. (2019). However, it is unfortunate that there is limited research available on the impact of domestic and wild animal feces on the effectiveness of WaSH interventions. Additionally, collaboration between the WaSH, public health, and animal health sectors in low- and middle-income countries (LMICs) is insufficient.

Reducing animal burden of disease has a direct effect on human prevalence of disease and vice versa, and therefore WASH programs applied equally to human and animal populations are likely to provide better results than a human-centered approach. Without adding safe management of animal faeces to current programs focused solely on human waste, rural WaSH programs will insufficiently reduce fecal exposure from all sources to the extent needed to improve child health. To emphasis this, a paradigm shifts in WaSH terminology, by upgrading the currently diminutive and redundant “a” to “A”-Water, Animals, Sanitation, and Hygiene highlighting that reducing exposure to animals and their faeces needs to be central to WASH approaches (Prendergast *et al*., 2019)

CHAPTER VI: CONCLUSION AND RECOMMENDATIONS

This study provided evidence that the existing WaSH program has a number of limitations such as the prevailed open defecation, households' poverty and KAP gaps to comply with WaSH standards, and the regrettable omission of animals and their environment. Attention to animal burden together with human burden of disease would allow for better understanding and optimization of WaSH programme effectiveness on both disease control and broader development objectives. By implementing appropriate measures and interventions, such as improved sanitation facilities, proper waste disposal systems, and hygiene education, the risk of transmission of zoonotic diseases can be significantly reduced. This not only protects human health but also contributes to the overall well-being of the community and the environment. Therefore, it is imperative to prioritize and invest in comprehensive animal faeces management programs that consider the One Health approach, taking into account the interconnectedness of human, animal, and environmental health. Based on this conclusion, the following recommendations are forwarded:

- To consolidate global evidences**,** comprehensive survey is needed to assess the knowledge, attitudes, and practices of residents on management of human and animal faeces and understand determinants of WaSH.
- Work with local authorities and community leaders on public education about the importance of proper faeces management and WaSH program and the risks associated with improper practices. This can be done through community meetings, workshops, and other outreach activities.
- Develop and implement policies and regulations that promote proper faeces management practices and enforce individuals and organizations accountability.
- Collaborate with relevant stakeholders, including healthcare providers, veterinarians, and environmental health experts, to develop and implement a One Health-WASH approach that considers the interconnectedness of human, animal, and environmental health.

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ANNEXES

Annex 1: Questionnaire

OHWASH KAP Questionnaire

OHWASH (One health water sanitation and hygiene): Integrated surveillance of human and animal faeces management and its determinants in HDSS sites of 3 kebeles of Kilte Awlaelo district, Tigray region.

PART-1: General Information

Number	Question	Answer
1.	Household ID (HDSS code)	☐☐☐☐
2.	Participant ID (HDSS code or name)	☐☐☐☐☐
3.	Questionnaire number/ID	☐☐☐☐
4.	Date of interview (dd/mm/yyyy)	☐☐/☐☐/☐☐☐☐
5.	Name of Kebele	*(text)*
6.	Kebele Code (HDSS code)	☐☐☐☐
7.	Gote	*(text)*
8.	Interviewer's ID	☐☐
9.	Supervisor's ID	☐☐
10.	Status of this Interview	1. ☐ Completed 2. ☐ Incomplete 3. ☐ Refused
11.	Household GPS coordinates	Latitude (N/S) _____ Longitude (E/W) _____

PART-2: Demographic and socioeconomic profile of households

Number	Question	Answer
12.	Gender of Household Head	1. ☐ Male 2. ☐ Female
13.	Age of household head	_____ years
14.	What is the education level of the **household head**? *Select one response*	1. ☐ Illiterate (cannot read and write) 2. ☐ Basic (adult) education 3. ☐ Primary 4. ☐ Secondary 5. ☐ College and above
15.	If **household head** has college/ diploma and above education level, what is his/her field of study?	1. ☐ Human health sciences 2. ☐ Animal health science 3. ☐ Social and economic fields 4. ☐ Technological fields 5. ☐ Biological sciences (excl. health) 6. ☐ Crop production 7. ☐ Other (specify):_____
16.	Age of Respondent	_____ years
17.	What is your education level? *Select one response*	1. ☐ Illiterate (cannot read and write) 2. ☐ Basic (adult) education 3. ☐ Primary 4. ☐ Secondary 5. ☐ College and above
18.	If **respondent** has college/diploma and above education level, what is his/her field of study?	1. ☐ Human health sciences 2. ☐ Animal health science 3. ☐ Social and economic fields 4. ☐ Technological fields 5. ☐ Biological sciences (excl. health) 6. ☐ Crop production 7. ☐ Other (specify): _____

<table>
<tr><td>19.</td><td>Household size (number of people living in the same house and sharing meal)?</td><td>_____ people</td></tr>
<tr><td>20.</td><td>What is the number of people per age category and gender in this household?</td><td><table><tr><td>Age (years)</td><td>Male</td><td>Female</td></tr><tr><td><6</td><td></td><td></td></tr><tr><td>7-15</td><td></td><td></td></tr><tr><td>15-50</td><td></td><td></td></tr><tr><td>50-65</td><td></td><td></td></tr></table></td></tr>
<tr><td>21.</td><td>What are the sources of income for this household?
Tick all that apply</td><td>1. ☐ Livestock farming
2. ☐ Crop farming
3. ☐ Crop-livestock mixed farming
4. ☐ Non-farming self-employment
5. ☐ Government employment
6. ☐ Non-governmental employment
7. ☐ Other (specify):_____</td></tr>
<tr><td>22.</td><td>What is the household's main income source?
Select one response</td><td>1. ☐ Livestock farming
2. ☐ Crop farming
3. ☐ Crop-livestock mixed farming
4. ☐ Non-farming self-employment
5. ☐ Government employment
6. ☐ Non-governmental employment
7. ☐ Other (specify):_____</td></tr>
<tr><td>23.</td><td>Does this household have land/garden where fecal materials applied?</td><td>1. ☐ Yes
2. ☐ No</td></tr>
</table>

24.	If yes, where is the land located?	1. ☐ Adjacent to my house 2. ☐ Another site
25.	What is the material(s) of the **floor** of the house for family dwelling? (just for observation, not to be asked) Tick all that apply	1. ☐ Earth/sand 2. ☐ Polished wood 3. ☐ Dung 4. ☐ Laminated plastic (synthetic) 5. ☐ Ceramic tiles 6. ☐ Cement 7. ☐ Other (specify) _____
26.	What is the material(s) of the **wall** of the house for family dwelling? (just for observation, not to be asked) *Tick all that apply*	1. ☐ Wooden core with mud & dung polished 2. ☐ Wooden core with mud & cement polished 3. ☐ Cement or cement brick 4. ☐ Mud or mud brick 5. ☐ Wooden core with mud cover 6. ☐ Other (specify) _____
27.	What type of fuel does your household use for domestic cooking? *Tick all that apply*	1. ☐ Electricity 2. ☐ Gas cylinder 3. ☐ Kerosene 4. ☐ Dung cake 5. ☐ Biogas 6. ☐ Firewood/straw 7. ☐ Charcoal 8. ☐ Other (specify)_____

PART-3: WASH

28.	What is the source of water for human use? *Tick all that apply* * *Improved* ^ *Unimproved*	Source	Drinking	Cooking	Cleaning	Washing
		Piped water*	☐	☐	☐	☐
		Boreholes or tube wells*	☐	☐	☐	☐
		Protected dug well*	☐	☐	☐	☐
		Protected spring*	☐	☐	☐	☐
		Rainwater*	☐	☐	☐	☐
		Packaged or delivered water*	☐	☐	☐	☐
		Unprotected dug well or spring^	☐	☐	☐	☐
		Surface water (e.g., lake, river/stream, pond, canal, irrigation ditch) ^	☐	☐	☐	☐
29.	Do you use different water sources in the rainy and dry	1. ☐ Yes 2. ☐ No				
30.	If yes, explain:	_____ _____				
31.	Is there latrine (toilet) in the	1. ☐ Yes 2. ☐ No				

32.	If no, what does this household	1. ☐ Latrine at neighbors' place 2. ☐ Bush or field
33.	If Yes, what type of latrine is it? *Select one response* *1-4 = improved* *5-7 = unimproved*	1. ☐ Flush/pour to piped sewer system, septic tank or pit latrine 2. ☐ Ventilated improved pit latrine 3. ☐ Composting toilet 4. ☐ Pit latrine with slab 5. ☐ Pit latrine without slab or platform (unimproved) 6. ☐ Hanging latrine 7. ☐ Bucket latrine 8. ☐ Other (specify) _____
34.	Do other people use the latrine other than	1. ☐ Yes 2. ☐ No
35.	How many people use the latrine?	_____ people
36.	Do children use the latrine?	1. ☐ Yes 2. ☐ No
37.	If no, where do they defecate?	1. ☐ Anywhere in the compound 2. ☐ Use mobile toilet 3. ☐ Other (specify) _____

38.	At what age do children start to use	_____ ☐ years/ ☐ months
39.	Is the latrine and bathroom combined? *(just for observation, not to be asked)*	1. ☐ Yes 2. ☐ No
40.	What is the construction of the **latrine's lab**? *(Just for observation, not to be asked)*	1. ☐ Open hole –mud floor 2. ☐ Open-hole-wooden floor 3. ☐ Open-hole concrete floor 4. ☐ Plastic slab-mud floor 5. ☐ Plastic slab-wooden floor 6. ☐ Plastic slab-concrete floor
41.	What is the **latrine superstructure wall** constructed from? *(Just*	1. ☐ Concrete blocks 2. ☐ Brick; Wooden 3. ☐ Mud; Grass 4. ☐ Plastic sheeting

42.	What is the construction of the **latrine substructure** ? *(Just for observation, not to be asked)*	1. ☐ Unlined pit 2. ☐ Concrete ring 3. ☐ Brick lined 4. ☐ Other (specify)_____
43.	What is the **latrine roof** constructed from? *(Just for observation, not to be asked)*	1. ☐ Corrugated iron sheets 2. ☐ Tiles 3. ☐ Grass thatch 4. ☐ Wooden 5. ☐ Plastic sheeting 6. ☐ No roof
44.	What do the household members use to clean after using the toilet? *Tick all that apply*	1. ☐ Water 2. ☐ Toilet paper 3. ☐ Used waste paper 4. ☐ Leaves 5. ☐ Nothing 6. ☐ Other (specify)_____
45.	Do people **usually** wash their hands after defecation?	1. ☐ Yes 2. ☐ No

46.	If yes, do people use soap?	1. ☐ Yes 2. ☐ No
47.	Did you use your own money to pay for construction of your latrine?	1. ☐ Yes 2. ☐ No
48.	If no, who paid for construction of your latrine?	1. ☐ NGO project 2. ☐ Government project 3. ☐ Community project 4. ☐ Other (specify)_____
49.	Does the latrine ever leak in to the environment?	1. ☐ Yes 2. ☐ No
50.	How do you dispose of domestic waste? *Tick all that apply*	1. ☐ Inside/beside house compound 2. ☐ Give to collectors with payment 3. ☐ Dispose on roadside 4. ☐ Dispose to municipal collection site 5. ☐ Other (specify) _____
51.	Is there flooding through your residential compound?	1. ☐ Yes 2. ☐ No

PART-4: Animal husbandry

Number	Question	Answer
52.	Does this household currently own any livestock?	1. ☐ Yes 2. ☐ No (note that this household is ineligible)
53.	If 'Yes' which type of livestock does this household own **currently**? *Tick all that apply*	1. ☐ Dairy cattle 2. ☐ Beef cattle 3. ☐ Goats 4. ☐ Sheep 5. ☐ Chicken 6. ☐ Donkeys
54.	Which type of feeding method do you follow? *Tick all that apply*	1. ☐ Zero grazing 2. ☐ Semi-intensive 3. ☐ Extensive 4. ☐ Other (specify)_____
55.	If zero grazing, what type of feed resources do you use to feed your livestock? *Tick all that apply*	1. ☐ Concentrated Animal Feed from factory 2. ☐ Locally available Animal feed 3. ☐ Other (specify)_____

			Cattle	Sheep/ goats	Chickens	Donkeys
56.	Where do you keep the livestock during the **day**?	Open paddock **with** access to residential compound	☐	☐	☐	☐
		Open paddock **without** access to residential compound	☐	☐	☐	☐
		Fenced area without roof	☐	☐	☐	☐
		Separate house adjacent to family home	☐	☐	☐	☐
		Separate room in	☐	☐	☐	☐
57.	Where do you keep the livestock during the **night**?		Cattle	Sheep/ goats	Chickens	Donkeys
		Open paddock **with** access to residential compound	☐	☐	☐	☐
		Open paddock **without** access to residential compound	☐	☐	☐	☐
		Fenced area without roof	☐	☐	☐	☐
		Separate house adjacent to family home	☐	☐	☐	☐
		Separate room in family house	☐	☐	☐	☐
		Share room with family members	☐	☐	☐	☐
		Other (specify)				

58.	Sanitary condition of the livestock living areas *(to be observed & only rated by interviewer)*		Poor	Medium	Good
		Odour	☐	☐	☐
		Waste drainage	☐	☐	☐
		Cleanness of floor	☐	☐	☐
59.	How frequently are the livestock living areas cleaned? *Select the best*	1. ☐ Two times per day 2. ☐ Daily 3. ☐ Once a week 4. ☐ 2-3 times a week			
60.	What is the source of water for the livestock? *Tick all that apply*	1. ☐ Stream/river 2. ☐ Borehole 3. ☐ Tap water 4. ☐ Harvested rainwater 5. ☐ Pond			
61.	What are the common livestock diseases you encounter in your farm?	_____ _____ _____			
62.	Who treats your livestock when they are sick? *Tick all that apply*	1. ☐ Self 2. ☐ Veterinarian 3. ☐ Animal Health Assistants 4. ☐ Other (explain) _____			
63.	Are there any records kept in regards to your animal's health?	1. ☐ Yes 2. ☐ No			

PART-5: Manure/faeces management & handling practices

Number	Question	Answer
64.	Who is/are the family member(s) responsible for managing animal faeces? *Tick all that apply*	1. ☐ Adult woman 2. ☐ Adult male 3. ☐ Female children 4. ☐ Male children 5. ☐ Servant
65.	How do you use animal faeces/animal waste in this household? *Tick all that apply*	1. ☐ Use as fertilizer 2. ☐ Use as fuel by making dry cake 3. ☐ Give away/sell 4. ☐ Don't use (discard/dispose)
66.	Do you store faeces/animal waste before use?	1. ☐ Yes 2. ☐ No
66.	If yes, how do you store animal waste/manure in this household? *Tick all that apply*	1. ☐ Heap within animal house 2. ☐ Heap outside animal house 3. ☐ Store underground in deep
67.	How far from living house do you store/dispose animal faeces?	1. ☐ Very close (<5m from homestead) 2. ☐ Nearby (5-10m from homestead 3. ☐ Far (>10m from homestead
68.	How do you collect/remove animal manure/faeces? *Tick all that apply*	1. ☐ Collection by hand picking 2. ☐ Collection by spade 3. ☐ Water splashing 4. ☐ Other (specify)_____

69.	If water splashing, how do you manage runoff from the animal house/barn? *Tick all that apply*	1. ☐ Direct release to lagoon 2. ☐ Direct release to the surrounding environment 3. ☐ Spread on soil to enhance the growth of vegetable & fruit 4. ☐ Other (specify) _____
70.	If collected, how often do you collect animal faeces/ waste? *Select the best answer*	1. ☐ More than once a day 2. ☐ Once a day 3. ☐ 2-3 times a week 4. ☐ Once a week 5. ☐ Other (specify)_____
71.	How do you carry animal waste from animal house? *Tick all that apply*	1. ☐ Wheel barrel/bucket 2. ☐ Plastic bags 3. ☐ Bare hands 4. ☐ Spade 5. ☐ Other (specify)_____
72.	If you use manure/animal waste as fertilizer, how do you treat animal faeces after collection? *Tick all that apply*	1. ☐ Spread to crop field directly/immediately without storage 2. ☐ Store in a heap and spread to the field later 3. ☐ Compost and spread to field later 4. ☐ Other (specify)_____

73.	If store in heap/composted, how long before manure is spread on crops? *Tick all that apply*	_____ ☐ days/ ☐ weeks
74.	Have you ever taken any training related to compost making?	1. ☐ Yes 2. ☐ No
75.	If yes, are you making compost currently?	1. ☐ Yes 2. ☐ No
76.	Do you have a biogas digester pit?	1. ☐ Yes 2. ☐ No
77.	What do you wear during manure/animal waste handling? *Tick all that apply*	1. ☐ Ordinary clothing 2. ☐ Gown for working 3. ☐ Special animal waste handling clothing 4. ☐ Other (specify) _____
78.	What do you use on your feet during manure/animal waste handling? *Tick all that apply*	1. ☐ Gum boots (rubber boots) 2. ☐ Closed shoes/boots 3. ☐ Open shoes/sandals 4. ☐ Nothing 5. ☐ Other (specify) _____
79.	Do you wash yourself after animal manure/waste handling? *Select the best answer*	1. ☐ Yes 2. ☐ No

80.	How do you wash yourself after animal manure/waste handling? *Select the best answer*	1. ☐ Wash hands with detergent 2. ☐ Wash hands without detergent 3. ☐ Wash the whole body with detergent 4. ☐ Wash the whole body without detergent 5. ☐ Other (specify) _____
81.	Do you have any problems managing livestock waste including manure?	1. ☐ Yes 2. ☐ No
82.	If yes, what are the problems? *List*	_____ _____
83.	Are human and animal faeces managed/handled in the same manner in this household?	1. ☐ Yes 2. ☐ No
84.	If no, how do you handle human faeces? *Explain*	_____ _____
85.	Why is human and animal faeces managed/handled differently? *Explain*	_____ _____

86.	Was there any complaint from neighbor on managing human or animal waste?	1. ☐ Yes 2. ☐ No
87.	If yes, describe the complaints *Explain*	_____ _____
88.	Was there any complaint from municipality?	1. ☐ Yes 2. ☐ No
89.	If yes, describe the complaints? *Explain*	_____ _____
90.	What action did you take to solve the problem?	_____ _____

PART-6: Awareness/knowledge related to WASH and animal faeces management

Number	Question	Answer
91.	Washing my hands can prevent me from getting sick	1. ☐ Agree 2. ☐ Don't know 3. ☐ Disagree

92.	If agree, what are these key moments to wash your hands to prevent being sick?	1. ☐ After going to toilet 2. ☐ After changing baby's nappy 3. ☐ Before handling food/eating 4. ☐ After handling raw food 5. ☐ After touching animals 6. ☐ After handling animal manure 7. ☐ Other (specify) _____
93.	Human faeces contain germs that can make people sick	1. ☐ Agree 2. ☐ Don't know 3. ☐ Disagree
94.	Animal faeces contain germs that can make people sick	1. ☐ Agree 2. ☐ Don't know 3. ☐ Disagree
95.	Spreading fresh manure in the garden can contaminate vegetables with germs	1. ☐ Agree 2. ☐ Don't know 3. ☐ Disagree
96.	Letting manure dry before it is handled can reduce the chance of me getting sick	1. ☐ Agree 2. ☐ Don't know 3. ☐ Disagree

97.	Making compost can reduce germs in faeces from spreading to people	1. ☐ Agree 2. ☐ Don't know 3. ☐ Disagree

Score:

For a score-based indicator of knowledge, each respondent is given a score based on the number of correct responses provided. The knowledge score of the population is calculated for each question by dividing the total number of correct responses by the number of respondents who answered the particular question. Exclude respondents who did not answer the question, or for whom information is incomplete (http://www.fao.org/3/i3545e/i3545e03.pdf).

Score of knowledge per question = Sum of correct responses given by all respondents / Total number of respondents

PART-7: Attitudes towards animal faeces management

Number	Question	Answer
98.	How likely do you think you are to get sick after handling animal faeces?	1. ☐ Not likely 2. ☐ Not sure 3. ☐ Likely
99.	If not likely, explain	
100.	How **important** is it to wear protective clothing when handling animal faeces?	1. ☐ Important 2. ☐ Not sure 3. ☐ Not important

101.	If not important, explain	
102.	How **difficult** is it to wear protective clothing when handling animal faeces?	1. ☐ Difficult 2. ☐ Not sure 3. ☐ Not difficult
103.	If difficult, explain	
104.	How important is it to wash hands after handling animal faeces?	1. ☐ Important 2. ☐ Not sure 3. ☐ Not important
105.	If not important, explain	
106.	How **difficult** is it to wash hands after handling animal faeces?	1. ☐ Difficult 2. ☐ Not sure 3. ☐ Not difficult
107.	If difficult, explain	

108.	How difficult is it for you to manage animal faeces?	1. ☐ Difficult 2. ☐ Not sure 3. ☐ Not difficult
109.	If difficult, explain	_____ _____
110.	(If practice composting) How difficult is it for you to prepare compost?	1. ☐ Difficult 2. ☐ Not sure 3. ☐ Not difficult
111.	If difficult, explain	_____ _____

Score:

For a score-based indicator of attitude, a numerical value or score is assigned to each choice in the range of responses. The attitude score of the population is calculated for each question by dividing the total score for all participants who answered the question by the number of respondents who answered the question. Exclude respondents who did not answer the question, or for whom information is incomplete (http://www.fao.org/3/i3545e/i3545e03.pdf).

$$\text{Score of attitude per question} = \frac{\text{Sum of the scores of all respondents}}{\text{Total number of respondents}}$$

Thank you for your time & cooperation!

Annex 2: Participant Consent Form

OHWASH (One health water sanitation and hygiene):

Integrated surveillance of human and animal faeces management and its determinants in HDSS sites of 3 Kebeles of Kilte Awlaelo district, Tigrai.

Version 1.1, 5th of February 2020

Research ethics approval number: ----------

Please put an X in the box

I confirm that I have read and have understood the information sheet version 1.1, dated 5th of February for the above study, or it has been read to me. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

I understand that taking part in the study involves **face-to-face interview**, collection of environmental samples as well as "hand plates" ☐

I understand that my participation is voluntary and that I am free to stop taking part and can withdraw from the study at any time without giving any reason and without my rights being affected. In addition, I understand that I am free to decline to answer any particular question or questions. ☐

I understand that I can ask for access to the information I provide and I can request the destruction of that information if I wish at any time prior to **publication**. I understand that following **publication**I will no longer be able to request access to or withdrawal of the information I provide. ☐

I understand that the information I provide will be held securely and in line with data protection requirements at the HORN, Project team members until it is **fully anonymised** and then deposited in the **Archive** for sharing and use by other authorised researchers to support other research in the future. ☐

I understand that signed consent forms and **questionnaires** will be retained in the HORN, Project team members **and who has access to data** until **the end of the study period**. ☐

I agree to take part in the above study: Yes ☐ / No ☐

Participant Name	Date	Signature or thumbprint
Name of Person taking consent	Date	Signature or thumbprint

Researcher	Work address	telephone	Work email
Birhanu Hadush	College of Veterinary Sciences, Mekelle University	0919366578	birhanu.hadush@mu.edu.et
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Annex 3: Participant Information Sheet

OHWASH (One health water sanitation and hygiene):

Integrated surveillance of human and animal faeces management and its determinants in HDSS sites of 3 kebeles of Kilte Awlaelo, Tigrai.

Version 1.1, 5th of February 2020

Research ethics approval number: ----------

Participant information for interviews and environmental samples collection

Name of researcher(s)	Contact details
Birhanu Hadush	College of Veterinary Sciences, Mekelle University.

	Tel: 0919366578
Chaltu Fikiru	School of Public Health, Jimma University. Tel: 0917764828
Girma Kebede	College of Veterinary Medicine and Agriculture, Addis Ababa University. Tel: 0929038290

Greetings, my name is _____. I am working in a research team for the HORN project: One Health Regional Network for the Horn of Africa. You are invited to participate in a research study about water sanitation and hygiene management in regard to animals and humans. Before you decide whether to participate, it is important for you to understand why the research is done and what it will involve. This leaflet is to give you some basic information about this research. Please feel free to ask for any further details. Please take time to read the following information carefully and feel free to ask us if you would like more information or if there is anything that you do not understand. Please also feel free to discuss this with your friends and relatives. We would like to stress that you do not have to accept this invitation and should only agree to take part if you want to.

Thank you for reading this.

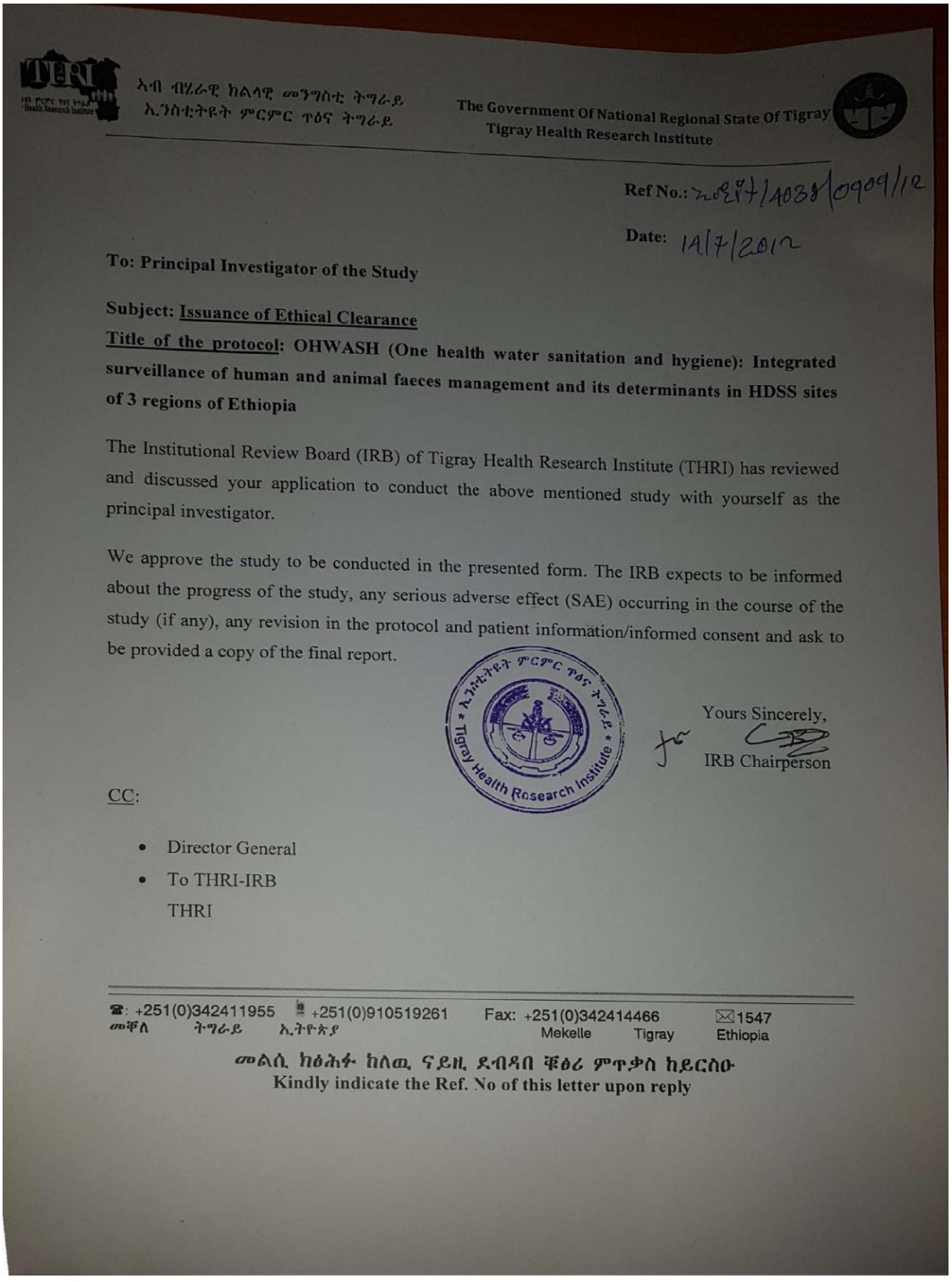
1. What is the study about?	The objective of this study is to explore knowledge, attitude and practices (KAP) related to human and animal WaSH (water sanitation and hygiene) management and in particular faeces management and its effect for human and animal health. We will look for the presence of bacteria in different
2. Why have I been chosen?	You have been randomly selected amongst the households belonging to Kilte Awlaelo Rural Health Program (KRHP), human and demographic surveillance system (HDSS) and owning livestock. We would like to ask you some questions

	and take some samples of the environment to better understand the relationship between WaSH practices and human and animal health
3. Do I have to take part?	We would like to emphasize that your participation is voluntary. If you consent and then later decide that you would like to withdraw, you are free to do this at any point. If you later decide that you do not want that the samples taken from you, or your information, to be used in the study, you can contact the study team and ask that your contribution be withdrawn
4. What will happen if I take part?	1. We will visit you only one time in your household to ask you some questions about your knowledge, attitude and practices towards human and animal WaSH (Water, Sanitation and Hygiene) management. 2. We will then take a "hand plate" sample from the surface of your hand. This procedure is completely safe and painless. You will just have to touch a plate with your fingers. 3. Finally, we will collect a few samples from your household environment: the floor, animal waste and/or water
5. How will the information I give to the study be used?	All information that you give in the interview will be kept strictly confidential. We will not share information about you or the information you give with anyone outside the research team. The answers you give will be anonymised so that no one other than the research team will know who provided the information. Information generated from the study may be shared with local government so they know about disease problems happening in your community. It may be included in scientific publications so that other researchers can learn

	about the findings. You will not be named in any publication arising from this research.
6. How much of my time will the study take?	The interview will take around 1 hour.
7. Are there any risks or costs associated with being in the study?	Aside from giving up your time, we do not expect any risks or costs associated with your participation.
8. Are there any benefits associated with being in the study?	You will <u>not</u> receive any financial compensation for your involvement in this study. There is no direct benefit for you if you decide to take part to the study. However, the information you provide may help inform policies and plans to minimise the impact of livestock diseases on your community.
9. Can I stop if I don't want to do the study anymore?	Yes, you can stop at any point if **you** do not want to take part anymore.
10. Can I tell other people about the study?	Yes, you are welcome to tell other people about the study.
11. What if I would like further information about the study?	When you have read this information, feel free to ask any further question. If you would like to know more at any stage, please feel free to contact either of the research team stated in the first page.
12. What if I have a complaint or any concerns about the study?	If you are unhappy, or if there is a problem, please feel free to let us know by contacting to either of Dr. Birhanu Hadush, If you remain unhappy or have a complaint, which you feel, you cannot come to us with then you should contact one of the

	Research Ethics and Integrity Office from one of the University collaborating to this study: - Kilte-Awlaelo site: Mekelle University; o email: xxxx,telephone: xxxx and we will try to help. When contacting the Research Ethics and Integrity Office, please provide details of the name or description of the study (so that it can be identified), the researcher(s) involved, and the details of the complaint you wish to make. The University strives to maintain the highest standards of rigour in the processing of your data.
 **If you have any questions, please ask!** **Thank you for reading about the study** **This information sheet is for you to keep.**	

Annex 4: Ethical Approvals



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The Government Of National Regional State Of Tigray
Tigray Health Research Institute

Ref No.: ጉጽሕ/1038/0909/12

Date: 14/7/2012

To: Principal Investigator of the Study

Subject: Issuance of Ethical Clearance

Title of the protocol: OHWASH (One health water sanitation and hygiene): Integrated surveillance of human and animal faeces management and its determinants in HDSS sites of 3 regions of Ethiopia

The Institutional Review Board (IRB) of Tigray Health Research Institute (THRI) has reviewed and discussed your application to conduct the above mentioned study with yourself as the principal investigator.

We approve the study to be conducted in the presented form. The IRB expects to be informed about the progress of the study, any serious adverse effect (SAE) occurring in the course of the study (if any), any revision in the protocol and patient information/informed consent and ask to be provided a copy of the final report.

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Tigray Health Research Institute

Yours Sincerely,

IRB Chairperson

CC:

- Director General
- To THRI-IRB
  THRI

☎: +251(0)342411955 +251(0)910519261 Fax: +251(0)342414466 ✉1547
መቐለ ትግራይ ኢትዮጵያ Mekelle Tigray Ethiopia

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Kindly indicate the Ref. No of this letter upon reply

Central University Research Ethics Committees

17 June 2020

Dear Dr Cavalerie,

I am pleased to inform you that the University is willing to accept the ethical review provided by the external ethics committee. Details and conditions of the approval can be found below.

Reference:	7838
Project Title:	OHWASH
Principal Investigator:	Dr Lisa Cavalerie
Co-Investigator(s):	Dr Siobhan Mor, Prof Nicola Williams
Student Investigator(s):	-
Department:	Epidemiology and Population Health
Approval Date:	17/06/2020
Approval Expiry Date:	Five years from the approval date listed above

The application was **APPROVED** subject to the following conditions:

Conditions

Please note: this approval is subject to the restrictions laid out in the Policy on research involving human participants in response to COVID-19. Therefore all face-to-face contact with human participants for the purpose of research should be halted until further notice; unless the study qualifies as one of the exceptions specified in the Policy and has been discussed with Research Ethics and Integrity team.

- All serious adverse events must be reported to the Committee within 24 hours of their occurrence, via the Research Integrity and Ethics Officer (ethics@liv.ac.uk).
- Any amendments or changes to the study must be approved by the external ethics committee and the University of Liverpool ethics committee
- If you wish to extend the duration of the study beyond the research ethics approval expiry date listed above, a new application should be submitted.
- If you wish to make an amendment to the research, please create and submit an amendment form using the research ethics system.
- If the named Principal Investigator or Supervisor leaves the employment of the University during the course of this approval, the approval will lapse. Therefore it will be necessary to create and submit an amendment form using the research ethics system.
- It is the responsibility of the Principal Investigator/Supervisor to inform all the investigators of the terms of the approval.

Kind regards,

Central University Research Ethics Committees

ethics@liverpool.ac.uk

794-8290

ILRI
INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

CGIAR

18th May 2020

Our Ref: ILRI-IREC2020-16

International Livestock Research Institute
P.O. Box 30709 00100
Nairobi, Kenya.

Dear Birhanu Hadush,

Ref: Integrated surveillance of human and animal faeces management and its determinants in HDSS sites of 3 regions of Ethiopia

Thank you for submitting your request for ethical approval to the International Livestock Research Institute (ILRI) Institutional Research Ethics Committee (IREC). ILRI IREC is accredited by the National Commission for Science, Technology and Innovation (NACOSTI) in Kenya, and approved by the Federalwide Assurance (FWA) for the Protection of Human Subjects in the United States of America.

This is to inform you that ILRI IREC has reviewed and granted final approval for your study titled *'Integrated surveillance of human and animal faeces management and its determinants in HDSS sites of 3 regions of Ethiopia'*. The approval period is 18th May 2020 to 17th May 2021 and is subject to the following requirements:

- Only approved documents including (informed consents, study instruments) will be used.
- All changes including amendments, deviations, and violations are submitted for review and approval by ILRI IREC.
- Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to ILRI IREC within 72 hours of notification.
- Any changes anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to ILRI IREC within 72 hours.
- Clearance for export of biological specimens must be obtained from relevant government agencies.