A Participatory Epidemiological Study of Major Cattle Diseases in Urban and Peri-Urban Dairy Settings in Ethiopia

ABSTRACT

A participatory epidemiological study was conducted in six towns in Ethiopia where there is intensive urban and peri-urban dairy production to study farmers' perspectives on the major cattle diseases in terms of their etiology, prevalence, and management. Data collection was conducted through FGDs and key informant interview. Two focus group discussions were conducted in small holder producers with less than 5 cattle and farms with more than five cattle making it a total of 12 FGDs. A total of 156 representatives from the two groups, of which 55 were female, participated in these discussions. Ranking and scoring techniques using 100 beans were conducted. The study revealed that mastitis, hypocalcaemia, Foot and Mouth Disease, Lumpy Skin Disease, Blackleg, and coughing, of which the latter may be related to bTB, were ranked as the most prevalent and economically important diseases in Ethiopian urban and peri-urban dairy farms. The reasons behind this ranking by the participants were found to be the impact of the disease on productivity, its contagiousness and costs of treatment. The costs associated with isolation and cares for disease management are often excessive and can lead to farm bankruptcy. This study indicates that in the absence of a monitoring mechanism for cattle trade and regulation of animal slaughtering remain as primary risk factors for the spread of contagious and zoonotic diseases such as bTB, brucellosis, anthrax, FMD, LSD, etc. Hence, a livestock trade movement and slaughtering control mechanism need to be put in place to control the spread of diseases.

Key words: Participatory epidemiology; Dairy farming; Cattle diseases; bovine TB; focus group; zoonosis

1. INTRODUCTION

Ethiopia has reported the largest livestock population in Africa, including approximately 70 million heads of cattle, of which 97.4% were indigenous zebu breeds and the remaining were hybrid and exotic breeds accounting for about 2.3% and 0.31%, respectively [1]. Current animal production in Ethiopia and many other countries is facing numerous challenges since demographic growth, urbanization, and economic development are all contributing to an increasing demand for milk, meat, eggs, and other animal products[2].The indigenous cattle and the prevailing extensive rural production system in Ethiopia are unlikely to be able to satisfy the rise in demand for animal products from the urban population; therefore intensification of dairy farming near the urban settings is required to satisfy such demand. However, the combination of intensified dairy development in peri-urban and urban systems with exotic and cross-breed cows for increased milk production has resulted in an increased transmission risk of contagious emerging and reemerging zoonotic diseases, as such diseases are often thriving in such settings. In addition, with limited conventional veterinary research and surveillance in Ethiopia, particularly in pastoral and agro-pastoral production systems, the situation to combat for such risk becomes challenging. To improve this, work to understand the epidemiology of zoonotic diseases is important but to be successful in preventing and controlling such infectious diseases, it requires stakeholder participation. In recent years, participatory and One Health approaches for the study of veterinary epidemiology are increasingly being used as methods to gain information about farmers' knowledge and insight into livestock diseases [3].

Understanding the mechanisms for the management of animal diseases and disease burdens among farm households as well as farm workers' households is very crucial for designing zoonotic disease control strategies. For this purpose, participatory epidemiology (PE), a widely used method to improve understanding of diseases and options for animal disease control [4] was used here to study urban and peri-urban dairy systems in Ethiopia. PE is based on the understanding that local people are knowledgeable about their environment, the animals they keep, the infectious and zoonotic nature of diseases that are prevalent in their area, as well as the impacts of these diseases on their livelihoods. This method uses participatory techniques to gather qualitative and semi-quantitative epidemiological data, in this case, from farmers and farm workers as well as knowledge of the local community and key informants. The current study was conducted in the described study sites with the objectives of identifying the major animal health problems, socioeconomic impacts of these diseases, the risk mitigation measures undertaken, as well as farmers'/farm workers understanding and management of animal health risks. Here we present the outputs from the performed Focus Group Discussions (FGDs) on livestock diseases in the urban and peri-urban dairy sector of Ethiopia in terms of the participant's assessments of disease prevalence, case fatality, farmers' understanding of disease symptoms, causality, impacts, as well as mitigation options.

2. RESEARCH METHODS

All field surveys were conducted as a participatory epidemiology study based on FGDs involving at least 10 people per group using a semi-structured interview guide (checklist). Key Informant Interview (KII) was performed independently with key informants before or after each group session. The researchers performing the study were veterinarians and economists. During the FGDs, the researchers used several ranking, scoring, and visualization techniques, such as proportional pilling, pair-wise ranking, timelines, and disease impact scoring based on Jost *et al.,* [5].
Proportional piling was conducted following Mariner, [6] technique. The research participants were given 100 beans and asked to divide them into piles, representing a number of categories, by agreed criteria. For example, in our study the community was listed livestock diseases. Respondents could then be asked to divide the pile into the smaller piles, to represent the relative impact of each disease on their livelihood. Proportional piling techniques was used to study issues such as disease prevalence and incidence, mortality rates, clinical presentation, epidemiological risk factors, disease impact and the efficacy of disease interventions/management.

Two FGDs were held (one for smallholder farmers and another for medium and large holders) at Hawassa, Holeta, Sululta, Bishoftu, Mekele, and Gondar, respectively, making it a total of 12 FGDs. Participants in the FGDs from smallholder urban and peri-urban dairy farms, who had up to five cross-breed cattle in their residence compound and who utilized family labor only (no employees), were represented by the farm owners and/or their family members. For the medium and large farm groups, the FGD participants were hired farm workers and/or their family members who in many cases were living on the farm they worked for. In the 12 FGDs, a total of 120 farms were represented (X smallholder farms and Y medium/large farms) by 156 participants, of which 55 (35%) were female (Table 1). Each FGD held between 10 and 17 participants, composed of both genders and different age categories. The sessions ran for about two hours and the discussions were conducted using mainly the Amharic language but sometimes Afan Oromo and Tigrigna were used with the help of translators. The interviews were guided by a checklist of open-ended questions. The checklist was pre-tested and adjusted before the initiation of the study at one of the study sites, i.e. Hawassa.

Table 1: Number of FGD participants by site and sex

	≤ 5 cattle			>5 cattle			Grand total		
Sites	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
Hawassa	10	6	16	8	2	10	18	8	26
Bishoftu	5	5	10	10	7	17	15	12	27
Holeta	10	4	14	5	6	11	15	10	25
Sululta	10	5	15	13	1	14	23	6	29
Mekele	6	4	10	5	7	12	11	11	22
Gondar	9	5	14	10	3	13	19	8	27
Total	**50**	**29**	**79**	**51**	**26**	**77**	**101**	**55**	**156**

Qualitative and semi-quantitative data were collected using PE techniques described in [4].Data were collected on the incidence and importance of animal diseases, including symptoms of these diseases, causal factors, or local ideas of infection and disease transmission. Case fatality rates, seasonality of diseases, affected groups, and socioeconomic impacts of these diseases as well as gender aspects of the diseases and mitigation options were also discussed. In addition to these listed discussion points, major problems of the dairy sector were discussed and ranked. The data collected was analyzed using qualitative data analysis techniques which involve coding of themes, identification of similarities and contrasts, triangulation using various sources of data, and making generalizations. We also used nonparametric statistical analysis of quantitative and semi-quantitative data collected through various ranking and scoring techniques using IBM SPSS version 20.

3. RESULTS AND DISCUSSION

In this study, 12 focus group discussions on livestock diseases were held in two groups; smallholder dairy producers, and that of farm workers and their families from medium and large farmers. The results from these two groups are presented separately but comparisons are made both between the two groups, as well as across sites, because the perception and knowledge of the respondents among different production system could be different based on their experience. The diseases of animals also differ in different production systems. Below follows summaries of the FGDs on each topic listed on the check list. The findings of this study showed that mastitis, tuberculosis and brucellosis are common in intensively managed dairy cows in large farms. Whereas, tick and tick borne diseases are common in high land areas which are not common in mid and low lands.

3.1. Determining the Relative Incidence and Importance of Dairy Cattle Diseases

The FGD participants were asked to list names of diseases occurring in their dairy farm. A number of disease names were listed down in their local languages. When they gave disease signs and/or symptoms, or when local disease names not known to the researchers, probing was done using open-ended questions to further characterize and identify the disease in its scientific and common name. In addition to this, veterinarians in the local vet clinics were asked to verify the name of the diseases and symptoms mentioned by the participants. Since we used a checklist of open ended questions, farmers were free to reflect up on their priority problems and, as a result, we found in each group a different list of diseases. This way, the data became more complete but it made statistical analysis difficult. The participants of a FGD often came up with 8-12 lists of dairy cattle diseases and symptoms. In order to narrow down the list and identify the most important diseases, the participants were given 100 beans and asked to put beans showing the relative incidence of each disease. Using this method, it was possible to narrow down the list of diseases to six in each FGD session. Then pair-wise ranking was done to rank the most important diseases in each study site. Probing questions were asked to investigate the reasons behind why participants think a chosen disease was more important than another. Tables 2 show the listed diseases and their ranks based on pair-wise ranking results at each site and Tables 3 summarizes the compiled results for all the sites.

Table 2: Farmers' dairy cattle disease ranking by farm size from the six study sites

Farm size	Location	1st	2nd	3rd	4th	5th	6th
Small Farms (≤5 cattle)	**Hawassa**	LSD	Anthrax	Coughing/ bTB	Mastitis	FMD	Milk Fever
	Bishoftu	FMD	LSD	Milk Fever	Coughing/bTB	Mastitis	
	Holeta	Blackleg	Coughing/ bTB	Mastitis	LSD	Fasciolosis	FMD
	Sululta	FMD	Blackleg	Btb	Dermatophilosis	RFM	Milk Fever
	Mekele	Milk Fever	FMD	LSD	Mastitis	bTB	Blackleg
	Gondar	Blackleg	Anthrax	Mastitis	Coughing/bTB	Bascilosis	*Kortim (blackleg)*
Medium and Large farms (> 5 Cattle)	**Hawassa**	Mastitis	Milk Fever	FMD	LSD	Brucellosis	Coughing/ bTB
	Bishoftu	LSD	FMD	Mastitis	Gastro-intestinal	Milk Fever	
	Holeta	Coughing/bTB	Brucellosis	Mastitis	FMD	Milk Fever	Foot rot
	Sululta	Blackleg	FMD	Coughing	Fungal diseases	Mastitis	Milk Fever
	Mekele	Mastitis	bTB	RFM	Repeated breeding	Milk Fever	LSD
	Gondar	Heart water	Mastitis	Milk Fever	RFM	Abnormal birth	Coughing/ bTB

FMD=Foot and Mouth disease, LSD=Lumpy skin Disease, bTB=Tuberculosis, RFM=Retained Fetal Membrane

Major cattle diseases which have economic and public health importance in Ethiopia, as reported by the Ethiopian Ministry of Agriculture based on Pan African Animal Health Year Book [7], were FMD, Contagious Bovine Pleuro Pneumonias (CBPP), LSD, Anthrax, black leg, Brucellosis, Dermatophilosis, Heartwater (Cowdriosis), Pasteurellosis, Rabies, Trypanosomiasis and tuberculosis. In general, this list of diseases is similar to our results described in Table 2. Additionally, production and reproductive diseases and disorders like mastitis, retained fetal membrane, abortion hypocalcemia (milk fever) were identified in our study. Similar study findings were reported from smallholder dairy farms in Jimma Zone [8], where Mastitis, Repeated breeding, retained fetal membrane, abortion, stillbirths, and dystocia were reported as the major reproductive health problems.

In many cases, farmers interchangeably used coughing and bTB; yet at Sululta and Mekele, they have distinctly used the term bTB. The participants indicated that bTB was ranked among the top six diseases in all the cases because it is contagious, lack of treatment and cure, costly to cleanse the farm once infected. Some farmers indicated that once a farm is infected with bTB and decide to clean the farms from the disease, it would be bankrupt as it is very costly to isolate or get rid of the infected animals by slaughtering or sales and to cleanse the farm.

In the FGDs at Hawassa and Gondar, Anthrax was ranked high for the reason that it is zoonotic, contagious to other animals, lack of treatment option, and for its suddenness. Concerning its incidence, the farmers indicated that there are a few cases of Anthrax every four or five years. At Holeta, Fasciolosis was ranked among the top six diseases because of that these farms also keep large number of local zebu cattle and graze their animals in local communal pasture lands which would be the sources of infection. Regarding the other listed diseases, dermatophilosis and bacillosis caused by bacillus anthracis were only reported in the discussions in Sululta and Gondar, respectively, and not even mentioned by the medium and large farms groups from the same localities. The symptoms described for dermatophilosis were very similar to those of LSD but the farmers insisted that the disease they described was not LSD. Another disease locally named kortim was found to be among the first diseases among smallholder farms at Gondar. Its symptoms were found to be generic ones. According to the participant farmers, a cattle affected by Kortim would show signs of loss of appetite, high fever, leg paralysis and lying down. Farmers insisted that the disease they were referring to was not hypocalcaemia and it was identified as blackleg by veterinarians and researchers who participated in this study. During our discussion, contagiousness of a disease, availability and cost of treatment and impact of the disease on productivity were found to be the most important reasons why farmers were ranking a disease more frequently. FMD, Bovine TB, and LSD were diseases ranked high because of these reasons. In some cases, the FGDs reasoned out that although a certain disease may be very fatal and contagious, such as Anthrax, but if its incidence is low it may not be considered as a serious threat and thereby ranked lower. Likewise, the smallholder farmers reasoned that mastitis may be contagious and prevalent but there are viable control and prevention options and hence it could not be ranked at the top. In contrast, the medium and large farms ranked mastitis among the top diseases because of its contagiousness, potential impact on productivity, potential cost if the animal is culled at young age, and cost of treatment and prevention associated with it. In agreement with the results of this study, numerous study results identified dairy cattle diseases like hypocalcemia, mastitis, retained fetal membrane, abortion, calve mortality, FMD, LSD, blackleg, and lameness as highly prevalent and that cause huge economic losses in the dairy industry. About 30–50% of dairy cows are affected by some form of metabolic or infectious disease around the time of calving [9]. In addition, a study report from Jimma town on dairy farms indicated that reproductive diseases and clinical mastitis were the most prevalent and incident dairy health problems in the area [10].

Table 3 shows compilation of the ranking of diseases by farm size. As it is indicated in the table, in the medium and large farms intensive production related disease such as mastitis and milk fever were important disease whereas in the small farms other infectious disease such as FMD and LSD were found to be high ranking. Pair-wise ranking of the identified diseases result showed that farmers' reasons behind their ranking were similar across sites and between the two study groups (smallholders, and medium and large farms). The reasons indicated were contagiousness, prevalence, fatality rate, morbidity, impact on productivity, lack of curability, and cost of treatment as well as possibility of zoonotic impacts.

Table 3: Compiled pair wise dairy cattle disease ranking by farm size in the study sites

Farm size	Diseases	Hawassa	Bishoftu	Holeta	Sululta	Mekele	Gondar	Total	Rank
Small Farms (≤5 cattle)	FMD	3	6	2	6	5	-	22	1
	Coughing/bTB	4	3	5	4	2	3	21	2
	LSD	6	5	4	-	4	-	19	3
	Blackleg	-	-	6	5	1	6	18	4
	Mastitis	3	2	4	-	3	4	16	5
	Milk Fever	1	4	0	1	6	-	12	6
	Anthrax	5	-	-	-	-	5	10	7
	RFM	-	-	-	2	-	-	2	8
Medium and Large farms (> 5 Cattle)	Mastitis	6	4	4	2	6	5	27	1
	Coughing/bTB	1	-	6	4	5	1	17	2
	FMD	4	5	3	5	-	-	17	2
	Milk Fever	5	2	2	1	2	4	16	4
	LSD	3	6	-	-	1	-	10	5
	Brucellosis	2	-	5	-	-	-	7	6
	RFM	-	-	-	-	4	3	7	6
	Blackleg	-	-	-	6	-	-	6	8

Dash (–) implies that the diseases was not mentioned by the participants, hence not ranked.
A disease ranked 1 in Table 2 was given a score of 6; when ranked 2, score 5 was given; rank 3 = score 4; rank 4 = score 3; rank 5 = score 2; and rank 6 = score 1.
FMD=Foot and Mouth disease, LSD=Lumpy skin Disease, bTB=Tuberculosis, RFM=Retained Fetal Membrane

In addition to this, there are also other discrepancies between the two groups; unlike among the smallholders, in the medium and large farms certain reproduction related diseases, such as brucellosis, Retained Fetal Membrane (RFM), , and abnormal calves, were ranked as important ones. The result is similar with the report by [11] inform dairy farms in Dessie and Kombolcha towns, in North Eastern Ethiopia. Reproductive health problems vary between different management systems. In our case management of dairy cows in medium and large farms was more intensive compared with small size farms and the above mentioned diseases and abnormalities are disease of intensification caused by overcrowding and deficiency of minerals. As herd size increase reproductive health problems also increase due to competition for feed, water, and space [12]. We run the nonparametric two related samples Marginal Homogeneity (MH) analysis to compare the ranking of diseases between the smallholder groups and that of the medium and large groups and the results showed that the two groups have the same rating of disease (p=0.881) with mean MH statistic of 26.500 and standard deviation of MH statistic of 3.354. This indicates that irrespective of farm size, the most important cattle diseases in the urban and peri-urban dairy farms are more or less the same. This indicates that Mastitis, hypocalcaemia, blackleg, LSD, FMD and coughing are the six most important diseases of the urban and Per-urban dairy sector in Ethiopia (Table 2 and Table 3).

3.2. Case Fatality, Curability, and Mortality after Treatment

Using the proportional piling technique, the FGD participants were also asked about animal fatality of each disease and the proportion of animals that could recover from an illness. For the smallholder group, the rank of diseases according to case fatality rates was Anthrax, Blackleg, LSD, Hypocalcaemia, and Coughing (Table 4). From this list of diseases, Anthrax scored the highest median score of 38 (n=2) with range between 34 and 44 while Blackleg was scored second with a median score of 30.5 (n=4) and range between 21 and 42.

Table 4: Median case fatality rates of diseases in smallholder farms groups (≤5 cattle)

	Gondar	**Mekele**	**Sululta**	**Holeta**	**Bishoftu**	**Hawassa**	**Median**	**Range**
Blackleg	28	33	21	42	-	-	**30.5**	**21-42**
Anthrax	44	-	-	-	-	34	**38**	**34-44**
Mastitis	0	0	-	0	3	0	**0**	**0-3**
Coughing	18	7	26	18	11	16	**17**	**7-26**
Hypocalcaemia	-	23	13	-	25	-	**23**	**13-25**
FMD	-	20	0	8	41	7	**8**	**0-41**
LSD	-	17	-	32	20	43	**26**	**17-43**
Dermatophilosis	-	-	23	-	-	-	-	-
RFM	-	-	17	-	-	-	-	-
Brucellosis	-	-	-	-	-	-	-	-
Total	100	100	100	100	100	100		

Dash (–) implies that the disease was not mentioned by the participants, hence not ranked.
FMD=Foot and Mouth disease, LSD=Lumpy skin Disease, TB=Tuberculosis, RFM=Retained Fetal Membrane

For the FGDs representing the group of medium and large farms, the ranking of diseases according to case fatality rates was Brucellosis, LSD, Blackleg, hypocalcaemia and Coughing (Table 5). The median score for Brucellosis was 42.5 (n=2) with range between 15 and 70; while that of LSD was 34.5 (n=2) with range of 3 and that of Blackleg was 33 (n=2) with range between 32 and 34. Mastitis and FMD had a low case fatality rate in both farm groups (Table 4 and Table 5).

Naturally anthrax and blackleg are soil-born bacterial infectious diseases common for grazing animals. From the results presented here, the case fatality of these two diseases was higher in smallholder producers, and that could possibly be because grazing was common feed source for smallholder producers. Reversely, brucellosis can be a disease of intensification in large scale production systems, and that can be mirrored in the results from our FGDs, which rated Brucellosis with higher case fatality among medium/large scale producers. Similarly research finding conducted in USA by McConnel et al., [13] indicated that case fatality rate are determined by host related, environmental, pathogen and health management factors. The case fatality rate was significantly higher in intensively managed dairy cows with poor body conditioned animals.

Annual mortality rate of 0.22% in Holstein herds in Western France and 0.19% in dairy herds Northern Ireland was reported by Faye and Pérochon, [14] and Menzies, [15], respectively, which is higher case fatality rate than our result of 0% case fatality rate of mastitis in small scale production system and lower than large scale production with case fatality rate of 0.5%. Seegers et al., [16] also indicated that case fatality of mastitis was very low compared with production losses. Regarding FMD, the case fatality rate was reported to be 3% by Molla et al., [17] from dairy farms in south Omo Zone Ethiopia which is lower than our research finding indicated in the table above as the case fatality rate of 8%.

Table 5: Median case fatality rates of diseases in medium and large farms (>5 cattle)

	Gondar	Mekele	Sululta	Holeta	Bishoftu	Hawassa	Median	Range
Blackleg	-	-	34	-	32	-	**33**	**32-34**
Mastitis	5	0	1	0	2	0	**0.5**	**0-5**
Coughing	21	20	29	0	5	-	**20**	**0-29**
Hypocalcaemia	22	40	18	30	16	43	**26**	**16-43**
FMD	-	-	16	0	45	9	**12.5**	**0-45**
LSD	-	36	-	-	-	33	**34.5**	**33-36**
Dermatophilosis	-	-	2	-	-	-	-	-
RFM	13	4	-	-	-	-	**8.5**	**4-13**
Brucellosis	-	-	-	70	-	15	**42.5**	**15-70**
Heart water	39	-	-	-	-	-	-	-
Total	100	100	100	100	100	100		

Dash (–) implies that the diseases was not mentioned by the participants, hence not scored.
FMD=Foot and Mouth disease, LSD=Lumpy skin Disease, TB=Tuberculosis, RFM=Retained Fetal Membrane

We ran Wilcoxon signed-rank test to investigate any difference between the case fatality rates of the two groups (smallholders' group vs medium and large holders group). The result showed that there was a significant difference in the median scores of the diseases between the two groups; Z=-2.207 and P=0.027, suggesting that the two groups did not have similar understanding of the case fatality rates of the listed diseases. A case fatality rate can be affected by host, pathogen and environmental factors often named as the disease triangle. In our study the difference in case fatality could be because of host and environmental factors. Regarding host factor the exotic blood level of the cows kept in large and medium farms were higher compared to small size farms. As the exotic blood level increased the susceptibility of diseases increase with increased case fatality rate. The reverse is true in small holder farms. The small farms in peri-urban areas also practiced mixed crop livestock production system and keep more non-dairy local cattle for draught purpose and manage the cows semi-intensively. Management system of the dairy cows is one of the determining factors for disease occurrence and mortality rate.

The participants were also asked to determine the proportion of cattle which would survive and get cured if given a treatment by veterinarians. We gave them 20 beans for each disease and asked them to indicate the number of cattle which would get cured if treated with antibiotics. The average proportions for the two groups are shown in Table 6. We ran Wilcoxon signed-rank test to investigate if there was a difference in the proportion of case curability between the smallholders and the medium and large holders groups. However, we found that there was no significant difference in the average curability proportions of the diseases between the two groups, with Z score of -0.944 and P value of 0.345. This indicates that the participants have similar understanding of curability of diseases.

Table 6: Participants perception on proportion of cattle which would get cured if given treatment

Name of the Disease	Average Curability Rate	
	Group S (up to five cattle)	**Group L** (more than five cattle)
Blackleg	66.7% (n=3)	62% (n=2)
Anthrax	0.0% (n=2)	-
Mastitis	100% (n=4)	99% (n=5)
Coughing	87.5% (n=2)	15% (n=4)
LSD	57.5% (n=2)	70%(n=2)
FMD	77.5% (n=4)	75% (n=4)
bTB	46.6% (n=3)	-
Hypocalcaemia	-	75% (n=5)
Brucellosis	-	95% (n=2)
Wilcoxon Signed Ranks Test		
		Greater than five cattle group - Less than or equal to five cattle group
Z		-.944
Asymp. Sig. (2-tailed)		.345

Number in brackets indicates number of focus group discussions
Dash (–) implies that the diseases was not mentioned by the participants, hence not scored.
FMD=Foot and Mouth disease, LSD=Lumpy skin Disease, TB=Tuberculosis, RFM=Retained Fetal Membrane

3.3. Local Perception of Disease Signs and Causes

In order to investigate the local farmers' perception of infection, treatment and cure, the participants were asked about the causes, symptoms and mitigation measures for different diseases. These were done using open-ended questions. The results indicate that regarding symptoms, participants from both groups described the major diseases with correct and similar details; not much discrepancy between the two groups was observed in their description of the disease symptoms of the major diseases. In case of Mastitis and hypocalcaemia, no major difference was observed among the discussion groups, both in terms of their causation and symptoms. All focus groups agreed that Mastitis is communicable and caused by poor animal and personal hygiene, as well as poor hygiene kept in the barn; in addition to this, they indicated that milk left in the udder is also a possible cause of Mastitis, while groups from Gondar and Holeta added that it is also caused by thick infestation of udder and tits. Similarly, all the focus groups agreed that Hypocalcaemia affects only exotic and crossbred cows with high milk yields, including those adult cows with two or more parity that are confined at home and do not graze on green feed. The participants indicated that milking these kind of cows beyond the six month in their pregnancy and lack of supplementary calcium rich feed would often cause hypocalcaemia and associated lameness, recumbence and possible death if not treated in time.

With regard to the cause of Blackleg, Coughing and LSD, there was quite a large discrepancy observed, both between the two groups in general as well as between members of the same focus groups, making consensus within the group sometimes difficult. In the cases of Blackleg, for instance, the smallholder group from Holeta indicated that it is caused by grazing early in the morning, by coldness, and by dust while the corresponding groups from Sululta and Gondar indicated that Blackleg is caused by a long dry season, by exposure to direct sun light, by high temperature, and by virulence polluted air coming from elsewhere. Regarding LSD, many of the participants and the groups seemed to have little idea in terms of its causes; some indicated that it could be caused by exposure to intense sunlight and wind, while those from Mekele indicated that it is transmitted mainly from infected camels as well as other infected cattle.

In the case of coughing (that many participants indicated could be a symptom of TB), there was pretty much agreement among the smallholder groups from Bishoftu, Holeta, Mekele, and Gondar in terms of its

causality; they indicated that it is caused by exposure to cold weather conditions and by feeding of moldy feed. However, participants from Sululta and Hawassa indicated that Cough/TB is caused by transmission from infected cattle, from dead cattle if dogs bring it to home.

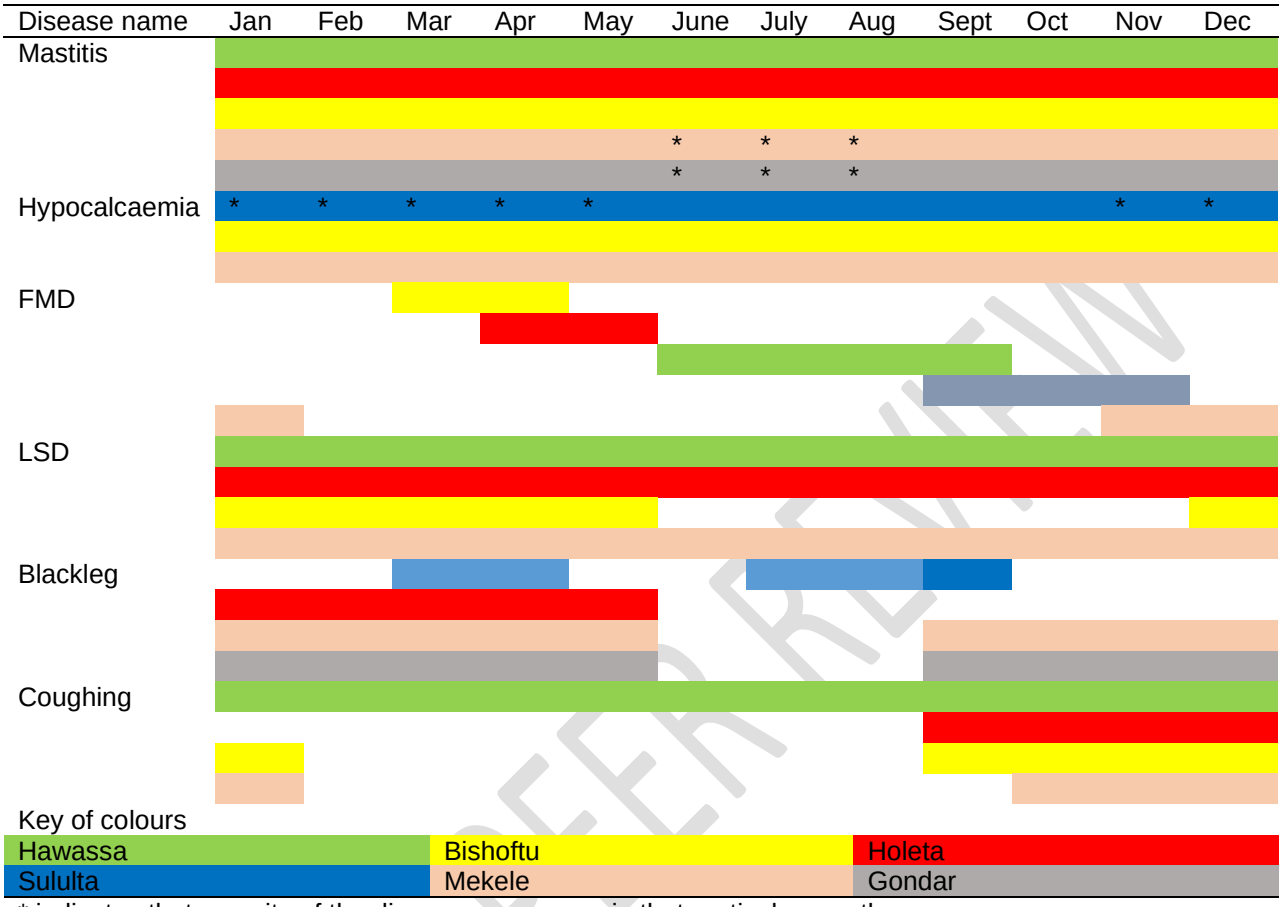
These results indicate that the germ theory of causation of diseases is scanty understood by farmers. They rather tended to attribute the cause of some diseases to weather conditions and sometime to what they called 'spirits'. As a result their solutions to some of the disease issues also tended to be occult practices, avoiding or delaying critical veterinary help. With regard to symptoms of diseases, it was observed that the participants were able to give detailed and accurate description of diseases identified in the local languages and it was possible to easily identify the common names of the diseases in English. In addition to this, high degree of similarity was also observed in the description of diseases among the groups and there was no major discrepancy.

Various study results indicated that livestock producers acquire indigenous knowledge on disease signs and symptoms through experience and they can also mention predisposing factors for the occurrence of the disease. Similar with our finding, more than 32 cattle diseases were identified based on the knowledge and experience of producers in South Sudan based on, extrapolation of clinical signs and symptoms mentioned by producer farmers [18].

3.4. Seasonality of Cattle Diseases

As can be seen in Table 7, there is a lot of agreement on the seasonality of dairy cattle diseases among the focus groups in the study sites. The participants indicated that mastitis and hypocalcaemia have no specific temporal pattern and can happen at any time of the year; yet groups from Mekele and Gondar indicated that Mastitis would get severe during the wet seasons (June, July and August) and Hypocalcaemia becomes sever during the dry seasons where there is no much green feed to graze. Similar research in Canada has indicated that mastitis prevalence and incidence can increase during the wet season from July to October [19]. On the other hand, mastitis prevalence and incidence were reported to be higher in spring, season from February-May by Penev et al., [20] which was not similar with our finding. With regard to FMD, the smallholder groups were found to have different understanding of its seasonality; while the groups from Bishoftu and Holeta indicated that it occurs mainly during the dry season of March to May and groups from Sululta and Mekele indicated that it occurs during the windy season from October to January and those from Hawassa indicated that it occurs during the wet seasons of June to Sept. This was due to their various understanding of the causality of the disease. For instance, at Holeta the participants from smallholder farms think that FMD is caused by drought and high temperature; on the contrary, at Sululta they indicated that it is caused by wet, windy and muddy condition. The fact is FMD can occur at any time rather appropriate temperature and presence of wind can be favorable conditions for the transmission of the diseases within short period of time for long distance. Similar research report on FMD stated that humidity and temperature were favorable for the transmission of the disease. If appropriate high humidity and temperature are maintained, the FMD virus can be multiplied and spread long distance, from 250 km across the sea and up to 60 km across the land along the wind direction as recorded by others [21]. On the other hand, Radostitis et al., [22] stated that the disease outbreak can occur at any time if the FMD virus escapes from research, vaccine production centers, and semen of infected bull which can be source of infection by artificial insemination. In the case of Coughing, except the Hawassa groups, which indicated that it is not seasonal and can occur throughout the year, those from the other sites indicated that it mainly occurs during the cold, windy and dry season from September to December.

Table 7: Seasonality of dairy cattle diseases as indicated by the smallholder groups (≤5 cattle)

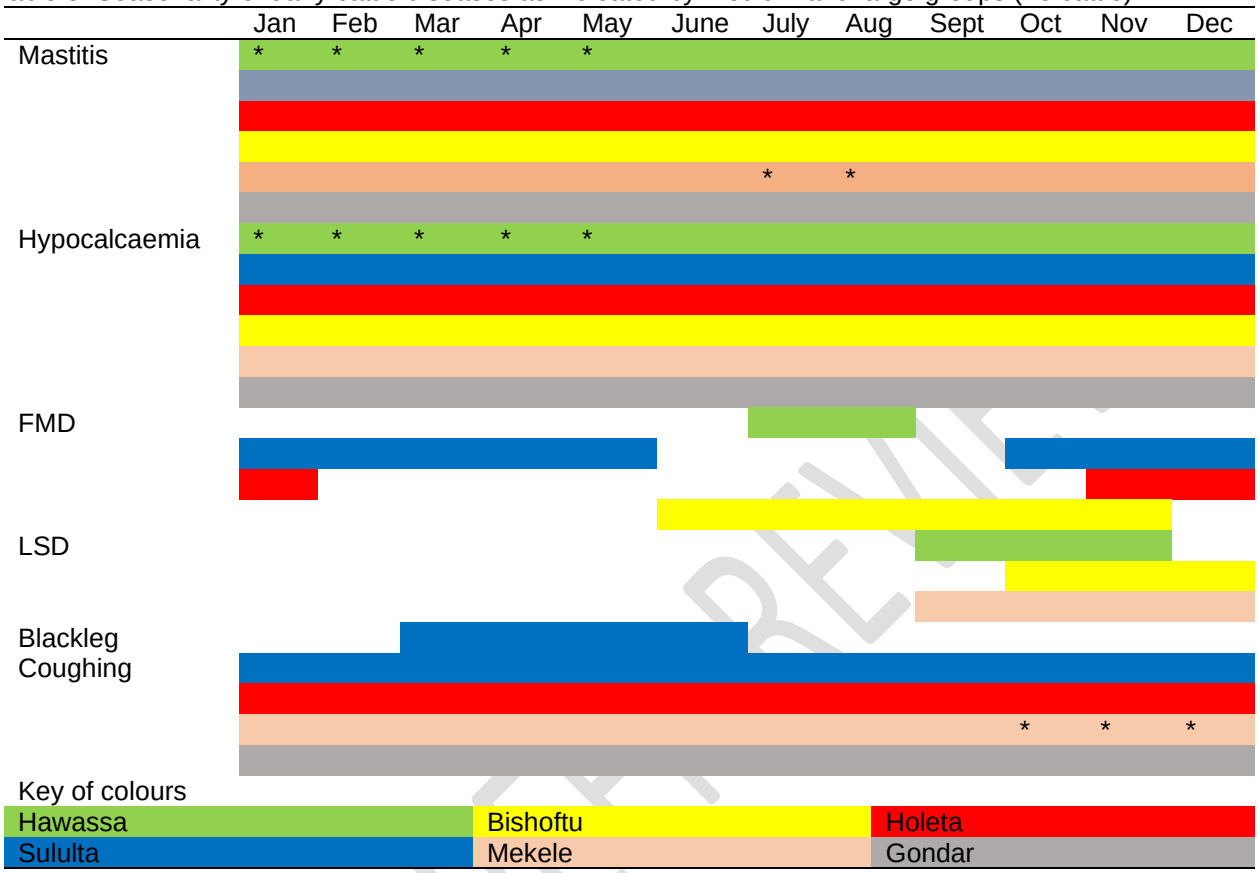


* indicates that severity of the disease occurrence in that particular month
FMD=Foot and Mouth disease, LSD=Lumpy skin Disease, TB=Tuberculosis, RFM=Retained Fetal Membrane

As in the case of the smallholder groups, the medium and large farms also showed high level of agreement in terms of the seasonality of dairy cattle diseases. Here we also saw some lack of agreement in the case of FMD (Table 7). Again, some groups indicated that FMD is a dry weather disease and some indicated otherwise, that the reason being the different conception of the causality of the diseases.

It can be seen in Table 7 and Table 8 that there is high level of agreement in the seasonality of major diseases between the smallholder and the medium and large groups. However, there is clear discrepancy in the case of coughing, in that the smallholder groups predominantly indicated that it is seasonal and cold, windy and dry weather favours its appearance, while the medium and large groups indicated that it can occur at any weather condition and no particular weather favours it. Since coughing can be caused by different factors which are not symptoms of a specific disease, it varies based on management of the cattle like housing, feeding and watering. Smallholder producers have a possibility of letting their cattle grazing land and exposure of cold weather during grazing outside the barn can be the predisposing factors for coughing.

Table 8: Seasonality of dairy cattle diseases as indicated by medium and large groups (>5 cattle)



* indicates that severity of the disease occurrence in that particular month
FMD=Foot and Mouth disease, LSD=Lumpy skin Disease, TB=Tuberculosis, RFM=Retained Fetal Membrane

3.5. Impact of Livestock Diseases on Livelihoods

Livestock disease can affect productivity directly and indirectly. Mastitis, hypocalcemia (milk fever), abortion, retained fetal membrane, repeat breeding, and calf mortality are the major reproductive diseases which cause productivity losses, milk discard, infertility, high treatment costs, and risk of premature culling of an animal. Disease can also affect the quality and safety of milk and milk products through metabolic changes, immune system and residues in milk which can cause milk discard and decrease profit [23].

Participants were also asked about the social and economic impacts that each disease may have on the farmers and their workers/families. In addition to this they were asked about the gender differential impacts of the diseases on livelihoods. They indicated that each disease has its own economic impact in terms of reduction of benefits such as reduction of milk yield, increased medical cost, loss of cattle due to death, loss of calves and replacement stock, selling cattle for low price, increased labour cost, or farmer time spent in seeking for veterinary help and caring for ill animals.

Focus group participants from Hawassa indicated that in terms of economic impact for the medium and large farms the most important disease is Mastitis as it would cause decreased milk yield, increased cost for medication and care, and risk of transmission to other animals (Table 9). Milk from a Mastitis infected cow will be discarded as it is contaminated by germs, blood and pus from infected tits, leading to

decreased income from milk sales. They also indicated that in some cases they could be forced to sell the cow for beef at a low price, if the disease becomes sever, more tits get infected and blinded. They indicated that a crossbred heifer or a milking cow can be sold for a minimum of 35,000 Birr but if it gets Mastitis and blind tits it would be sold for beef for not more than 10,000 Birr. Even though farmers know the cause of Mastitis, the problem is still severe in the farms, which suggests the need for intensive practical training on prevention and management of diseases.

Next to Mastitis, they ranked Hypocalcaemia as the top disease with severe economic impact. This is because the cost of drugs for Hypocalcaemia is exorbitant and not readily available. They indicated that treating a cow suffering from hypocalcaemia would cost as much as 1,500 Birr for drugs which is not often available in public vet drug shops. They also indicated that if left untreated immediately, hypocalcaemia could reduce income significantly as there wouldn't be any milk produced from the affected animal and it could also die. LSD and FMD were ranked third and fourth due to their increased impact on cost of treatment, milk yield reduction and fast transmission of disease within and between herds. Abortion is ranked fifth as it leads to lack of replacement stock and financial and labour costs of repeated insemination.

Table 9: Rank of diseases in terms of economic impact at Hawassa (>5 cattle group).

No	Disease type	Proportional pile	Rank
1	Mastitis	31	1
2	Hypocalcaemia	27	2
3	LSD	18	3
4	FMD	14	4
5	Abortion	10	5

The participant farmers from Bishoftu, Gondar and Mekele, indicated that Coughing and/or TB has very high financial impact as the farmer would not be able to sell his cattle if it is known that the animal is affected by this disease. Participant from Sululta narrated a case where a farm went bankrupt because of TB as it was not possible to sell the cattle for breeding and when the farmers sold the cattle for beef the carcass was condemned by the local abattoir and had to be burnt. The price of the cattle would also be low due to weight loss that would be caused by the coughing. They also indicated that once a cow or the farm is affected by TB, it would not be possible to sell the milk, as consumers would not be willing to buy such milk. They also indicated that the costs associated with isolation and care is also exorbitant leading the farm to bankruptcy.

With regard to the relative impact of diseases between men and women, the participants indicated that women were affected more than men, arguing that women cover household miscellaneous costs themselves, such as school fees, from milk selling. If cattle are sick and its milk yield reduced or stopped altogether, the woman would lose a significant amount of her income from milk sale. A female farmer from the smallholder group of Hawassa indicated that "*sometimes these costs [miscellaneous cost related to different household chores] might be sources of conflict between wife and husband because the husbands do not recognize these costs. Hence, the woman gets worried if she could not cover these miscellaneous costs by selling milk because she has to request money from her husband which would lead them into conflict*."

Other female farmers in the groups indicated that women often engage in the management of diseased cattle. Hence, when animals get ill, it is more of a burden for the women than for the men. According to FGD participants, this is because it is difficult for women to seek solution for the disease such as contacting animal health workers, searching for medicine and feed for the animals, specially to buy feed in the rural areas as these things require leaving their farm and interacting with male extension workers. As a result they tend to use traditional medicines and it is only when the diseased animal gets worse that makes them seek veterinary professionals. In that case also they prefer to call the veterinarians than to take the animal to veterinary clinic. In fact, men also prefer to bring the veterinarians to their farm rather than taking the animal to the clinic which would cost them more. Moreover, local clinics have the regulation that farmers should aim to bring their cattle to the clinic rather than veterinary professionals go

to the farms. Veterinary clinic officials indicated that this is because there are not sufficient vehicles for movement and also it is for the reason that when the veterinary professionals go door-to-door, they tend to take bribes for the services they provide. Yet the farmers indicated that they prefer door-to-door service and would rather pay bribes than bringing cattle to the veterinary clinics which may be located far from their vicinity.

With regard to the impact of diseases on the society, the participants indicated that consumers could not get milk and especially children are affected more because if milk yield decreases their share of milk consumption will decrease and they would possibly be malnourished. Moreover, the participants indicated that the impact of diseases is not limited to dairy farming, it affects public health as well; particularly women and children are affected more than men. Dairy cattle management activities such as feeding, milking, watering and caring for ill animals is mainly done by women and children, thus women and children are more exposed to possible zoonotic diseases such as Coughing.

3.6. Management of Diseases

After the above scoring exercises, participants discussed their cattle disease management practices. They were asked about their primary options for the management of each disease as they occur. The results indicate that for the majority of diseases they seek public veterinary service. They tended to depend on low cost or free vaccine service from the local public veterinary clinics. However, in cases where there was no veterinary drug supply for a particular disease (such as for hypocalcaemia), or for farms far from the public vet clinic, or in cases when support was needed during the weekends when the government veterinary clinics were closed, then farmers used private veterinary clinical service and drug vendors at high costs. Also, the participants indicated that quite a large number of farmers often used occult practices, traditional medicines, and home treatments for a variety of diseases. In terms of use of traditional medicines, we found no difference between the smallholder and the medium/large farm groups, despite that the larger farms often have their own veterinary professionals hired, either individually or between groups of farms.

With regard to use of traditional medicines, we found a wealth of indigenous technical knowledge and practice. For instance, for mastitis they use traditional medicine such as black cumin or homemade alcohol and clean infected teat with hot water using soap. They also use combined antibiotic called multiject by buying drugs from public or private veterinary drug shop. In order to prevent spread of the disease to the herd, they tried to improve farm and animal hygiene through separate milking practice for each cow, washing hands with soap before and after milking of each cow and also milking the infected cow and teat last. Yet if the cow is not cured, they would fatten and sale it for beef as a last resort. For Blackleg, they often seek veterinary service, yet they also use traditional treatments such as bleeding at the bottom of the tongue and branding of the affected muscle. They also indicated that they apply salt on the cut area of the animal to trigger bleeding as tool to disinfect the wound. For FMD, traditionally, they would apply honey on the affected mouth and hoof. They also wash the foot with hot water mixed with salt and apply alcohol, isolate the animal in a separate barn, feeding and watering trough. Disease of livestock, including dairy cattle, can be prevented and controlled by using conventional veterinary medicament, traditional medicinal plants and practice. According to reports by Luseba and Tshisikhawe, [24] and Syakalima et al. [25], 80% of livestock producers in Africa depends on traditional medicines because of poor veterinary service. Similarly there are various traditional healing practices in developing countries which are designed for either therapeutic or prophylactic use in animals and humans [26].

For coughing and/or TB, Pasteurelosis, respiratory disease complex, the FGD participants indicated that they had neither a traditional medicine nor a veterinary treatment. The primary measure they use to take was avoidance of feed contaminated with mold as they think that it is the cause of coughing and/or TB. They have the understanding that coughing is transmittable from animal to animal and maybe also to humans by the route of inhalation; otherwise, very few of them indicated that consumption of raw milk and raw meat, as well as handling of meat and having close contact with infected animals are potential risk

factors for zoonotic transmission. With regard to the management of coughing, once they have an infected animal, they would isolate the infected animal (in a separate barn if available); have its own feeding and watering troughs, and see if it gets better or sell the animal before the coughing gets worse. They sell the animal for beef or for breeding to far-off places which increases the potential risk of the disease spread both to cattle and humans. This indicates that in the absence of some form of monitoring the trade of cattle for breeding and in the absence of regulated slaughtering, traditional, informal and unregulated cattle trade remains to be a primary risk factor for the spread of contagious and zoonotic diseases such as bTB.

4. CONCLUSIONS

It can be concluded that some farmers, not all, have a profound knowledge of animal diseases in terms of describing their symptoms, seasonality, impacts and to some extent causes, way of disease prevention and control. This indicates that outsider professionals can learn a lot from farmers and participatory epidemiological methods are important for quick survey of diseases and farmers understanding of them. However, the fact that a considerable number of farmers do not attribute diseases to germs but to spirits and seek treatments through occult practices creates a formidable challenge thwarting outsider efforts to improve animal health services. By not seeking medical treatment for diseased animals, farmers risk economic loss and spread of diseases to their herd and beyond. Therefore, it is important that more awareness creation and knowledge transfer efforts be made to make farmers understand real causative agents behind animal diseases.

With regard to important diseases in the dairy industry, it can be concluded that mastitis, hypocalcaemia, FMD, LSD, Blackleg and coughing, which may be related to bTB, are the most prevalent and economically important diseases in Ethiopian urban and peri-urban dairy sector. The reasons behind this ranking were found to be contagious nature of the diseases, availability and cost of treatment and impact of the disease on productivity. However, in the group representing medium and large farms certain reproduction related diseases such as abortion, calve mortality, Retained Fetal Membrane (RFM), repeat breeding and abnormal calves were ranked as important ones. It is not easy for farmers to identify bTB. This indicates that efforts to support urban and peri-urban dairy intensification in Ethiopia need to give emphasis not only to the common diseases such as mastitis, FMD, and hypocalcaemia but also to the reproductive health issues such as Retained Fetal Membrane (RFM), repeat breeding, and abnormal calves as well as calf mortality.

With regard to bTB, farmers often confuse coughing with bTB and they think that coughing is caused by stale feed. Coughing and/or TB have financial impact as there would be reduction in milk yield, weight loss and treatment is not available. The costs associated with isolation and care is also exorbitant leading the farm to bankruptcy. One of the option farmers use in the management of chronic diseases is culling or by sales. This indicates that in the absence of some form of monitoring, the sale of cattle for breeding and in the absence of regulated slaughtering, traditional, informal and unregulated cattle trade remains to be a primary risk factor for the spread of contagious and zoonotic diseases such as bTB, brucellosis, anthrax, FMD, LSD etc. Hence, livestock movement control mechanism need to be in place in order to control the spread of diseases through trade.

DISCLAIMER (ARTIFICIAL INTELLIGENCE

Author(s) hereby declare that no use of Artificial Intelligence (AI)

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Verbal consent was taken from each dairy farmer and key informants were asked before the start of the study. Only voluntary dairy farmers and key informant were included for this study.

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