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Assessment of Financial Losses from Mastitis Cases of Dairy Cows in Tiro Afeta District of Jimma Zone, Southwestern Ethiopia

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Abstract
A cross-sectional study was conducted in Jimma Zone between April 2019 and June 2020 on 460 lactating cows to estimate the prevalence of mastitis, assess risk factors, and estimate the economic loss due to mastitis under current farming system. Based on clinical and California Mastitis Test examination (CMT), overall prevalence of mastitis were 63.5% (292/460) and 26.7% (491/1840) at cow and quarter level. Logistic regression analysis revealed that lactation stages, parity, drying of teat with the same towel, hygiene and presence of teat lesions are a significant contributor to mastitis (P<0.05). A split udder investigation on 20 cross bred cows with sub clinical mastitis showed an average quarter production of 0.95kg per milking. Reduced milk production due to sub clinical mastitis was 1.2%, 6.3% and 32.8% with quarters with scores 1+, 2+, 3+ respectively. With the given distribution of CMT scores on the study populations, a quarter with sub clinical mastitis lost 12% of its milk production. Mastitis losses cost was 33978.68 birr in a single lactation or 103.58 birr per cow per lactation. Milk production losses, treatment and withdrawal contributed 49.8%, 31.5% and 18.6% respectively. Mastitis is a major problem causing significant losses so further preventive and control measures are recommended. The study indicated overall annual financial losses due to mastitis in the area was 359,453.63ETB (15,625.42USD) (8.79%) per year. Therefore hygienic housing and milking practices, minimizing irrational use of antibiotics and molecular studies on the pathogens of mastitis for resistance gene isolation are very important.
Keywords: Bovine Mastitis, Prevalence, Risk factors, Financial loss.
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INTRODUCTION

Ethiopia constitutes the largest livestock population in Africa (57,829,953 cattle; 28,892,380 sheep; 29,704,958 goats; 2,082,203 horses; 405,950 mules; 7,881,394 donkeys; 60,505,327 poultry and 5,916,100 beehives) with different distribution and quantities depending on animal husbandry system and agro-ecological zone. From these cattle population, 42% of total cattle heads for the private holdings are milking cows (CSA, 2016). This indicates that Ethiopia holds a substantial potential for dairy development mainly due to its large livestock population coupled with the relatively suitable environment for livestock production (Bereda *et al.,* 2014). Dairy cows are increasingly becoming an important in poverty reduction efforts by the improvement of households' income from sales of milk and milk products as well as generation of employment in addition to improved nutritional status of families in the world. (Tolosa *et al.,* 2015). However, dairy production has not been fully exploited in Ethiopia, mainly due to several constraints including disease such as mastitis, malnutrition and traditional management (Idriss *et al.,* 2014; Dabash *et al,* 2014). Mastitis has been known to cause a great deal of loss or reduction of productivity, to influence the quality and quantity of milk yield and to cause culling of animals at an unacceptable age (Nuradis, 2017). A number of previous reports from different parts of Ethiopia indicated that mastitis is a serious problem in the dairy cattle. Getahun *et al.* (2008), Lakew *et al.* (2009), Regasa *et al.* (2010), Tigre *et al.* (2011), Tolosa *et al.* (2013) reported mastitis prevalence as 69.8, 56 and 71, 36.69 and 62% in Sebeta, Addis Ababa, Asella, Holeta town, in and around Jimma town and in smallholder dairy farms in Jimma, respectively.

Mastitis has been known to cause a great deal of loss or reduction of productivity, to influence the quality and quantity of milk yield and to cause culling of animals at an unacceptable age (Nuraddis, 2017). Mastitis results in economic loss by increasing the cost of production and by decreasing productivity (Hossain *et al.,* 2017). Most estimates have shown a 30% reduction in productivity per affected quarter and a 15% reduction in production per cow/lactation, making the disease one of the most costly and serious problems affecting the dairy industry worldwide (Nuradis, 2017). Discarded milk from cows with clinical mastitis and treated cows and veterinary service for treatment are the minimum components of economic loss due to mastitis. In addition, about 75% of the economic loss from sub- clinical mastitis is attributable to loss of milk production (Radostits *et al*., 2007). Milk production is reduced considerably in the affected animals and estimated loss of milk yield may range from 100 to 500 kg per cow per lactation (NAAS, 2013). The predictable loss caused by clinical mastitis in cows is nearly 700kg in first lactation and 1,200kg in the second lactation (Wilson *et al.,* 2004). In United States, expenses related to mastitis on dairy farms are around US$ 200 per cow per year and an estimated annual loss of 2 billion dollars for dairy industry. Australian dairy industry is losing more than US$130 million every year because of poor udder health causing reduced milk production that is mainly associated with mastitis (Hossain *et al.,* 2017).

In Ethiopia no or little effort has been made to assess the economic loss due to mastitis. Only few authors were reported economic loss due to mastitis throughout the country. The economic loss from mastitis in the urban and peri urban area of Addis Ababa are US$58 and 78.65 per cow per lactation respectively (Mungube *et al*., 2005 and Tesfaye *et al*., 2010). According to Beyene and Tolosa (2017), an average annual milk loss in cross breed and local zebu cattle of Horo-Guduru Wollega Zone, Western Ethiopia was 22.3% and 2.24% respectively. Mastitis causes a reduced milk production, not only at the occurrence of the mastitis but throughout the rest of the lactation (Hagnestam *et al.,* 2007), increases the risk of new cases of mastitis and increases the risk of culling (Melese, 2012). Schneider *et al.* (2007) revealed that welfare of the cow is negatively influenced by mastitis as it can induce pain and even cause death. Consequences for the farmer are economic losses mainly due to reduced milk production and increased culling. Mastitis is not just an issue for the cow and farmer, but also for the consumers. Consumers expect that milk comes from healthy animals, and the quality of milk is negatively influenced by mastitis.

Tiro Afeta districts is located within the Jimma Zone having a high potential for dairy production. The production system in the area is categorized under “Mixed crop livestock production system”. Peoples in Tiro Afeta are livestock based society where livestock and its products are more important sources of food and income and dairy production is a critical issue but dairying has not been fully exploited and promoted mainly due to mastitis and several constraints including malnutrition and traditional management. The local communities also witnessed that mastitis was among their main problems. They also complained that milk yield is continuously decreasing per cow from year to year (personal communication). Comprehensive information on prevalence of mastitis, factors contributing to the occurrence and economic consequences of the disease is lacking in the area. Hence, this study was initiated to determine the prevalence of mastitis, to assess the major risk factors and to estimate the minimum monetary loss associated with mastitis under current farming system in the area.

MATERIALS AND METHODS

Description of the Study Area: The present study was conducted between January 2019 and April, 2020 in Tiro Afeta district, which is found in the eastern central part of Jimma Zone, at 64 Km from Jimma town in Oromia regional state at 316 km south west of Addis Ababa at longitude of 35°52’-37°37’E and latitude of 7°36’-8°56’N. It has an area of 1001.9 km^2 and five centre of rural community (CRC) namely: Akko, Dimtu, Gebbera, Busa and Raga-siba centers with 26peasant associations. It has common boundaries with Botor Tolayi, Sekoru, Limu Kossa, Kersa, Omo Nada districts and Southern Ethiopian peoples Regional State. Altitudinally, the district lies between 1640 and 2800 metres above sea level. The district is classified into woinadega (85%) and dega (15%) agro climatic zones. The average minimum and maximum annual temperatures were 7^0C and 30^0C, respectively. Agriculture is the livelihood for more than 90% of the population in rural farming community. The main agricultural system in the area is mixed crop livestock production and animals are mainly reared in an extensive system (JAO, 2015).

The area has livestock population of 414,297 (188,835 cattle; 56,338 sheep; 37,053 goats; 8,829 donkeys; 7,243 horses; 4,581 mules and 111,418 poultry) among which 39,379 were cows (TALPHO, 2016). Accordingly, the study was conducted in seven kebeles of the district (Akko town, Akko, Kejelo, Busa, Dimtu, Raga Siba and Dacha Gibe) (Figure 1).

Figure 3: The map of study area

Study Population

The study population was indiginous local zebu and cross breeds of lactating cows of different age, parity, sex, and body condition score all from Tiro Afeta District. The animals were categorized under small scale dairy and livestock keeping system which are kept under semi intensive and extensive husbandry system.

Study Design and Sampling Method

Cross-sectional study design was conducted between April 2019 and June 2020. The districts were purposively selected for this study, due to it shigh potential for dairy production. Types of samples included were quarter milk samples and questioner survey.

In consultation with Jimma Zone Livestock and Fishery Resource Development office, development agent and Kebele experts, all households in study area were stratified as those who have 1-5, 5-10, 10-15 and >15 heads of dairy cow. Then, 460 lactating cows were randomly selected from 166 households (owners of lactating cows) and included in this study. The reason for stratification is to know the impact of herd size on dairy cow management, get true data on milking procedures such as washing udder and hand before milking, how they are using towels to dry the washed udder for prevention of contagious pathogens. In addition, it ensures that all strata are represented in the sample.

Sample Size Determination:
The sample size for lactating cow were determined according to Thrusfield (2005) using 95% confidence interval, 5% absolute level of precision and expected prevalence of 85% which was reported by Tolosa *et al.* (2015), from Jimma, which has similar features with the current study area.

$$n = \frac{1.96^2 Pexp(1-Pexp)}{d^2} = \frac{1.96^2(0.85)(1-0.85)}{(0.05)^2} = \frac{0.5762}{(0.0025)} = 230$$

, Where n= sample size; P_{exp}= expected prevalence and d = desired absolute precision.

Accordingly, the sample size was determined to be 460 (230 local and 230 cross breed) lactating cow. However, due to the fact that few cross breeds are present in the area368 local and 92 cross breed) lactating cow or 1840 quarters were included in the study.

Study Methodology
Questionnaire survey:
Data on each sampled cow were collected from the owners using a structured questionnaire to assess the associated risk factors contributing to mastitis distribution. This includes breed, age, husbandry system, stage of lactation, parity, hygiene, washing of udder and hands before milking, how towel were used to dry hand and udder, previous history of mastitis occurrences and presence of teat lesion (tick infestation).
Clinical Examination and California mastitis Test (CMT):
Before milk sample collection the udders were carefully inspected followed by thorough palpation to detect possible fibrosis, inflammatory swellings, visible injury, tick infestation, atrophy of the tissue, and swelling of supra-mammary lymph nodes, viscosity and appearance of milk secretion from each mammary quarter were examined for the presence of clots, flakes, blood, and watery secretions to categorize cows as infected (clinical mastitis) and healthy. Then visually healthy udders were washed with tap water, dried and swabbed with cotton, soaked in 70% alcohol (NMC, 2004). Then the milks were milked and subjected to California Mastitis Test (CMT) and the animal were categorised as healthy (CMT0) and infected (CMT Trace, 1, 2 and 3).

Determination of Monetary loss associated with Mastitis at current farming system
Average milk production in healthy and infected lactating cows:
Most of authors indicates that a local zebu (Horro breed) and cross breed cow was assumed to have a uniform quarter production of 0.34 and 3.03 litres based on the daily yield of 1.35 and 12.11L /days/ cow with 323 litters (L) (range of 276-376L) and 3,694L (range of 3473-3915 L) in 240 and 305 days lactation period respectively (Beyene and Tolosa, 2017; Gari *et al.,* 2011; Nielsen, 2009). In this study, udder split trial were done on 70 (31cross and 39 local) lactating cows and continuous record of milk yield were done on healthy (CMT0) and infected (CMT1, 2 and 3 culture positive) lactating cows for twenty three weeks to determine average daily milk production of cross breed and local zebu (Horro breed) cows and to estimate economic loss associated with clinical and subclinical mastitis. Hence continuous recording of milk production were restricted to both local and cross breed lactating cows with non-blind teat which are healthy were done to know average milk production of healthy cross and local lactating cows in the area. Continuous records of milk production were also done on mastitis infected lactating cows to know average milk production of sub clinically infected cows (cows with CMT1, 2 and 3).
Economic loss due to reduced milk production:
Aaverage quarter milk production loss of lactating cows with sub clinical mastitis was calculated by formula developed by Mungube *et al., (*2005) and FAO in 2014.

$$PLy = \frac{\mathrm{CMT0} * \mathrm{PLCMT0} + \mathrm{CMT1} * \mathrm{PLCMT1} + \mathrm{CMT2} * \mathrm{PLCMT2} + \mathrm{CMT3} * \mathrm{PLCMT3}}{CMT0y + \mathrm{CMT1y} + \mathrm{CMT2y} + \mathrm{CMT3y}}$$

Where: $PL_{CMT0,1,2,3}$= Production losses determined in the split-udder investigation; and$CMT_{0y,1y,2y,3y}$= Number of quarters with the respective CMT score in the sub-system.
Total SCM losses = quarters affected in the positive animals* daily milk yield per quarter* the percept loss estimated on split-udder trial * days in lactation when a cow had the disease
The calculations for losses due to CM were performed based on the cost of loss due to blind teat with previous normal history, milk discarded due to clinical mastitis and cost of medicines (average estimate).
Economic loss associated with treatment:
The information about average prices of the commonly used intramammary infusion and parenteral antibiotics

were collected from the veterinary clinics and veterinary drug shops in and around the district. During study period, all veterinarians in the area were governmental workers, and it is difficult to estimate veterinarian fees for mastitis in specific. As a result, veterinarian fees were not included as economic loss due to mastitis. The cows clinically affected were made to be followed by veterinarians and finally the records of treatment given, milk withdrawal due to the drug residue and the costs applied were taken. Similarly, total treatment cost was estimated as the sum of cost of intramammary and parenteral treatment.

Cost of intramammary treatment = price per unit *treated quarters *treatment duration * number of times a cow was treated in lactation.

Milk withdrawal losses:

A loss due to milk withdrawal was calculated as: Cows treated * losses amounted to cows treated * milk production / cow / day * treatment duration in lactation (Putt *et al.,* 1998).

$$\text{Percentage of annual losses} = \frac{\text{total annual production losses due to mastitis}}{\text{total annual production with out mastitis}} \text{X } 100$$

Data management and statistical analysis:

All data collected were entered into Microsoft excel spread sheet, transferred to software SPSS version 23 and processed for analysis. The mastitis was the dependent variables while parity, stage of lactation and presence of teat lesions, milking hygiene were independent variables. Descriptive statistics were done to summarize the raw data. Logistic regression statistical test was used to check the presence of association between risk factors and the mastitis. Factors with $p < 0.25$in univariable analysis were initially considered for inclusion in the multivariable analysis. Multivariable logistic regression analysis was run and only variables with $p < 0.05$ judged significant. Confounding was checked by removing and replacing variables one by one. Model results are presented as odds ratios (OR) along with their 95% confidence interval (CI). Total losses due to mastitis = losses in milk yield + cost of treatment + milk withdrawal losses

RESULTS

Prevalence of Mastitis in the Tito Afeta District:

A total of 460 (368 local and 92 cross) lactating cows were examined by visual inspection (for identification of clinical mastitis) and California Mastitis Test (for identification of sub clinically infected cows). A total of fifty two cows have blind quarters (32, 17 and 3 cows have 1, 2 and 3 blind quarters respectively). This means 35 local lactating cows have 53 blind quarters (20, 12 and 3 cows have 1, 2 and 3 blind quarters respectively) while 17 cross breed have 22 blind quarters (12 and 5 cows have 1 and 2 blind quarters respectively). Seventy cows (24 cross and 46 local breed) cows were clinically infected and 390 (68 cross and 322 local breed) cows were subjected to California mastitis test (CMT). A total of 222 (36 cross and 186 local breed) were positive with California mastitis test (CMT).

From the total positive for mastitis (clinical and subclinical), twenty eight (28), twenty nine (29),fifty seven (57) and one hundred seventy eight (178) cows have 4, 3, 2 and 1 affected quarters respectively. This means nineteen (19), seventeen (17), thirty eight (38) and one hundred fifty eight (158) local cows have 4, 3, 2 and 1 affected quarters respectively while 9, 12, 19 and 20 cross breed cows have 4, 3, 2 and 1 affected quarters respectively excluding 236 (148 local and 88 cross) Trace CMT scores.

The overall prevalence of mastitis at cow level was 63.5% (292/460), among which 15.21% (70/460) were clinical mastitis cases and 48.3% (222/460) were subclinical mastitis cases. From70 clinical mastitis cases, 26.1% (24/92) and 12.5% (46/368) were cross and local horro cows respectively (Table 4).

Table 4. Overall prevalence of mastitis (n=460)

Breed (No. examined)	Clinical mastitis (%)	Subclinical mastitis (%)	Prevalence (%)	95% CI
Local (368)	46 (12.5)	186 (50.5)	232 (63.0)	[58.1– 68.0]
Cross (92)	24 (26.1)	36 (39.1)	60 (65.2)	[55.5 – 74.9]
Total (460)	**70 (15.2)**	**222 (48.3)**	**292 (63.5)**	[59.1–67.9]

CI=Confidence Interval

Concerning prevalence of mastitis at quarter level, a total of 1840 quarters were examined and 1,765 (95.9%) were functional quarters. The overall prevalence of mastitis at quarter level is 26.7% (491/1840). On the other hand the prevalence of mastitis at quarter level were 24.52% (361/491) and 35.33% (130/491) in local and cross breed respectively.

In cross breed, one hundred twenty eight quarters had CMT score 0 and 138 quarters were found positive in this study, out of which 99(11+88), 27 and 12 had a CMT score of +1, +2 and +3 respectively. In local breed, eight hundred forty four quarters had CMT score 0 and 419 quarters were found positive, out of which 259(49 + 210), 117 and 43 had a CMT score of +1, +2 and +3 respectively.

Risk factors associated with Mastitis

Different factor from management point of view, animal related and environmental were assessed for their potential contribution to the distribution of mastitis/ or bacterial pathogens causing mastitis in the study area. Breed, age, body condition score (Appendix II), number of parity, lactation stage and previous history of mastitis, origin of animals (area), husbandry (livestock keeping system), washing udder before milking, drying of teat with the same towel, cow's hygiene were analysed by univariable logistic regression. Risk factors with a trend toward significance ($p < 0.25$) (body condition score, breed, age (in years), parity, lactation stage (in month), previous exposure to mastitis, washing udder before milking, drying of teat with common towel, cow's hygiene and presence of teat lesion) were then analysed in the multivariable logistic analysis (Table 13).

Table 13 illustrates multivariable logistic regression result of the prevalence of mastitis at cow level as influenced by different risk factors. Body condition score, age, parity, lactation stages, drying of teat with common towel after washing, hygiene of the cow and presence of teat lesion (tick infestation) are statistically significantly associated with mastitis. Poor body conditioned cows are 3.44 times more like affected with mastitis than cows of good body conditioned. Those cows of poor body conditioned are also 1.95 more likely affected than those of medium body conditioned cows. Lactating cows with greater than five calves are 3.17 times more like affected with mastitis than cows those gives one to three calves and 3.01 times more likely affected than those gives three to five calves. Lactating cows at last lactation stages are 2.29 times more like affected with mastitis than cows at early lactation stages and 2.1 more likely affected than those at medium lactation stages. Lactating cows in which there is a practice of drying udder with common (single) towel after washing are 3.32 times more like affected with mastitis than cows in which no practice of drying udder with common towel. Lactating cows with teat lesion are 0.19 times more affected those cows without teat lesion. Those cows kept in house with poor hygiene are 5.47 and 3.04 times more likely affected with mastitis than cows kept in house with good and medium hygiene respectively (Table 14).

Table 14: Final multivariable model output for mastitis (n=460)

Variables	No. examined	Number of Positive (%)	95%CI (Prevalence)	OR(95%CI)	P- Value
BCS					
Good	131	66 (50.4)	41.3 -59.2	Reference	
Medium	183	113 (61.7)	54.3 – 68.8	1.95 (1.04 - 3.65)	0.037*
Poor	146	113(77.4)	70.0 – 83.4	3.44 (1.9 -6.25)	0.001*
Age (in years)					
young (4-7)	137	67 (48.9)	40.3 - 57.6	Reference	
Adult (7-9)	163	108 (66.3)	58.5 – 73.5	3.11 (1.19 -8.12)	0.021*
Old (>9)	160	117 (73.1)	65.6 – 79.8	4.78 (1.42 - 6.12)	0.012*
Parity (No. calves)					
1-3	164	76 (46.3)	38.5 – 54.3	Reference	
3-5	145	103 (71.0)	62.9 – 78.3	3.01 (1.03 - 4.11)	0.001*
>5 calves	151	113 (74.8)	71.3 – 81.5	3.17 (1.66 - 5.34)	0.001*
Lactation stage (in month)					
Early (<3)	171	115 (67.3)	59.7 – 74.2	Reference	
Medium (3-6)	151	75 (49.7)	41.44 – 57.9	2.10 (1.14 - 3.71)	0.017*
Late (> 6)	138	102 (73.9)	65.8 - 81.0	2.29 (1.23 - 4.26)	0.009*
Drying of teat[a]					
No	287	226 (78.7)	73.6 – 83.3	Reference	
Yes	173	66 (38.2)	30.9 – 45.8	3.32 (1.95 -5.64)	0.001*
Hygiene					
Good	136	43 (31.6)	23.9 – 40.1	Reference	
Poor	160	141 (88.1)	82.1 – 92.7	5.47 (2.68 -1.16)	0.001*
Fair	164	108 (65.9)	58.1 – 73.1	3.04 (1.59 - 5.78)	0.001*
Teat lesion					
No	416	251 (60.3)	55.5 – 65.1	Reference	
Yes	44	41 (93.2)	81.3 – 98.6	0.19 (0.05 - 0.67)	0.010*
Total	**460**	**292 (63.5)**	**58.9 – 67.9**		

PHM: Previous history of mastitis, BCS: Body condition scores, [a]: Drying of teat with the same towel, OR: Odds ratio, CI: Confidence Interval, * there was significant association

Assessment of Economic loss due to Mastitis

Estimation of average milk production per cow per day:

Investigation from continuous record of milk production from healthy and sub clinically infected lactating cows for twenty three weeks by splitting udder (dividing the udder by CMT into CMT0, 1,2,3) indicates that a healthy (CMT0) local zebu of Horro breed and cross breed cows in the area have average daily yield of 1.36 and 7.77 per day per cow (Figure 12). This long term recording was done to control and balance the magnitude of milk yield which is different from one stage of lactation to the next. According to Nielsen (2009), the magnitude of the yield loss is affected by the stage of lactation in which the cow developed mastitis. Subclinical mastitis cause greatest loss when it occurred in late lactation. Multiparous cows generally suffered more severe yield loss than primiparous cows. The study showed that, in cross breed quarters with CMT scores 0, +1, +2 and +3 yielded 1.94, 1.66, 1.49 and 1.22L per milking respectively (Table 18)

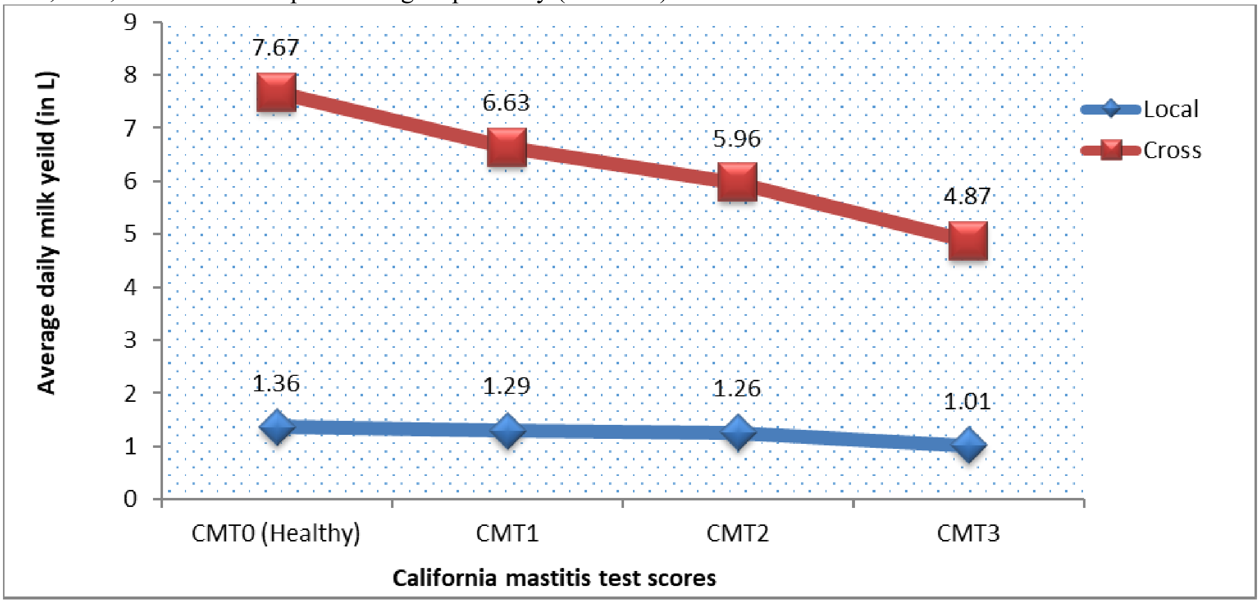

Figure 12: Average daily milk yield of healthy and subclinical mastitic cows

Loss in milk yield

Loss in milk yield due to clinical mastitis (Blind teats): In the case of clinical mastitis that resulted in blind teats (lactating cows that have previous history of normal teat) the average milk production loss were 0.34L and 2.1925L of milk per day in local and cross breed respectively. During the study period the minimum cost of 1L milk is 30 ETB. Accordingly, 17 cross breed cows with 22 blind quarters estimated to loss 1.94L * 22 * 305 days of lactation =13017.4 litres of milk *30 ETB =390522 ETB or (22971.88 ETB per cow per year) and 35 local zebu cows with 53 blind quarters losses 0.34 *53*240 lactation days = 4,324.8L of milk *30ETB = 129744ETB or (3706.97 ETB per cow per year). Therefore economic loss due to Blind teat = economic loss due to Blind teat in local + economic loss due to Blind teat in cross breed =129744+390522 ETB =520266ETB (18580.92857 USD).

Loss in milk yield due to subclinical mastitis: In cross breed, one hundred twenty eight (128) quarters had CMT score 0 and 138 quarters were found positive in this study, out of which 99(11+88), 27 and 12 had a CMT score of +1, +2 and +3 respectively. Average milk production per quarter per day was 2.1925 liters. CMT scores 0, +1, +2 and +3 had average milk production 1.94-(1.94*0), 1.94-(1.94*14.43%), 1.94 - (1.94*23.2%) and 1.94-(1.94*37.11%) liters which is 1.92, 1.66, 1.49 and 1.22 respectively (Table 18). Therefore, average quarter milk production of cross breed with sub clinical mastitis using formula developed by Mungube *et al., (*2005) gives:

$$PLy = \frac{((128* 1.94)+(99* 1.66)+(27* 1.49)+(12 *1.22))}{(128+99+27 + 12)} = \text{1.76Lper quarter}$$

Milk loss percentage in SCM per quarter =1.94-1.76= 0.18 =9.28%

SCM losses in cross breed=138*1.94*9.28 6.6%*305=7577.55liter* 30ETB =227326.5 ETB (8118.80USD).

Table 18: The distribution of quarter CMT scores and losses in milk yield

Breed	Milk production across CMT Scores				Losses associated with CMT score (%)		
	CMT0	CMT1	CMT2	CMT3	CMT0-CMT1	CMT0-CMT2	CMT0-CMT3
Local							
Per cow	1.36	1.29	1.26	1.01	0.07 (5.15)	0.1 (7.35)	0.35 (25.74)
per quarter	0.34	0.323	0.315	0.253	0.018 (5.3)	0.025 (7.35)	0.0875 (25.73%)
Cross							
Per cow	7.67	6.63	5.96	4.87	1.04 (13.56)	1.71 (22.29)	2.8 (36.5)
Per quarter	1.92	1.66	1.49	1.22	0.26 (13.54)	0.43 (22.39)	0.7 (36.45)

In local breed, eight hundred forty four quarters had CMT score 0 and 419 quarters were found positive, out of which 259(49 + 210), 117 and 43 had a CMT score of +1, +2 and +3 respectively. Average milk production per quarter was 0.34 liters. CMT score 0, +1, +2 and +3 had average milk production of 0.34, 0.32, 0.31 and 0.25 respectively. Substituting the formula average quarter milk production of local zebu cows with sub clinical mastitis was 0.33L per quarter per day.

$$PLy = \frac{((844 * 0.34)+(259 * 0.323)+(117 * 0.315)+(43 * 0.253))}{(844+259+117+43)} = 1.76\text{Lper quarter}$$

SCM losses in local zebu=419*0.33*2.94%*240=975.63 4liter*13ETB=12683.19ETB

Loss in SCM milk yield = loss due to SCM in cross + loss due to SCM in local breed.

= (98,508.15+12,683.19) ETB = 111,191.3ETB (4834.4USD)

Total loss in milk yield = loss due to SCM + loss due to CM

= (111191.3+225,448.62) ETB=336,639.9194ETB (14,636.52USD)

Economic loss associated with treatment (cost of drugs): In this study, treatment was only restricted to clinical cases since majority of the farm owners were not even aware of the presence of subclinical mastitis. The drugs commonly used for treatment of mastitis in the area were intramammary infusion (IMI), parenteral drugs (penstrep, oxytetracycline 20% and oxytetracycline 10%). The cows clinically affected were made to be followed by veterinarians and finally the records of treatment given, milk withdrawal due to the drug residue and the costs applied were taken. Accordingly 15 lactating cows (10 local and 5 cross) were treated with intramammary infusion (IMI) and 47 cows (17 cross and 30 local) were parenteral treated.

Total cost due to IMT= Number of animals treated *Average cost per ampoule (Birr)* Number of treated quarters * Treatment duration =36*48*6 =10368ETB (450.8USD) (Table 19).

Total cost due to parenteral treatment= Number of animal treated *Average dose per cow * Treatment duration * Average cost per ml =2,308.7 (85.5 USD)(Table 19).Similarly, total treatment cost was estimated as the sum of cost of intramammary and parenteral treatment.

Total treatment cost = cost of IMI (Table 18) +cost of parenteral antibiotics (Table 20).

=10,368ETB+ 2,308.7ETB=12,676.7ETB (551.2USD)

Economic loss associated with discarded milk (withdrawal losses): The cost of milk withdrawal was calculated from the records of milk withdrawal period following intramammary and parenteral treatment. Accordingly, average losses due to milk withdrawal =Number of withdrawal days per cow * Number of animal treated * Amount of milk yield (in L Per cow/ day) * Average cost of milk/L during study. Then total loss due to milk withdrawal is the sum of milk withdrawal loss caused by each drugs which was 10137.01 (440.72USD) (Table 21).

Total losses due to mastitis in the area = losses in milk yield + cost of treatment + milk withdrawal loses

= (336639.9194+12676.7+10137.01) =359,453.63ETB (15,625.42USD) per year

Table 19: Losses due intramammary treatment of clinical mastitis

Breed	Number of animals	Average cost per ampoule (Birr)	Number of treated quarters	Treatment duration	Total Cost of IMI treatment	
					In ETB	In USD
Local	10	18	31	3	6696	248
Cross	5	18	17	3	3672	136
Total		**36**	**48**	**6**	**10368**	**384**

Table 20: Average cost incurred to the owner due to parenteral cost of parenteral antibiotics

Breed and drugs used for treatment	Number of animal treated	Average dose per cow	Treatment duration	Average cost per ml	Total cost
Cross Breeds (n=17)					
Penstrip (ml)	7	15	5	1.5	787.5
Oxytetracycline 10% (ml)	6	24	3	0.35	151.2
Oxytetracycline 20% (ml)	4	20	1	0.5	40
Local Breeds (n=30)					
Penstrip (ml)	15	10	5	1.5	1,125
Oxytetracycline 10% (ml)	8	20	3	0.35	168
Oxytetracycline 20% (ml)	7	12	1	0.5	37
Total (n=47)					**2,308.7**

Table 21: Losses due to discarded milk (milk withdrawal period) during clinical mastitis treatment.

Breed and drugs used for treatment	No. withdrawal days per cow	No. of animal treated	Amount of milk yield in L Per cow/ day	Average cost of milk/L during study	Average losses due to milk discarded
Cross Breeds (n=22)					
Penstrip (ml)	5	7	1.94	13	882.7
Oxytetracycline 10% (ml)	4	6	1.94	13	605.3
Oxytetracycline 20% (ml)	6	4	1.94	13	605.3
IMI (Ampoule)	18	5	1.94	13	2269.8
Local Breeds (n=40)					
Penstrip (ml)	5	15	1.35	13	1316.25
Oxytetracycline 10% (ml)	4	8	1.35	13	561.6
Oxytetracycline 20% (ml)	6	7	1.35	13	737.1
IMI (Ampoule)	18	10	1.35	13	3159
Total (n=62)					10137.01

IMI =Intramammary infusion

$$\text{Overall percentage of annual monitory losses due to mastitis} = \frac{359{,}453.63}{4087980.4} \text{X } 100 = 8.79\%;$$

$$\text{Percentage of annual milk losses in Cross breed} = \frac{272{,}097.45}{2215324.6} \text{X } 100 = 12.28\%$$

$$\text{Percentage of annual milk losses in Local breed} = \frac{118{,}571.6}{1872655.8} \text{X } 100 = 6.33\ \%$$

3. DISCUSIONS

3.1. Prevalence of Mastitis

Numerous diseases are responsible for reduction in milk production, among these mastitis is the most important and various contributory factors have been reported, but such reports are scanty in Jimma Zone Tiro Afeta District. Therefore, it was necessary and crucial to know the prevalence of mastitis and different extrinsic and intrinsic risk factors which favour the entry of different pathogens in the udder. Therefore the current study revealed that the overall prevalence mastitis at cow level was 63.5%. The result of the present finding is in line with the previous findings of Alemayehu (2015), Lakew*et al.* (2009), Bedada and Hiko (2011), Mungube *et al.* (2005) who reported62.06%, 65.6%, 61.11%, and 64.5% bovine mastitis prevalence in dairy farms of Jimma, Bahir Dar and its surrounding north west Ethiopia,Asella and Sebeta respectively. In contrast, this result was found to be lower than the reports of Dabash *et al.,* (2014), Regasa *et al.,* (2010) and Getahun *et al.,* (2008), who reported the prevalence rate of 88, 71, and 69.8%, in North Showa Zone of Ethiopia, dairy farms of Holeta town, and Addis Ababa, respectively, but higher than that of Mekonnen and Tesfaye (2010) and Lidet *et al.* (2013)

who reports 56%, and 52.9% in Asella, Bahir Dar and in and around Areka town, Southern of Ethiopia respectively. This difference might be due to different management system and milking practice.

The prevalence of mastitis at quarter level in the present study was 26.68%. This is in line with the report of Biffa *et al*. (2005) who reported 28.2% in southern Ethiopia and close to that of Melese (2012) who found 37% in Alage State Dairy farm, Ethiopia.The current finding was lower than reports made by Tolosa (2016), Abera *et al*. (2013) and Mekibib *et al.* (2010) who reported 51%, 42% and 44.8% in Jimma, Adama and Holeta town respectively, but higher than reports of Almaw (2004) and Kerro and Tareke (2003) who found 17.9% and 19 % in Bahir Dar and southern Ethiopia respectively. The higher mastitis infection was observed in hindquarters than front quarters. This is similar with previous report of Alemayehu (2015), Dabash *et al.* (2014), Zeryehun *et al.* (2013) and Zenebe *et al.* (2014). This might be due to increased milk production performance followed with relaxed teat sphincters and contaminated hind legs as a result, the pressure on teat canal forces the canals to be opened widely which allows entrance of microbes.

In the present study, the proportion of blind quarters was 4.1%. This is in line with the report of Lakew*et al.*(2009), Melese (2012), Tolosa (2015) and Alemayehu (2015) who reports 4.5%, 5.2%, 6.1% and 4.82%, and close to the finding of Mungube (2001), Almaw (2004), Mekonnen and Tesfaye (2010), who reported 3.75% in Addis Ababa and 3.8% in Bahir Dar and 3.6% in Adama respectively. This could be an indication of serious mastitis problem in dairy farms and absence of culling that should have served to remove a source of mammary pathogens/or infections (Dabash *et al.,* 2014). The variations in reports of mastitis prevalence between authors at cow and quarter level as well as clinical and subclinical mastitis could be due to types and burden of pathogens that can transmit between lactating cows as results of improper milking hygiene, lack of post milking teat dipping and poor housing facilities. In addition, variations in husbandry practices between different areas might, at least, partly explain the difference in prevalence reported by different authors.

The prevalence of clinical mastitis at cow level in this study was 15.2%. This is in line with reports made by Kerro and Tareke (2003), Hundera *et al*. (2005) and (Tolosa, 2015) who reports 10%, 16.11% and 11% in southern, in central Ethiopia and Jimma town respectively. However this finding was higher than reports made by Bitew *et al*. (2010), Tigre *et al.* (2011) and Abera *et al*. 2013) who reported 4.8%, 7.75% and 3.9% in Bahir Dar, in and around Jimma town and Adama, Ethiopia respectively.

In the present study, overall 48.3% prevalence of subclinical mastitis at cow level was recorded. The prevalence of sub clinical mastitis in present study is comparable with previous reports of Tolosa *et al.* (2013), Regasa *et al.* (2010), Moges *et al*. (2012) and Mekibib *et al*. (2008), who studied its prevalence 62%, 34.8%, 30.6 and 25.22% in Jimma, Adama town, Hawassa (Southern Ethiopia) and Holeta Town (Central Ethiopia) respectively, and many other reports in different areas of Ethiopia. In the past, increased prevalence of subclinical mastitis in cattle has been reported: the prevalence of sub clinical mastitis of this finding is lower than reports made by Argaw and Tolosa (2008) and Dabash *et al.* (2014), who found 89.5% and 80.6%, in North Showa Zone of Ethiopia and Selale, North Shewa Zone (Central Ethiopia) respectively. Getahun *et al*. (2008), Mekonnen and Tesfaye (2010) and Tigre *et al.* (2011),however recorded lower level of sub clinical mastitis prevalence in Selalle (13.6%),in and around Jimma town (28.94%) andAdama area dairies (22.7%) respectively.

The difference in prevalence of subclinical mastitis may be due to the different husbandry practices, diagnostic techniques, environmental conditions and immune status of animals (Ahrar *et al.,* 2016). This was due to the fact that subclinical form of mastitis received little attention and efforts have been concentrated on the treatment of clinical cases Ethiopia. In summary, milking practice, breed difference, management practices and other risk factors influence mastitis prevalence, which might explain the observed differences between the reports of different authors in mastitis prevalence.

Risk factors associated with Mastitis

The present study showed that breed, body condition score, lactation stages, parity, drying of teat with common towel after washing, hygiene of the housing and presence of teat lesion (tick infestation) are statistically significantly associated with mastitis ($p < 0.05$).The result of this study showed that the prevalence of mastitis was not significantly associated ($P < 0.05$) with breed (65.2 and 63.0% in cross and local zebu cows respectively).

The lactation stage was significantly associated with mastitis in this study as reported earlier (Kayesh *et al.,* 2014; Adane *et al.,* 2012). The prevalence of mastitis was 67.3, 49.7 and 73.9 in early (<2 month), medium (3-6 month) and late (> 6 month) respectively. The occurrence of mastitis in this study was 2.08 times higher in late (> 6 month) lactation stage than early lactation stages. ie. OR=2.08 (1.14 - 3.83). However, different studies showed higher prevalence of mastitis in early stage of lactation (Girma *et al.,* 2012). The increased prevalence of mastitis with advancing lactation stages agrees with previous investigations by Abinet, (2015). Isolation frequencies of pathogens increase with lactation stage. The linear increasing of pathogens with lactation stages in this study indicates the lack of proper milking procedure before milking, during the time of milking and post milking which can contribute to the spread of these pathogens from infected teats to healthy ones and remaining persistence. Most owners of the lactating cows did not use towel and a few of them used a single towel for all cows commonly to dry the udders as well as their hands. The reuse of towel for cleaning and sanitizing may result in recontamination of the udder. According to Anderson and Pritchard (2008), pre milking udder preparations play an important part in the contamination of udder during milking. Furthermore, milkers wash their hands at the beginning of milking but did not dry their hands and not repeat washings between milking and some of the milkers used milk to moisten the teats when they became dry in between milking, which could be additional sources of contamination for udder. This finding is similar with findings of (Fikru, 2014; Jirata and Indalem, 2016).

The prevalence of mastitis was high in cows having higher parity (33.5, 54.5 and 58.3% in cows with 1-2 calves, 3-4 calves and >5 calves respectively). The occurrence of mastitis was 3.17 times higher in cows having >5 calves i.e. [OR=3.17 (1.66 - 5.34). A significant association of increased parity with mastitis has been reported (Biffa *et al.,* 2005; Mekibib *et al.,* 2010; Tolosa *et al.,* 2013; Kathiriya *et al.,* 2014). This might be due to the increased opportunity of infection with time and the prolonged duration of infection, especially in a herd without mastitis control program. In addition, the prolonged duration of infection and the physiological defence mechanism of the udder reduced with advancing age to overcome bacterial pathogens, so that pathogenic organisms get access to the glandular tissue and cause inflammation of mammary glands (Tufani *et al.,* 2012). On the other hand this might be caused by contagious pathogens. Contagious pathogens (*S. aureus* and *S. agalactiae*) survive in the udder of the cow and difficult to eliminate from mammary gland due to very low rate of self-cure and treatment result.

In this study, hygiene was also highly significant ($p<0.001$) with mastitis. The prevalence of mastitis was 31.6, 65.9 and 88.1% in good, medium and poor hygiene.The occurrence of subclinical mastitis in this study was 6.13 times higher in poor hygiene.i.e. OR=6.13 (3.05 - 12.35).Cows kept in poor hygiene were severely affected with mastitis than those with good hygiene practices. Similar results were reported byBitew *et al.,* (2010), Lakew *et al*. (2009), Sori *et al*. (2005) and Tolosa *et al.,* (2015). The poor hygiene status of the animals indicates that the surrounding environment is not sufficiently clean and provides a risk for spreading of environmental udder pathogens (Hogan and Smith, 2003). Based on observations made throughout the study period in the farms poor hygiene practices contributed to the presence of environmental pathogens. The pathogensincidences are at aconsiderable higher percentage which indicates that the alarming situation for dairy farmsand for public health as well. This finding isagreement with reports made by (Grace *et al*., 2009; Mekuria *et al*., 2013; Fikru, 2014 and Biruke and Shimeles, 2015).

The body condition score was significantly associated with mastitis in this study as reported earlier (Girma *et al.,* 2012; Kathiriya *et al.,* 2014). The prevalence of mastitis was 50.4, 61.7 and 77.4% in good, medium and poor body condition. The occurrence of mastitis was 2.03 times higher in cows having with poor body condition i.e. OR=2.03 (1.13 - 3.65).Lactating cows in which there is a practice of drying udder with common (single) towel after washing are 3.28 times more like affected with mastitis than cows in which no practice of drying udder with common towel. This might be due to using of common udder cloths, which could be vectors of spread especially for contagious mastitis (Hogan and Smith, 2003).

Assessment of Economic loss due to Mastitis

This study indicates that a healthy local zebu of horro breed and cross breed cows in the area have average daily yield of 1.36 and 7.77 per day per cow. Daily yield of 7.77 per day per cow in cross breed is in line with report of Mungube, (2005) and Tadesse, (2007) who had reported 8.8, and 7.8 L respectively. On contrast, this is lower compared to report of Beyene and Tolosa, (2017) and Misgana *et al,* (2013), which are 12.11 and 11.5 liters per day per cow. On the other hand, average daily yield of 1.36 per day per cow in in local zebu cow is in line with report of Beyene and Tolosa, (2017) who reported 1.35.The study showed that, in cross breed quarters with CMT scores 0,+1,+2 and +3 yielded 1.94, 1.66, 1.49 and 1.22L Per milking respectively. This is similar with reports of Mungube, (2005) who reported 2.2, 2.1736, 2.0614 and 1.474L and slight lower than reports of Misgana *et al,* (2013), who reports 2.875, 2.8,2.35 and 2.0L Per milking respectively and varies greatly from Mungube, (2001) and Tadesse, (2007) who had reported 0.9188, 0.861 and 0.616L and 1.043, 1.033, 0.9286 and 0.741L per quarter per milking respectively.

The overall loses were estimated to be 359,453.63ETB (15,625.42USD) with average annual milk loss of 12.28% in cross breed and 6.33% in local zebu cattle. This result is in line with result reported by Tadesse, (2007) and Misgana *et al,* (2013) who had reported 33973.68 and 291468.55ETB per lactation per year respectively; but higher than report of Beley and Tolosa, (2017) who reported 59,719.08ETB. This loss could be reduced or totally avoided with proper mastitis control and prevention measures. Milk production losses contributed to 8.5% of the total losses, which is in agreement with report of Tadesse, (2007) who had reported 12.8% and slight lower that of Mungube, (2001) as well as Beyene and Tolosa (2017), who reported 17.1 and 22.3% respectively. In conclusion this study indicates that reduced milk production constituted the major cost component of the economic loss caused by mastitis. This means economic losses caused by mastitis in the area represent production losses and higher costs associated with the disease which are expressed in money as compared to healthy dairy cows. These include: lower income from lower sales of milk per cow; higher costs on herd recovery (medicine and veterinary performance) as well as low value of the cow.

4. CONCLUSION AND RECOMMENDATIONS

4.1. Conclusion

Mastitis is a disease having multiple aetiologies, which appears to be worldwide in distribution and affects all species of animals. The current study revealed that the overall prevalence mastitis in the area was 63.5% (15.2% clinical and 48.3% subclinical mastitis). Sub-clinical infections constituted the major component of prevalence indicating the fact that the farmers are only concerned with clinical mastitis and often are unaware about sub-clinical infection in their herds. As a result, bacterial pathogens are the most important factor that contributes for reduced milk production and increased losses in dairy farm in different expenses, which are treatment cost, veterinary and other costs that could affect the profitability of the farmers business and has public health importance. The study showed that, average economic losses due to mastitis in the area were estimated to be 359,453.63ETB (15,625.42USD) per year with average annual milk loss of 12.28% in cross breed and 6.33% in local zebu cattle. Based on this conclusion the following points are recommended:

4.2. Recommendations

- This study revealed that subclinical mastitis was the main performance of the disease and attention should be given to subclinical mastitis diagnosis, treatment and control.
- Awareness creation by implementing short-term training on the importance of applying high hygienic standards of housing and milking practices such as separate drying of udder withsingle towel for each cow before every milking is recommended to effectively stop the spread of both contagious and environmental pathogens in the area.
- It is important if antibiotic susceptibility test is carried out to choose effective drug for treatment of mastitis.
- It is also important if further research is carried on both contagious and environmental pathogens by using molecular methods on the genes favour multidrug resistance of the pathogens so as to block the economic impact of mastitis in the study area.
- The milk samples positive for CMT and negative on culture could be due to difference of causative agents of the disease: it could be caused by Mycotic, Mycoplasmal, Nocardial or viral mastitis. Therefore further study should be conducted on Mycoplasmal mastitis.

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