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Prevalence of bovine tuberculosis in and around Ambagiorgies town smallholder dairy farms and assessment of farm owner's awareness about the disease, North Gondar, Ethiopia

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Abstract
A cross-sectional study was conducted from October, 2013 to May, 2014 on 60 smallholder dairy farms in and around Ambagiorgies town, North Gondar, Ethiopia, using comparative intradermal tuberculin skin testing (CIDT) and questionnaire survey to determine the prevalence of bovine tuberculosis and awareness of cattle owners about the disease. A significant variation in prevalence (P) was observed in regard to herd size (χ^2= 26.6, P < 0.05); age group (χ^2 = 11.47, P < 0.05); general management of the farm (χ^2 = 5.16, p< 0.05) and reproductive status (χ^2 = 10.9, P < 0.05). In contrast, statistically insignificant variations were observed among sex, breed, and year of duration of dairy operation. The questionnaire survey indicated that, only 13/60 (21.6%) of the respondents knew about bovine TB and its zoonotic nature, while 47/60 (78.3%) were not knew that cattle have tuberculosis. However, statistically insignificant (χ^2 =1.071, P > 0.05) association was recorded between the presence of reactor cattle and history of human TB cases in a household. The fact that the history of human TB patients and reactor cattle were present in the same household suggests the transmission of mycobacterial species between cattle and their owners, while the awareness of these farmers about bovine TB and its transmission was generally poor. The current result underlines the importance of launching control strategy before the disease reaches its climax and pose great economic and public health hazard.

Keywords; Ambagiorgies, Bovine tuberculosis, comparative intradermal tuberculin test, prevalence, smallholder dairy farms

Introduction
Ethiopia has the largest livestock population in Africa, including an estimated, 53.99 million cattle that contribute to the livelihoods of 60–70% of the population [22, 14]. The vast majority of the cattle are indigenous zebu (*Bos indicus*) managed under traditional husbandry systems (grazing in the field) in rural areas. However, in recent years the number of dairy cattle of highly productive exotic (*Bos taurus*, mainly Holstein-Friesian) and cross breeds has been on the rise, particularly in urban and peri-urban areas in response to the increasing demand for milk products and the Ethiopian government's effort to improve productivity in the livestock sector. The population of dairy cows accounts for 6.3 million animals (around 12% of the total cattle population) and the estimated total national milk production per year is 2.6 billion liters of which the urban and peri-urban dairy farmers produce 2% [13]. In a country such as Ethiopia, where livestock are extremely important for people's livelihood, animal diseases can be a real threat to animal productivity and thus negatively impact on the agricultural sector and economic development. From those diseases bovine tuberculosis (BTB) is one of the major important diseases that causes devastating economic loss in once country [8]. Bovine tuberculosis is a chronic and contagious disease of cattle and other domestic and wild animals including human [36]. *Mycobacterium bovis* (*M. bovis*) is a causative agent which is a member of the *Mycobacterium tuberculosis* complex, a group of mycobacterial species that includes *M. tuberculosis, M. bovis, M. africanum* and *M. microti.* From those, *M. bovis* is the most universal pathogen for the disease bovine tuberculosis among mycobacterium species and affects many vertebrate animals of all age groups including humans although,

cattle, goats and pigs are found to be most susceptible, while sheep and horses are showing a high natural resistance and the disease is characterized by progressive development of tubercles in any tissue/organ of the body [39, 26]. Characteristic tuberculous lesions occur most frequently in the lungs and the retropharyngeal, bronchial and mediastenal lymph nodes. Lesions can also be found in the mesenteric lymph nodes, liver, spleen, on serous membranes, and in other organs (Office International des Epizootics [31]. Bovine TB can be transmitted from animals to humans and vice versa. The most common means of transmission is through the respiratory system. Invisible droplets (aerosols) containing TB bacteria may be exhaled or coughed out by infected animals and then inhaled by susceptible animals or humans. The risk of exposure is greatest in enclosed areas, such as barns. Inhalation of aerosols is the most common route of infection for farm and ranch workers and veterinarians who work with diseased livestock. Livestock also are more likely to infect each other when they share a common watering place contaminated with saliva and other discharges from infected animals. Calves and humans can contract bovine TB when they drink unpasteurized milk from infected cows [35, 8]. As well as causing a high morbidity, bovine tuberculosis (BTB) can also be a financial burden to farmers owning infected cattle; it has been suggested that cattle with BTB have a reduced productivity affecting milk yield and carcass value as well as through reduced pulling power in traditional farming system [21]. Is also an economically important disease with zoonotic potential, particularly in countries with emerging economies, mainly through consumption of unpasteurized milk products and its prevalence in Ethiopian cattle can therefore be a contributing factor to the human burden of TB in the country that currently is ranked as the 7th highest in the world (world health organization [45, 42]. Currently, the BTB in humans is becoming increasingly important in developing countries, as humans and animals are sharing the same micro-environment and dwelling premises, especially in rural areas. At present, due to the association of mycobacterial agent with the human immune virus (HIV/AIDS) pandemic and in view of the high prevalence of HIV/AIDS in the developing world and susceptibility of *AIDS* patients to tuberculosis in general, the situation changing is most likely [37]. Nowadays human tuberculosis of animal origin (zoonotic TB) is an important public health concern in developing countries. More than 94% of the world population lives in countries in which the control of bovine tuberculosis in cattle is limited or absent. Rural inhabitants and some urban dwellers in Africa still consume unpasteurized and soured milk potentially infected with *M. bovis*. Therefore *M. bovi*s can infect humans, primarily by the ingestion of unpasteurized dairy products but also in aerosols and through breaks in the skin. Raw or undercooked meat can also be a source of the organism. Person-to-person transmission is rare in immune competent individuals, but *M. bovis* has occasionally been transmitted within small clusters of people, particularly alcoholics or HIV-infected individuals. Rarely, humans have infected cattle via aerosols or in urine [41].The disease is prevalent worldwide but prevalence data is scarce in most developing countries due to lack of active control programmes. Although bovine tuberculosis was once found worldwide, control programmes have eliminated or nearly eliminated this disease from domesticated animals in many countries. But still in a large number of countries bovine tuberculosis is a major infectious disease among cattle, other domesticated animals, and certain wildlife populations [30].

Several studies conducted since 2006 have confirmed that BTB is endemic in Ethiopia with prevalence rates varying from 0.8% to around 10% in extensive rural farming systems [21], while higher prevalence rates have been reported from regions in Ethiopia where intensive husbandry systems are more common [41] and also more prevalent in intensive dairy farms than in smallholder dairy farm regions with a prevalence ranging from 3.4% in small holder production system to 50% in intensive production system. [11],[2] However, there is no data on the nation-wide distribution of the disease as there are still areas where such studies have not yet been conducted; for example in the northern part of Ethiopia, Amhara Regional state, especially Northern zone of Amhara region, Wogera district, Ambagiorgies town. Therefore, the general objective of this study was to determine the prevalence of bovine tuberculosis on smallholder dairy farms in and around Ambagiorgies town and to assess farmer's awareness about the disease. The specific objectives of this study were

- To estimate the prevalence of Bovine tuberculosis in smallholder dairy farms of the area
- To identify related risk factors for the prevalence of bovine tuberculosis
- To assess farmers awareness about bovine tuberculosis based on questionnaire survey

Materials and Methods

Description of the study area

A cross sectional study was conducted from October, 2013 to May, 2014 in and around Ambagiorgies town smallholder dairy farms, which is a capital of Wogera District located in Amhara regional state, North Gondar administrative zone between 37.36 ºE and 12.460 ºN longitude and at an altitude ranges from 1600 to 3000 meter above sea level with the average of 2900 m. a. s. l in the northern highlands of Ethiopia. It is located at 778 km north of capital of the country, Addis Ababa and 40 km from its zonal capital city of Gondar. [9] The rainfall pattern is bimodal, with a short rainy season from March to May, followed by a long rainy season from June to September. It has an average annual rainfall of 700 mm and The temperature varies from 10 °C to 28 °C with the mean annual temperature 12.7 ºC, the livestock population of Wogera district is estimated to be 209,117 cattle, 214,150 sheep, 113,100 goats, 33,431 equine and 213,721 poultry. Its human population is 249,297 (National Metrology Agency [29, 43].

Study population and sample size determination

The study was conducted on 200 cattle belonging to 60 smallholder dairy farms in and around Ambagiorgies town depending on the convenience and willingness of the farm owners. The number of the smallholder dairy farm in the district was not recorded by the agricultural office of the Woreda, even though total cattle population in and around Ambagiorgies town is recorded as 1796. Some of the farms own both cross and zebu, and some owned mixed zebu cattle in their farm and a few may even only cross breed cattle. The dairy cattle found in the farms included in the study were noted for the detailed information through recording the age, breed, sex, body condition, reproductive status and origin and herd size is included. The dairy cattle fit for the study (excluding those calves under six months of age and late pregnancy (>7 month)) were subjected to CIDT test.

The required sample size for the validation of the test was estimated by considering the expected prevalence of 7.1%

based on a study conducted by [28] and the desired precision was decided to be 5% while the confidence level was 95%. The formula described by [40] was used to determine the sample size as follows:

$$n=\frac{1.96^{2*}p_{exp\ (1-p_{exp})}}{d^2}$$

Where: n =required sample size
p_{exp} = expected prevalence
d=desired absolute precision

Which gives 101 the required sample size, but in order to increase the precision the sample size was doubled (200).

Study design and methodology
A cross-sectional study was conducted from October, 2013 to May, 2014 to determine the prevalence of bovine tuberculosis and associated risk factors in and around Ambagiorgies town on comparative intradermal tuberculin (CIDT) test and questionnaire survey.

Comparative intradermal tuberculin test
The dairy cattle fit for the study (excluding those calves under six months of age and in late pregnancy) were subjected to CIDT test following the manufacturer's instructions. The animal was restrained and two sites, 12 cm apart, on the lateral side of the mid neck were shaved to measure a skin-fold thickness using a caliper. The skin thickness was measured with calipers before the tuberculin was injected. Accordingly, aliquots of 0.1 ml (25,000 international unit (IU)/ml, 0.4-0.5 mg / ml, *Mycobacterium avium subspecies avian*, strain D4ER, Lelystad Biologicals BV, Lelystad, the Netherlands) avian tuberculin and 0.1 ml (3000 IU /ml, 0.4-0.5 mg / ml, *M. bovis*, strain ANS, Lelystad Biologicals BV, Lelystad, the Netherlands) of bovine tuberculin were injected intradermal in the and lower sites, respectively were injected into the dermis at these sites. After 72 hours, the thickness of the skin at the injection sites was measured, using digital calipers.The results were interpreted in accordance with the recommendations of the World Organization for Animal Health. [41] Briefly, when the change in skin thickness was greater at the avian PPD injection site, the animal was considered positive for mycobacterial species other than the mammalian type (*M. tuberculosis* and *M. bovis*). However, when an increase in thickness was observed at both sites, the difference in thickness was considered. Thus, if the increase in thickness at the injection site for bovine PPD (Bovine) was greater than that at the avian PPD site (Avian), and if ΔB minus ΔA was less than 2 mm, the animal was classified as negative for bovine TB. If ΔB minus ΔA was between 2 mm and 4 mm, or above 4 mm, the animal was classified as suspect(doubtful) and positive, respectively.

Questionnaire survey
Cattle owners were interviewed according to their willingness to participate and after verbal consent on the same day that cattle were tested for BTB. Each smallholder dairy farm owner of the animal was interviewed using a pre- designed questionnaire format (Annex 2). A questionnaire format had been include a semi-structured closed questionnaire on livestock management and household characteristics, such as herd size, mixing of cattle or cattle contact with other cattle herds, purchasing of animals and housing system especially the sanitation, and ventilation of the house. Furthermore, questions related to human consumption habits, knowledge of tuberculosis and relevant information like, owners awareness about bovine tuberculosis, its transmission through consumption of raw milk and meat, and recent history of tuberculosis upon them or in their family members were also asked.

Data collection and analysis
CIDT result was interpreted and recorded from each individual of dairy cattle under the study after 72 hours of injection. Other factors of the individual animal such as body condition, sex, age, breed, were also registered (Annex 1 and 5). Body condition scoring is based on [36] (Annex 3).Where animals were classified as poor (score 1 (rare) and 2), medium (score 3) and good (4 and 5(rare)). Farms with good aeration, drainage, and lightning effect, and having separate calving pen was categorized as farms with good management system; the contrary was taken as a farm under poor management system (Annex 4). All data recorded were entered to Microsoft excel coded and then subject for analysis using SPSS 16.0 version. Individual animal level prevalence was computed as the number of positive reactors per 100 animals tested and the herd level prevalence was calculated as the number of herds with at least one reactor animals per 100 herds. The variations between different factors were analyzed using Pearsons Chi-square (χ^2) test to the occurrence of BTB in cattle. In all analysis confidence level was held at 95% and p-value<0.05 was set for significance at 5% significant level.

Results
Herd Level Prevalence
A herd level prevalence of 10 % (6/60) was resulted by CIDT in and around Ambagiorgies town smallholder Dairy Farms. The differences in prevalence among the different sized herds were statistically significant (χ^2= 26.66, P= 0.000) and there was a significance difference in prevalence of bovine tuberculosis with management system (χ^2= 5.16, p= 0.023). However there was no significant difference associated with the age of the duration of dairy farm establishment (χ^2= 4.058, p= 0.131) as shown below (Table 1).

Table 1: The effect of herd size, age of farm, establishment and general management of the farm on prevalence of bovine tuberculosis in and around Ambagiorgies town smallholder dairy farms.

Variable	Category	Number of her tested	Number of herd tested positive (%)	Chi-squere	p-value
Herd size/ number of animal	2≤5	36	0(0)	26.66	0.000
	≥5≤9	20	4(20%)		
	≥10	4	2(50%)		
Age of farm established/ in year	<5	5	0(0)	4.058	0.131
	5-10	9	1(11.11)		
	>10	46	5(10.86)		

General management	Poor	22	4(18.2)	5.16	0.023
	Good	38	2(5.3)		

Individual animal level prevalence

In this study the individual animal level prevalence of 3% was recorded (6/200). Thereby the prevalence of bTB was varied significantly among different age groups (χ^2=81.14, p=0.000). The difference in reactivity to CIDT test among physical condition and reproductive status of female animals were also statically significant (χ^2=18.74, p= 0.001 and χ^2=26.63, p= 0.009) respectively. But at different breed and sex of animal was statically insignificant association with the prevalence (χ^2=3.83, p=0.147 and χ^2=1.101, p = 0.577) respectively. Origin of the animal also has statically insignificant (χ^2=8.27, p= 0.126) as shown below (Table 2).

Table 2: Association between risk factors and tuberculin reactivity of cattle in small holder dairy farms in the area

Variables	Category	No of anima tested	No of animals affected (%)	Chi-square	p-value
Age (years)	≤2	63	0(0)	81.14	0.000
	>2<5	64	1(1.56)		
	≥5≤7	50	2 (4)		
	>7	23	3(13)		
Body condition	Poor	38	2(5.2)	18.74	0.001
	Medium	108	3(2.8)		
	Good	53	1(1.9)		
Sex	Male	57	1(1.75)	1.101	0.577
	Female	143	5(3.5)		
Breed	Cross	127	5(4)	3.83	0.147
	Local	73	1(1.4)		
Reproductive status	Lactating	63	3(4.76)	26.63	0.009
	Dry	24	2(8.3)		
	<6 month pregnant	15	(0)		
	Calf	48	1(2.08)		
	Heifer	20	0(0)		
Origin	Purchased	50	3(6)	8.27	0.126
	Born	150	3(2)		

Assessment of the knowledge of cattle owner about bovine tuberculosis

The result of questionnaire concerning farmer's knowledge about BTB showed that 58.3% (35/60) of the respondents did not know that cattle have tuberculosis and only 13/60 (21.6%) recognized that bovine tuberculosis is zoonotic and 12/60 (20%) of the respondents knew that bovine tuberculosis is zoonotic but have no knowledge about transmission as shown below (Table 3).

Table 3: Animal owners or attendant awareness about Bovine Tuberculosis and its mode of Transmission

Farmer's knowledge	Number of respondents (%
Not know BTB is zoonotic	35(58.3%)
Know that *M. bovis* is transmitted through milk	5(8.3%)
Know that *M. bovis* is transmitted through meat	1(1.7%)
Know that *M. bovis* is transmitted through both milk and meat	5(8.3%)
Know that *M. bovis* is transmitted through coughing	2(3.3%)
Know that *M. bovis* is transmitted through other ways	12(20%)
(i. e. Blood, Wound, Contact etc.)	

Rincipal Risk Factors for Transmitting Tuberculosis from Cattle to Humans

The result of the questionnaire survey conducted in and around Ambagiorgies town smallholder dairy farm owners showed that 1/60 (1.7%) households have the habit of only raw milk consumption. Conversely, 41/60 (68.3%) boil fresh milk before consumption although they consume soured milk without heat treatment and of the respondents, 18/60 (30%) uses both boiled and raw milk. The purpose of boiling of milk before consumption was not for the fear of the transmission of bovine tuberculosis from cattle to human rather they blindly boiled and consume. Among the households interviewed, only 2/60 (3.3%) households sold regularly fresh milk to the local market such as cafeteria and intermediate caters, and 14/60 (23.3%) of the respondents both for home consumption and sell for consumers, of the respondents 44/60 (73.3%) kept dairy cows to produce milk and milk products only for home consumption as shown below (Table 4). From all smallholder dairy farms tested, there were 6 farms with at least one reactor, 7 found to be doubtful, and the rest 47 were negative. With regards to humans a total of 4 households have gotten with a history of tuberculosis, 1 from the reactor, 1 from the doubtful and 2 from the non-reactor (negative) though all the individual had been cured from the disease. The association between reactor animals and history of human TB was statistically insignificant (χ^2=1.071, p=0.301) (Table 5).

Table 4: Assessment of purpose of farm, form of milk consumption and to whom the milk and milk products are sold

Variable	Category	Number of herd tested	Number of herd tested positive (%)	Chisquere	p-value
Herd size/ number of animal	2≤5	36	0(0)		
	≥5≤9	20	4(20%)	26.66	0.000
	≥10	4	2(50%)		
Age of farm established/ in year	<5	5	0(0)	4.058	0.131
	5-10	9	1(11.11)		

	>10	46	5(10.86)		
General management	Poor	22	4(18.2)	5.16	0.023
	Good	38	2(5.3)		

Table 5: Assessment of the association between reactor cattle and history of human TB cases in the households in and around Ambagiorgies town

CIDT herds results TB history of		
households	**Chi-square**	**p-value**
Positive	6	1/6(16.66%)
Doubtful	70. 1.071 301	1/7(14.28%)
Negative	47	2(4.25%)

Discussion

The herd prevalence (10%) recorded by this study was by far lower than the previously reported herd prevalence in Wuchale-Jida district, central Ethiopia [3] (42.6%). However, it was higher than with that reported by [38] (5.5%) in Asella Town, south-eastern Ethiopia. This may be due to the fact that the present study was conducted on herds of small sizes in contrast to previous studies, which were conducted on relatively large herd-sized farms; in addition sample size and methodology also might be a factor for the difference. O'reilly and Daborn [33] have indicated that the transmission of BTB from cattle to cattle is largely influenced by herd size, the larger the herd size the greater the chance of transmission. Moreover, when larger proportions of the animals are grazing in the field, the level of confinement is increased to a certain degree, which in turn maximizes the rate of infection in the herd. [31] However it was lower than as compared to the previously reported prevalence in the country and neighboring countries, Ameni [3] and Omer, [32] who recorded 14.2% and 14.5% in southern Ethiopia and Eritrea, respectively, Asseged [6] reported a similar individual animal level prevalence in and around Addis Ababa. And the prevalence shown in this study was still lower as compared to previous result reported from central Ethiopia; prevalence 7.9% was observed [2]. This suggests that BTB epidemiology in smallholder dairy farm very likely differs from large dairy farm (central Ethiopia) in the country. This could be explained by different husbandry practices and a higher number of cross-breeds and exotic breeds (considered to be more susceptible to BTB) found in the urban and large dairy farm in the country. In contrast to previous report by Asseged [6] the significant difference among different body conditioned animals obtained in this study agrees with finding of Ameni [3], body condition was seen to have an effect on tuberculin reactivity. This may be due to the fact that bovine tuberculosis is more common and more serious in poor body conditioned animals with the established fact that poor nutrition predisposes to tubercular infection and higher TB prevalence is expected in animals with poor body condition [15]. Several studies have indicated that as herd size increases, the risk of cattle within the herd showing a positive reaction also increases [6, 10]. In the present study, the herd tuberculin test result showed a statistically significant ($p< 0.05$) with herd size; also, the proportion of reactors increased parallel to an increasing herd size. This finding is consistent with previous report [16], and may arise from the fact that increased contact in larger herds favors lateral spread of infection within a herd, making the prevalence of infection greater than in large herds as shown (Table 1). This is because, as stated by Radostits [34] bovine TB is a disease of overcrowding. Thus, when the number of animals in a herd increases, the transmission of the disease is promoted. Similarly with this study herd tuberculin results showed a statistically significant association with herd management conditions, signifying that poor managerial inputs increase the risk of tuberculosis [16]. Previous studies (Ameni [3] Elias [18] had similarly documented higher infection rates in farms under poor management conditions. In this study the proportion of reactors observed was increased with age. One of the main individual risk factors identified by numerous studies in both developed and developing countries is the age of animals, as carried out in Tanzania and Zambia [16] which was in agreement with the present study in all the study sites. This is because; according to Griffin [20] a young animal might be exposed to the pathogen, but express the disease in adult age. In addition, Radostits [34] indicates the relatively longer duration of exposure than an inherent age predisposition. Francis [19] and Wood [44] have indicated that pregnant animals show lower reactivity as a result of stress induced immuno-suppression, which accords with the findings of this study. This could be because animals lose sensitivity to tuberculin shortly before and after calving [36]. Breed based analysis indicated that statically not significant ($p>0.05$) though the prevalence of cross breed cattle is higher than that of indigenous cattle as shown (Table 2). When compared with previous report the results of the current study are consistent with that of [1]. This study diverts from the fact that the prevalence of BTB is influenced by the breed of cattle [17]. This is most evident in areas where European breeds of cattle have been used to establish a dairy industry, as imported breeds of dairy cattle may also be less resistant to BTB than the indigenous breeds of cattle. But in this finding it may be due to the presence of cross breeds with low blood level means that there were no a pure European breed (HF) in the time of study. In harmony with Awah-Ndukum [7] and Katale [24] findings from this study have indicated no significant association between sex and intradermal skin positivity (Table 2). The finding concurs with previous studies conducted in Tanzania and in the country, southern Ethiopia, which reported similar findings for bTB positivity between male and female cattle [21]. Contrary to these findings, other studies have reported an association between sex and intradermal skin positivity. For example Inangolet [23] in Nigeria reported female cattle being at greater risk of testing positive than males contrary to findings by Kazwala [25] where male cattle were more affected than female cattle as male cattle particularly castrates are kept longer and hence more chances of contracting a disease than female cattle. In this study the statistically insignificant difference might be due to the duration of year kept in the farm, which the male and female cattle are almost similar since in the area most of the household uses their animal both for draft power and dairy purpose. The questionnaire survey has provided information regarding the knowledge and practices of the smallholder dairy farm owners about bovine tuberculosis and its zoonotic importance. Although most of the individual farm owner and their family have a habit of consuming milk after boiling, the purpose of boiling is not for fear of bovine tuberculosis. A high number of respondents had no detailed and accurate knowledge about bovine tuberculosis and in relation to zoonoses. This low awareness may result a limiting factor in the implementation of control and prevention of the disease in the country. The existence of history of human TB patients and reactor cattle in a household suggests that either the

former or the latter could be a source of infection for the other. The transmission could be cyclical, cow—man—cow [17]. Similar finding was reported in Wolaita Soddo, southern Ethiopia by Ameni [3] Different authors Cosivi [17] Ashford [5] have indicated that prevalence of tuberculosis as well as epidemiology of tuberculosis of animal origin would continue to be a public health problem especially in areas where prevalence of infection in cattle is there and where raw milk and its products are commonly consumed. It is strengthened by Aranaz [4] in many developing countries, milk and dairy products are still consumed unpasteurized, and the risk of *M. bovis* transmission remains likely.

Conclussion and Recommendations

The current study has determined the prevalence of bovine tuberculosis in smallholder dairy cattle in and around Ambagiorgies town with a herd level prevalence of 10 % and an individual animal level prevalence of 3% respectively. Despite the small magnitude of individual animal prevalence the present study indicated the presence of BTB in the study area from tuberculin skin test. It has shown that underlines the importance of launching control strategy before the disease reaches its climax and pose great economic and public health hazard. The CIDT, although not 100% sensitive, is the standard test widely used in developed countries for this purpose. As such policy is considered costly it has no compensation scheme for elimination of infected animals currently in practice in Ethiopia. Thus, the presence of tuberculosis in cattle and its history in human; the lack of smallholder dairy farm owner awareness about the disease, and consumption habit of raw milk in the area; highlights the high risks of infection. In light with the above facts, the following recommendations are forwarded.

- Since no compensation scheme for elimination of infected animals is currently in place in Ethiopia and due to financial constraints such policy might not be feasible in the near future. So, a test-and-segregation policy of tuberculin positive animals should be pursued.
- In the study area there is a habit of milk consumption on raw form so that there should be milk pasteurization plant in the locality to secure milk origin of tuberculosis infected animals.
- As the dairy industry in the country has expanded in recent years and is expected to continue doing so, significant number of high productive exotic and cross breed animals are likely to be traded from the urban areas around the capital to the rural areas (similarly in the study area). So there should be spread of knowledge about BTB and its risks to farmers and people involved in the smallholder dairy farms.

Since this study could not established the source of the infection whether it was from the human to cattle or vice versa, further study, establishment of collaboration between physician and veterinarians to trace back positive patient to get profile of their cattle should be in mind.

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