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Serological survey of bovine brucellosis in *barka* and *arado* breeds (*Bos indicus*) of Western Tigray, Ethiopia

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ABSTRACT

A cross sectional study was conducted to determine the seroprevalence and associations with potential risk factors of brucellosis in indigenous cattle breeds of Western Tigray zone, North West Ethiopia. A total of 1968 cattle were examined between October 2007 and April 2008. Of these, 1120 cattle were from semi-intensive production system composed mainly of *barka breed* while 848 cattle were from extensive system with *arado* breed being predominant. Sera were screened using Rose Bengal Plate Test (RBPT) and positive samples were then confirmed by Complement Fixation Test (CFT). The overall individual animal-level prevalence was 4.9%. Brucellosis seroprevalence was higher in herds reared under semi-intensive production systems. 7.7% and 63.6% prevalence were found at individual- and herd-level in the semi-intensive system, respectively. 1.2% and 3.3% were the figures for the extensive system. Both individual- and herd-level seroprevalence were higher in Mykadra and Bereket towns among all investigated towns. Though the odds ratio for Humera was more than two, seroprevalences across the three districts in the extensive production system were comparable. Herd size, age, sex, and husbandry practices were significantly associated with seropositivity and brucellosis increased the calving interval. Higher risk to infection was found in *barka* breed than *arado* in the semi-intensive production system but not in the extensive production system. Breed management systems, but not breed caused breed susceptibility variation. A high prevalence of brucellosis in *barka* breed in the study area indicates that it might serve as source of infection for others in the region. Hence, screening tests aiming at culling seropositive *barka* was recommended before distribution to other poverty-prone areas of the region.

1. Introduction

Worldwide, brucellosis remains an important disease in humans, domestic and wild animals (Tsolia et al., 2002). It is an infectious disease caused by bacteria of the genus *Brucella*. These bacteria are primarily passed among animals and they cause disease in many different vertebrates. Brucellosis in animals is characterized by abortion in females, epididimitis and orchitis in males and infertility in both sexes (Walker, 1999; Kubuafor et al., 2000; Omer et al., 2000; Radostits et al., 2000).

In Ethiopia, several investigators have established the epidemiology of bovine brucellosis and the available information on brucellosis clearly showed that the disease occurrence is endemic and wide spread with significant economic importance with a seroprevalence of up to 22% reported across different cattle management systems

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(Tekleye et al., 1989; Tariku, 1994; Yilkal et al., 1998; Abay et al., 2000; Kelay, 2002; Mussie, 2005; Berhe et al., 2007). No comparable data however is available in western part of Tigray, home to *barka* and *arado* cattle breeds (*Bos indicus*).

Barka cattle breed (commonly known as *begait*) is an indigenous zebu breed inhabiting South Sudan, Southern Eritrea and Northwest Ethiopia (Rege, 1999). The breed is mainly known for its milk production (yields up to 12 L/day), meat and traction power. Like many tropical breeds, *barka* has special adaptive traits, including disease tolerance, climatic tolerance, ability to use poor quality feed and to survive with irregular supplies of feed and water (Rege, 1999). Knowing all these merits of the breed, the regional government is providing these cattle to farmers in different districts to up-grade the genetic potential of the low producing *arado* cattle breed. Moreover, this relatively productive breed is being distributed to various poverty-prone areas of the region and many new settlers to satisfy the demand of animal products (meat and milk) within the shortest time possible.

Despite all the goals of local government (i.e., food secured society by boosting livestock production), there is an evident gap on the practical implementation of this strategy when it comes to livestock distribution. Many farmers are skeptical on the perceived benefits of the breed. There are various complaints that there were problems of reproductive failure (one of the main symptoms of bovine brucellosis) in the said breed after distributing in various districts. For any sound implementation to take place, the epidemiology of production related diseases, such as, brucellosis should be clearly investigated. Therefore, the objective of the study was to determine the seroprevalence and associations of potential risk factors of brucellosis in selected cattle breeds of the north western Ethiopian region.

2. Materials and methods

2.1. Study area

The study was conducted in the Western Zone of Tigray regional state, North West Ethiopia. Its geographical location is 13°42′to 14°28′ North latitude and 36°23′ to 37°31′ East longitude. Its elevation ranges from 560 to 2800 m a.s.l. The study area is bordered North by Eritrea, South by Gonder, and East by Tahtai Adiabo and West by Sudan. The Western Zone is one of the five administrative zones in the Tigray regional state and has three districts, namely, Welkait, Tsegede, and Humera with distance range of 580–750 km from Mekelle, the capital city of Tigray. The area is a remote, tropical region where extensive agriculture is performed manually by large numbers of migrant laborers. Throughout the zone, livestock agriculture is the predominant economic activity with about 95% of the total population engaged directly or indirectly in it. Main cattle breeds raised in the Western Zone are the local *arado* and *barka*/*begait* cattle. Semi-intensive production is practiced in the towns, Humera district, while extensive production system predominates in the remaining two districts. The study area's position near the Eritrean and Sudanese borders means that it is a transit point for cross-border trade and traffic.

2.2. Study animals

The study was conducted on cattle owned by smallholder farmers comprised of local *barka* and *arado* cattle breeds, which are all categorized under East African Zebu Cattle (Rege, 1999). *Barka*, the dominant cattle breed in the study area, is one of the five distinguishable main cattle breed types identified in Ethiopia used primarily for milk, meat and traction power. The breed is usually white with black spots or splashes. Occasionally red or color sided individuals may be seen. The breed is usually horned although polled individuals are occasionally seen.

2.3. Study design

Cross sectional study was conducted using serological procedures and questionnaire survey. Animal inventory, site assessment and an extension system for the farmers were made during August 2007. Blood sampling and administration of the questionnaire survey were performed from October 2007 to April 2008. Livestock owners, both from the two systems of production, were interviewed using a pre-tested and structured questionnaire. This was to determine management and husbandry risk factors known or thought to influence the spread and maintenance of brucellosis. Reproductive parameters that are presumed to be affected by brucellosis were also incorporated in the questionnaire. The serological survey was carried out with the intention of determining individual animal- and herd-level prevalence.

2.4. Sample size determination

Two types of cattle production systems were classified as extensive and semi-intensive. The extensive production system consists of mostly local *arado* cattle and in some pockets of *barka* breed. The semi-intensive production system contains mainly *barka* cattle breed and depends on feed supplementation at home. Occasionally they are allowed to graze around the homestead and at field level. The study animals were selected from a total of approximately 702,119 cattle in the Western Zone. The true representatives of the study population were selected by combination of simple random and cluster sampling methods. Sample size calculation was performed based on Thrusfield (2005, p. 187) using the formula:

$$T_s = \frac{1.96^2 g P_{exp}(1 - P_{exp})}{gd^2 - 1.96^2 V_c}$$

where g is the number of clusters, P_{exp} is the expected prevalence, d is the desired absolute precision, T_s is the total number of animals and V_c is the between cluster variance.

In the extensive production system, a complete list (sampling frame) of the peasant associations (PAs) in each district was established. 42 PAs were selected from a total of 69. Summary of the PAs and total number of herds

Table 1
Summary of Peasants Association and herds sampled from the three districts of Western Tigray Zone, North West Ethiopia.

District	Peasant Association (PAs)		Herd sampled	
	Sampled	Total	Extensive system	Semi-intensive system
Humera	5	20	23[a]	110
Tsegede	26	26	132[a]	–
Welkait	11	23	55	–
Subtotal	42	69	210	110

[a] Two herds originally from Humera district reside in the edge of Tsegedie sharing watering and grazing land with herds from the later. Though their origin, these two herds were analyzed along with the herds of Tsegede.

sampled is indicated in Table 1. Access of at least one season road was considered for PAs selection.

A complete list of herds in the identified PAs was established as 2103 herds. To balance the number of herds within the resource available for the project, we decided 10% of the herds for sampling. Thus, 210 herds were the established clusters. Two-stage cluster sampling technique was used in the calculation. The total number of animals sampled was determined using 95% confidence level, 8.2% expected prevalence (Gebreyesus, 2001, unpublished) and 2% desired absolute precision (d^2). Between clusters variance was assumed to be 0.0006235 (estimated from previous cluster sample data) (Gebreyesus, 2001, unpublished). This gave us a total of 848 cattle.

To determine the number of animals to be sampled from each herd, we divided the total number of animals (T_s) to the number of herds (g) (848/210). Accordingly, four animals were designed for sampling from each herd the method of which was simple random sampling. The minimum herd size during sampling was therefore four animals.

In the semi-intensive production system, a total of 1100 herds were established as a sampling frame. Like the previous production system, 10% of all herds (n = 110) were considered for sampling. We assumed an expected prevalence of 6% from similar production system (Mussie, 2005) with 95% confidence interval and 2% absolute precision. This gave us a total of 560 cattle. However, in the absence of between cluster variance data, it was stated that inflating the sample size two- to four folds can account for the potentially large variation that may occur among clusters (Thrusfield, 2005). We inflated two folds and obtained a total of 1120 cattle. Division of the total number of animals (1120) to the number of herds (110) gave us 10. Herds with at least 10 animals were sampled. Random selection was carried out in case the herd size was more than 10 animals.

2.5. Blood collection

About 10 ml of whole blood sample was collected from the jugular vein, using plain vaccutainer tubes and needles, from each animal aged above six months of age. There was no history of vaccination for brucellosis in the region in general and our area in particular. Each sample was labeled using codes specific to the individual animal and herd information. The tubes were tilted on a table overnight at room temperature to allow clotting. Serum was collected either passively by decanting or using centrifuges at 2500 rpm for 5 min. The serum was stored at −20 °C until it was tested by Rose Bengal Plate Test and Complement Fixation Test.

2.6. Serological testing

The Rose Bengal Plate Test (RBPT) was used as a screening test for detection of *Brucella* agglutinins and samples giving positive results were then confirmed by the Complement Fixation Test (CFT).

2.6.1. Rose Bengal Plate Test (RBPT)

Serum samples were screened using the standard Rose Bengal plate test (RBPT), employing stained *B. abortus* antigen (Institute Pourquir, Montpellier Cedex 5, France) and known positive and negative reference sera. *B. abortus* antigen was heat inactivated and 0.5% phenol adjusted to pH 3.65 and colored with Rose Bengal. For the RBPT the procedure described by Staak et al. (2000) was followed. Briefly, 30 μl of the sera samples were dispensed onto the plate and 30 μl of RBPT antigen was dropped alongside the sera. The plate was rocked by hand for 4 min and the test was read by comparing with the positive and negative control sera by examining for agglutination in natural light. Magnifying glass was used to detect micro-agglutination. Results of RBPT were interpreted as 0, +, ++ and +++ as described by Staak et al. (2000). 0 = no agglutination; + = barely visible agglutination (seen by using magnifying glass); ++ = fine agglutination and +++ = coarse agglutination. Samples with no agglutination (0) were recorded as negative while those with +, ++ and +++ were recorded as positive.

2.6.2. Complement Fixation Test (CFT)

The CFT procedure was undertaken at the National Veterinary Institute, Department of Immunology, Debre-Zeit. Preparation of the reagents was performed according to OIE protocols (OIE, 2000). A titration of hemolysin and antigen was performed before the test. The minimum hemolytic dose was also estimated for each run. As for the interpretation of test results, positive reactions were indicated by sedimentation of Sheep Red Blood Cells (SRBC) and absence of hemolysis. Negative reactions were revealed by hemolysis of SRBC. According to OIE (2004) sera with strong reaction, more than 75% fixation of complement at a dilution of 1:10 and at least with 50% fixation of complement at a working dilution (1:5) was classified as positive.

2.7. Data management and analyses

Data obtained from both serological tests and questionnaire survey were stored in Microsoft excel spreadsheet (Microsoft Corp.). These data were analyzed by descriptive statistics, univariable and multivariable regression using the SPSS 11.5 statistical package (SPSS, 2002). Animals tested positives to CFT were defined as seropositive. Herd having at least one seropositive cattle

was considered positive, otherwise negative. Individual animal-level seroprevalence was calculated on the basis of CFT positive results divided by total number of animals tested. Similarly, herd-level seroprevalence was computed as the number of herds with at least one positive animal divided by the total number of herds tested. We estimated individual- and herd-level seroprevalence using SPSS with seropositivity (positive/negative) as outcome of interest and stratifying according to district, production system and breed. Questionnaire data that included risk factors associated with husbandry management systems like, females having infertility problems, whether sold or kept within herds (reasons for sale of breeding cows), method of disposal of fetal membranes, dry season watering point and those reproductive parameters thought to influence the disease like, calving intervals were administered and compared with that of serological results. To answer the question of whether or not there is a significant correlation between all the risk factors, we conducted two-sided Fisher's exact test using the cross tabulation feature of the software. Univariable logistic regression was applied to measure the strength of that association. Variables with two-sided Fisher's exact value $P \leq 0.25$ and without any single missing value were identified as potential risk factors for inclusion in the multivariable model as previously described by Muma et al. (2007). Then, the multivariable logistic-regression model was fitted with herd seropositivity (positive/negative) as the outcome. The model was built using the forward stepwise (conditional)-selection procedure by applying the iterative maximum-likelihood estimation procedure and statistical-significance contribution of individual predictors (or group of predictors) to the models tested using the Wald's test and likelihood-ratio test. Any interaction between variables was assessed by constructing a model as Muma et al. (2007) except we used custom/stepwise-factor interaction term for the significant main effect and examined changes in the coefficients and *P*-values of the main effects instead of two factor in the model. The logistic model was checked for goodness-of-fit using the Hosmer and Lemeshow test. $P < 0.05$ was taken as significant.

3. Results

3.1. Seroprevalence of brucellosis in cattle

A total of 1968 bovine sera were examined from Western Zone of Tigray Region. The overall seroprevalence of brucellosis in the study population was 4.9% (96/1968). A total of 86 (7.7%, $n = 1120$) samples were found *Brucella* seropositive in cattle managed under semi-intensive production system (Table 2). Though not statistically significant, higher prevalence was found from cattle of Mykadra. Moreover, 70 herds (63.6%, $n = 110$) in the semi-intensive were harboring at least one seropositive animal (Table 2). The figure varies from 43% to 84.4% prevalence (Table 3).

In the extensive production system, individual level of 1.2% (10/848) seroprevalence was found. Similarly, herd-level prevalence was analyzed across the three districts. Seven herds (3.3%, $n = 210$ herds) were maintaining infected animal (Table 2). Logistic-regression analysis was performed to measure the strength of the relationships between seropositivity and each district. There was no significant association between seropositivity and districts in both individual and herd of animals.

3.2. Breed susceptibility to brucellosis

To see breed difference in susceptibility, both *arado* and *barka* breeds kept under the same production system were examined. In the semi-intensive system, 1.0% of the *arado* and 8.3% of the *barka* cattle were seropositive. This difference is statistically significant ($P = 0.028$). On the other hand, in the extensive production system, 1.4% of the *arado* and 0.5% of the *barka* cattle were found seropositive. This difference was not statistically significant ($P = 0.390$) (Table 6).

3.3. Univariable and multivariable logistic-regression analyses of risk factors for brucellosis

The differences between brucellosis seroprevalence in cattle per each risk factor categories as well as their associations are summarized in Table 4. During the

Table 2
Individual- and herd-level *Brucella* seroprevalence in cattle managed under extensive and semi-intensive production system of Western Tigray Zone, North West Ethiopia.

Production system	Districts (towns)	Individual seroprevalence			Herd seroprevalence		
		n^i	Prevalence (%)	95% CI	n^h	Prevalence (%)	95% CI
Semi-intensive	Tirkan-Adigoshu area[a]	227	5.3	2, 8	21	43	22, 64
	Baeker	264	6.8	4, 10	27	55.6	37, 74
	Adebay	129	7.8	3, 12	14	57.1	31, 83
	Bereket	144	8.3	4, 13	16	68.8	46, 92
	Mykadra	356	9.6	7, 13	32	84.4	72, 97
	Total	1120	7.7	6, 9	110	63.6	55, 73
Extensive	Welkait	220	0.91	0.4, 2	55	3.6	0, 9
	Tsegede	528	0.95	0.1, 2	132	2.3	0, 5
	Humera	100	3.00	0, 6	23	8.7	0, 20
	Total	848	1.2	0.5, 2	210	3.3	1, 6

n^i: total individual animals tested; n^h: total herds sampled.
[a] Includes individual cattle and herds from Tirkan Aidola, Rawian, Humera town, Hagereselam and Adigeshu.

Table 3
Seroprevalence of brucellosis in *barka* and *arado* cattle managed under similar production systems in Western Tigray Zone, North West Ethiopia.

Production system	Breed	*n*	Prevalence (%)	*P*-Value	OR	95% CI of OR	
						Lower	Upper
Semi-intensive	*Barka*	1018	8.3	0.028	9.202	1.268	66.786
	Arado	102	1				
Extensive	*Barka*	182	0.5	0.390	2.479	0.312	19.699
	Arado	666	1.4				

n: total sample.

Table 4
Summary results of the univariable and multivariable logistic-regression analyses (LR) of risk factors with dependent *Brucella* seropositivity in cattle in Western Zone of Tigray, North West Ethiopia.

Risk factors	Category levels	*n**	Prevalence (%)	Univariable LR analysis results				Multivariable LR analysis results			
				P-Value	OR	95% CI of OR		*P*-Value	OR	95% CI of OR	
						Lower	Upper			Lower	Upper
Production system	Extensive	848	1.2	>0.0001	6.97	3.60	13.5	0.004	3.382	1.49	7.67
	Semi-intensive	1120	7.7								
Breed	*Arado*	768	1.3	>0.0001	5.85	3.02	11.34	0.070	2.130	0.94	4.83
	Barka	1200	7.2								
Sex	Male	446	2.7	0.017	2.11	1.14	3.91	0.026	2.029	1.09	3.78
	Female	1522	5.5								
Age	<3 years	702	3.4	0.017	–	–	–				
	3–6 years	822	4.9	0.162	1.45	0.86	2.42				
	>6 years	444	7.2	0.005	2.19	1.28	3.78	0.012	1.427	1.08	1.88
Herd size	<5 cattle	351	1.1	>0.0001	–	–	–				
	5–10 cattle	721	3.1	0.067	2.73	0.93	7.98				
	>10 cattle	896	7.8	>0.0001	7.35	2.66	20.29	>0.0001	2.014	1.38	2.95

statistical analyses of all risk factors, the first level of each independent variable was used as a reference category. The result indicated that seropositivity to *Brucella* antibodies in semi-intensive production system was significantly ($P < 0.0001$) higher than in the extensive one. There were significant ($P < 0.0001$) differences among the herd sizes with higher seroprevalence in large herds. *Barka* breed demonstrated higher seroprevalence (7.2%) compared to *arado* (1.3%). Univariable logistic-regression model showed that cattle with ages of above 6 years had significant impact on animal seropositivity to brucellosis ($P = 0.005$). Female cattle demonstrated higher seroprevalence.

The multivariable logistic-regression model (Table 4) showed that production system, sex, age and herd size were significantly associated with cattle seropositivity. However no significant association ($P = 0.070$) was observed between breeds and seropositivity. Nevertheless, Odds Ratio (OR) = 2.13 was greater than one.

3.4. Association of brucellosis seropositivity with management risk factors and some reproductive parameters

Though all herd owners were provided to fill the questionnaire, there were some non-returned questionnaire papers and only those forms with full information were eligible for analysis. Thus questionnaire data from 110 and 62 sample herd owners from the semi-intensive and extensive production system, respectively, were analyzed to correlate the associations of the management and husbandry risk factors with serological results. Questionnaire and test result in the extensive production system revealed no positive results. In contrast, in the semi-intensive production system, it was observed that 24.5% (27/110) of the respondents had seropositive cattle. Among the management and husbandry risk factors, less *Burcella* antibody seroreactors (3.1%) were revealed from cattle owners who sell and slaughter animals with infertility problems than those who kept with the herd (32.9%; Table 5). There was no difference in seropositivity between the grazing systems. Similarly, the impact of *Brucella* antibody seroprevalence on herd reproductive performance was analyzed by comparing serological results with questionnaire data. Higher *Brucella* antibody reactors (36.1%) were observed from cattle having above 15 months of calving interval compared to below 15 months (10.2%) ($P = 0.002$, OR = 4.964).

3.5. Sensitivity and specificity of RBPT and CFT

A summary of the RBPT and CFT test results for the sera at the individual animal- and herd-level used for the calculation of sensitivity and specificity of the tests is presented in Table 6. Values calculated at the individual animal level for the sensitivity and specificity were, 100% (95% confidence interval (CI): 96.23–100%) and 99.04%

Table 5
Association of management and husbandry risk factors with *Brucella* seropositivity in cattle managed under semi-intensive production system in Western Tigray, North West Ethiopia.

Management and husbandry risk factors	CFT test		*P*-Value	OR	95% CI of OR	
	*n**	Prevalence (%)			Lower	Upper
Grazing system						
Individual	67	22.4	0.512	1.342	0.557	3.235
Communal	43	27.9				
Culling method (cattle having infertility problem)						
Sell and slaughter	31	3.1	0.001	14.717	1.901	28.964
Keep with their herd	79	32.9				
Watering point						
Wells	32	6.3	0.003	7.075	1.566	31.974
River	78	32.1				
Disposal of fetal membrane						
Burring	21	14.3	0.272	2.215	0.598	8.201
Throwing to the field	89	27.0				

Table 6
Summary of RBPT and CFT test results of *Brucella* infected sera in individual animal- and herd-level of cattle of Western Tigray, North Western Ethiopia.

	Individual animal level		Total	Herd-level		Total
	CFT (+ve)	CFT (−ve)		CFT (+ve)	CFT (−ve)	
RBPT (+ve)	96	18	114	77	12	89
RBPT (−ve)	0	1854	1854	0	231	231
Total	96	1872	1968	77	243	320

(95% CI: 98.48–99.43%) respectively. Similarly, the sensitivity and specificity of the tests at herd-level were 100% (95% CI: 95.32–100%) and 95.06% (95% CI: 91.53–97.43%), respectively.

4. Discussion

Seroprevalence of bovine brucellosis have been established at different times from various regions of the country (Tekleye et al., 1989; Tariku, 1994; Yilkal et al., 1998; Abay et al., 2000; Kelay, 2002; Mussie, 2005; Berhe et al., 2007). These studies also address the occurrence of the disease in various breeds. There was no data however on the status of the disease in the remote part of northern Ethiopia where indigenous *barka* cattle breed at large followed by *arado* breed dominate the cattle production. An overall seroprevalence of 4.9% was found in our area. This proportion is considerably higher than that was reported previously in crossbred dairy (exotic and indigenous breed) cattle in the region (Berhe et al., 2007).

The rates of infection vary greatly from one country to another, within a country and production systems (Acha and Szyfers, 2001). Comparison of seroprevalence in the different production systems indicated that the occurrence of the disease, both at individual- and herd-level, was much lower under the extensive production system than that of the semi-intensive. At individual level, there was no significant difference observed among all towns where cattle are kept under semi-intensive production system; nevertheless, proportionally higher seropositive cattle were found in Mykadra and Bereket compared to other towns. No significant difference was observed among the different districts under the extensive management system though the odds ratio for Humera district was more than two. The finding of higher herd seroprevalence in the semi-intensive system was interesting. The figure ranged from 43% to 84.4%. Our finding also revealed that 70 herds out of the 110 sampled (63.6%) were maintaining at least one seropositive animal. Herds from Bereket and Mykadra kept under the semi-intensive system demonstrated statistically significant higher prevalence than in other towns. The reason for higher prevalence in these areas was probably due to the fact that these areas are located on Sudan and Eritrea borders where free animal movement is common. Mixing of animals from different areas can facilitate spread of the disease between an infected herd and *Brucella* susceptible free herds (Kubuafor et al., 2000; Menachem, 2002). Absence of veterinary services, such as vaccination, in the remote part of the districts and little awareness of the diseases among cattle owners may have contributed to the relative higher occurrence of the diseases.

Univariable logistic-regression analysis of the risk factors indicated that production system, herd size, age, sex, and breed were highly associated with brucellosis seropositivity. The variation in seroprevalence of different production systems agrees with previous reports (Abay et al., 2000; Kassahun, 2004; Mussie, 2005). Stocking densities are important potential determinants for brucellosis transmission (Omer et al., 2002; Muma et al., 2007). This concept coincides with the current study that the seroprevalence of brucellosis among three categorized herd sizes showed significant variations with higher seroprevalence recorded in the large herd size. The rise of infection rates with age is consistent with previous reports (Abay et al., 2000; Kubuafor et al., 2000; Omer et

al., 2002). Female cattle demonstrated higher prevalence ($P = 0.017$) than male animals. Cows are kept longer in a particular herd than bulls; this is particularly true in the semi-intensive production systems where *barka* cattle are kept for dairy purpose. This may explain the variation observed in the sexes.

An attempt was also made to compare the seropositivity rates between *arado* and *barka* cattle. Higher seroprevalence with significant difference ($P < 0.0001$) was revealed in *barka* breeds in the univariable regression analyses but due to some confounders no difference ($P = 0.070$) was observed in the results of adjusted multivariable regression analysis. This may raise a question of if there was a variation in breed susceptibility. We examined the serum of *arado* and *barka* cattle under the same production system. Apparently 1% of *arado* and 8.3% of *barka* cattle breed were found seropositive in the semi-intensive production system, which was significantly different ($P = 0.028$). However, no statistically significant difference ($P = 0.390$) was recorded between the two breeds in the extensive production system. The difference was found only in cattle breeds that are grouped together in the semi-intensive production system. Our data suggests that the management system where *barka* cattle are raised played a pivotal role for increased seroprevalence in the breed. *Barka* breed is raised in semi-intensive production system while *arado* are kept under the extensive ones.

Management risk factors, such as, grazing site, watering point, culling methods and disposal of fetal membranes have been incriminated to contribute in the disease's prevalence (Jiwa et al., 1996; Mussie, 2005; Muma et al., 2007). Our study confirms these management risk factors had considerable risk to seropositivity. Farmers that disposed the fetal membrane to the fields and gave to dogs as well as those who used communal grazing system were found to have high proportion of seroreactors. Animals in private grazing area demonstrate lower seroprevalence than those at communal. This agrees with the findings of Muma et al. (2007). The difference was, however, not significant. The relatively lower sample size may be the reason for it. Considering the contagious nature of *Brucella* species, sharing grazing land and drinking water facilitate transmission of the disease (Mussie, 2005; Muma et al., 2007). Culling method and watering points had significant risk to seropositivity. This is in agreement with Muma et al. (2007) where farmers that used individual wells, as watering points had lower proportions of seroreactors than farmers that used communal ones. Farmers who cull animals with fertility problem through slaughtering and/or selling, had less ($P = 0.001$) herd seroreactors than those who retain such animals in the herd. Walker (1999) indicated brucellosis transmission was high when infected animals were found in the herd. This result was common habit among farmers in our study area. Cattle are kept for prestige and farmers are unwilling to sell their cattle even in the face of infertility. This could have increased the risks of disease transmission.

Brucellosis causes heavy economic losses to livestock producers that stems from abortion, loss of calves and increasing calving interval (Georgios et al., 2005). This is consistent with the present study at which seropositive *barka* cows had relatively longer calving intervals than the seronegative ones, one potential explanation for the farmer's skeptical attitude towards the regional government plan of 'one *barka* cow to poverty-prone and new settlement areas'.

In conclusion, the results of the present study revealed that bovine brucellosis is widely distributed in indigenous cattle breeds of the Western Zone of Tigray. The rate was higher in *barka* breed, a breed traditionally meant for semi-intensive production system. However, the apparently higher brucellosis prevalence in *barka* cattle as compared to the *arado* breed is attributed to the management system by which *barka* is reared. The presence of higher positive seroreactors among the *barka* cattle was mutually exclusive with the strategy of the regional government of providing *barka* cattle to farmers to up-grade the genetic potential of less productive *arado* cattle. Hence, the findings of positive serological reactors does not only suggest the occurrence of the disease in cattle population of the study area, but also indicates the presence of foundation (foci) of infection that could serve as source of infection for the spread of the disease into unaffected animals around and elsewhere in the new settlement areas. The husbandry and management systems were found important risk factors associated with *Brucella* seroreactors. Extension service system aiming at proper hygienic practices and good husbandry practices should improve efforts to combat the disease transmission to livestock and owners. Simultaneously with regional government, screening test should be carried out before distribution of *barka* cattle breeds from the study area to other poverty-prone districts and new settlement areas.

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