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Original Research

Epidemiology of Calf mortality, Reproductive Health and Performance traits of Heifers and Cows in Dida Tuyura Ranch, Boranaa Oromia, Ethiopia

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Abstract

This study was performed in Dida Tuyara Government Ranch in Boranaa Zone, Oromia Regional State, with the objective of assessing the epidemiology and factors associated with calves' mortality and reproductive performance of the Borana cattle breed. The study was based on the retrospective epidemiological record of calves, heifers, and cows. The data was taken from 1994–2010 on the calf mortality rate and 1994–2005 on the reproductive performance of the breed on the ranch. The retrospective data collected over the years was used to identify factors associated with calf mortality or death to see if the motto of the farm was attained in rearing a sufficient number of calves, improving replacement heifers and bulls for the ranch, and redistributing pure line breeding for the community. The retrospective data collected was analysed with Microsoft Excel version 20 and generated descriptive statistics of the parametric variables. A chi-square test of significance was used for the non-parametric variables for associated risk factors for calves' mortality and reproductive performance. The mortality rate of calves before and after weaning was 13.3% and 11.2%, respectively. Age, sex, and birth weight of the calf had a significant effect on the mortality rate. The overall mean values of age at first service, age at first calving, calving interval, days open, and gestation length were 42.52, 51.67, 20.67, 11.30, and 9.30 months, respectively. Parity had a significant effect on both the calving interval and days open. Gestation length was not significantly affected by parity, sex, or the birth weight of the calf. In conclusion, from the present study, it can be concluded that the excess calf mortality rate and inefficient reproductive performance factors were found to be major problems for the ranch not to achieve its pre-established objective of producing sufficient replacement calves and bulls for the pastoralists and need to be corrected if selection-based breeding of the Boranaa breed is to be successful.

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INTRODUCTION

Ethiopia, with its 52 million head of cattle, has the largest cattle population in Africa (CSA, 2010). Cattle production plays an important role in the economies of farmers, pastoralists,

and the country at large. The agricultural sector in Ethiopia, which engages 80% of the population, contributes 52% of the gross domestic product (GDP) and 90% of the foreign exchange. The livestock sub-sector contributes an estimated 12% to total GDP and over 45% to agricultural GDP. (MOA, 2010) Cattle produce a total of 1.5 million tonnes of milk and 0.331 million tonnes of meat annually (FAO, 2005). In addition, 14 million tonnes of manure are used annually primarily for fuel, and six million oxen provide the draught power required for the cultivation of cropland in the crop-livestock mixed production system (Azage & Alemu. 1997).

Borana, a popular cattle breed, is predominantly utilised and widely distributed across various countries in Africa. The Ethiopian Borana breed is one of the cattle breeds widely used in Ethiopia (Rege JEO *et al., 2006;* Ojaango GM *et al., 2006).* Available archaeological records indicate that Zebu cattle are the most recent types of cattle to be introduced into Africa. Recent molecular genetics as well as archaeological evidence (Marshal, 2000; Hantote *et al., 2002)* also showed that the introduction of Zebu cattle into Africa centred in East Africa rather than through the land connection between Egypt and the Near East. Their hardened hooves and lighter bones enable them to endure long migrations. These adaptive attributes have facilitated their importation and spread by Indian and Arabian merchants across the Red Sea to the drier agro-ecological regions of the Horn of Africa (Loftus & Cunningham, 2000).

The Borana breed originally descended from the first introduction of Zebu into Africa from West Asia. The breed established its presence first in the semi-arid and arid pastoral Boranaa plateau of southern Ethiopia. The Boranaa pastoralist community maintains it. Pastoral movements and migrations led to the spread of the Ethiopian Borana to the eastern rangelands of Ethiopia as well as into northern Kenya and southwestern Somalia. The Orma Borana, the Ethiopian Borana, and the Kenya Borana have evolved from these migrations, whereby only the Orma and the Ethiopian Borana exist on the Borana plateau. (Rege *et al., 2006;* Hantote *et al., 2002)*

The Borana subtype in Ethiopia is considered to be the original pure one. The breed is well adapted to semi-arid tropical conditions, has a high degree of heat tolerance, is tolerant of many diseases prevailing in the tropics, and has the ability to survive long periods of feed and water shortages. 10 (Hantot *et al*., 2000) Besides, comparisons of the reproductive performance of Ethiopian Borana with other indigenous breeds in Ethiopia indicated that Borana cattle calve at a younger age and have a shorter calving interval (Rege *et al., 2006;* Ouda *et al.,* 2001).

Today, the existence of this breed is threatened due to various underlying causes, the most important of which are bush encroachment and recurrent droughts, poor herd management, and difficulties in accessing markets (Coppock, 1994). With these facts in mind, Dida Tuyura cattle breeding and improvement ranch was the only ranch involved in the improvement of Borana cattle in Ethiopia. It was established in 1987 on 5550 hectares of land with the objective of conserving and improving the Borana breed

through selection and controlled breeding. It also supplies pure Borana bulls and heifers for local pastoralists and other concerned bodies. Calf mortality rate and reproductive parameters are among the most important factors affecting progress in selection. So far, little is known about the calf mortality rate and reproductive performance of this breed, especially at Dida Tuyura Ranch. Therefore, the present study was designed to:

- To depict the long-term trend of calf health or mortality rate of Borana in the ranch
- To identify factors that are associated with a calf mortality rate
- To evaluate the reproductive performance of Borana cattle and
- To assess the non-genetic factors affecting reproductive performance under ranch conditions

MATERIALS AND METHODS

Study Area

The Dida Tuyura cattle breeding and improvement ranch is found in the Boranaa plateau, Boranaa Zone, of Yabello district and is situated about 550 km south of Addis Ababa and 20 km north of Yabello town (Figure 1). It is part of the Boranaa plateau, which covers 95,000 km2, or 8.5% of the total area of Ethiopia and 14.6% of the lowland areas. Yabello district is characterised by a rather semi-arid climate. The annual mean daily temperature varies from 19 to 24 ºC. The average annual rainfall, as registered by the National Meteorological Service Agency at Yabello Station, is 600 mm. The rainfall distribution is bimodal but erratic and unreliable. About 59% of annual precipitation occurs from March to May and 27% from September to November (Coppock, 1994).

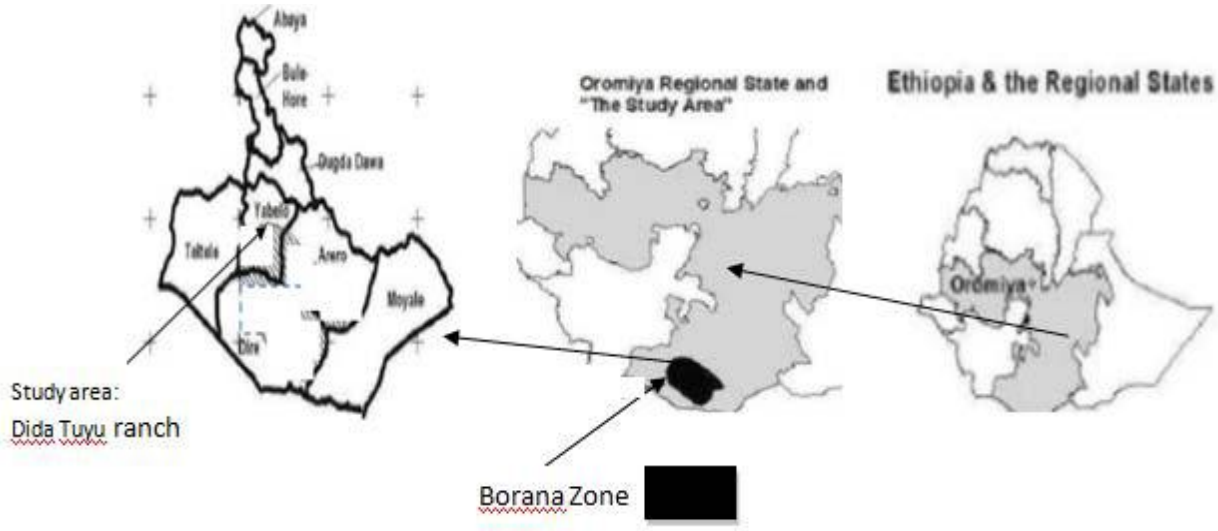

Figure 1 *Map of Boranaa zone, Oromia, Ethiopia*

Study Animals and Management

At Dida Tuyura Cattle Breeding and Improvement Ranch, the Borana breed is maintained. They are reasonably large and have good general body conformation. Their colour is mainly white, light grey, fawn, or light brown, with grey, black, or dark brown

shading on the head, neck, shoulders, and hindquarters. The horns are thick at the base, very short, erect, and pointing forward. The hump is well developed in the male, is of pyramidal shape, and overhangs to the rear or to one side. The dewlap is well developed. In the male, the preputial sheath is pendulous, while in the female, the udder is well developed. Average wither height is 118 to 124 cm in males and 116 to 120 cm in females. Body weight ranges from 318 to 680 kg in males and 225 to 454 kg in females. The breed is known for its tolerance to heat stress and seasonal feed shortages. (Albero & Haile Mariam, 1982)

The management of the ranch is an extensive system. Animals are herded into groups based on age and sex. They constantly graze natural pastures year-round. Dry (hay) grass was collected from the field, stored, and used as a source of feed in the dry period. Supplementary feed during the long dry season was given in limited amounts to all groups of cattle. Ponds in ranches are the water source for cattle (once per day), except calves. There is an ad libitum tap water source for calves and weak animals.

Calves suckle their dams once a day from 4 or 5 days of birth up to 2 months of age. After 2 months, calves are allowed to run with their dams until weaning at six months of age. Based on weight, body conformation, and health status, both males and females are selected for further breeding. Animals were grouped into a 1 (male) ratio of 30 to 50 (females) during the mating period (June, July, and August). Heat detection was practiced during grazing time by observation of unskilled herd's men and experience in natural mating. Pregnancy was confirmed by rectal palpation. Different categories of cattle, like heifers, cows, bulls, and weaned calves, were kept separately outside, but calves less than six months old were kept in common pens.

The veterinary medicaments and requirements budget were supplied by the Oromia Pastoral Development Commission. Cattle greater than six months old on the ranch were routinely vaccinated against anthrax, blackleg, pasteurellosis, contagious bovine pleura pneumonia, and foot and mouth disease. Preventive measures for both external and internal parasites were also carried out regularly.

Study Design

A retrospective epidemiological study was carried out to evaluate the calf mortality rate and reproductive performances of Borana cattle on the ranch. Recorded data from 1994–2010 on the calf mortality rate and 1994–2005 on the reproductive performance of the breed in the ranch were used for this study. Recent data can't be obtained due to the poor recording system on the ranch for both calves and cows. Only the data of cows and calves with complete information were included in the study. The retrospective data collected over the years was used to identify factors associated with calf mortality or death. For reproductive performance**,** Borana heifers born from 1994 to 2005 were used to determine the age at first service and age at first calving. Additionally, cows that gave birth from 1994 to 2005 at varying parity levels were included in the study to determine the calving interval (CI), days open (DO), gestation length (GL), and non-genetic factors associated with them.

Data collection and analysis

Data on **Borana** cattle breed calves in Dida Tuyura Ranch from 1994 to 2010 were collected from herd records. Information on calf identification number, birth date, and sex of calf, birth weight, weaning date, a terminal event like death, and their dates were collected. A total of 929 records were available for analysing the mortality rate of Borana calves. At the same time, reproductive records (1994–2005) were used to estimate age at first service (AFS), age at first calving (AFC), calving interval (CI), days open, and gestation length (GL), respectively.

Collected data were entered into a Microsoft Excel sheet and analysed using SPSS (version 20). The percentage of calves that died was calculated with descriptive statistics. The effect of age, sex, and birth weight of the calf on the calf mortality rate was analysed by X^2. In addition, descriptive statistics were used to summarise the mean and standard error of reproductive performance parameters. The effect of different factors on reproductive performance was analysed by a general linear model.

RESULTS

Calf Mortality and Mortality Rate

The mortality rates of 929 calves are presented in Table 1. The cumulative mortality rate of calves was 24.5%, with 13.3% before weaning and 11.2% after weaning. The mortality rate of calves was compared for different age, sex, and birth weight categories. The comparison indicated a statistically significant difference ($p<0.05$) in the probability of calf mortality between different age groups, sexes, and varying body weight categories (Tables 1 and 2).

Table 1

Calf Mortality Rate in Dida Tuyura Cattle Breeding and Improvement Ranch from 1994 to 2010

Out Come	Number of Animals	Percentage	*p* value
Dead before weaning age	124	13.3	
Dead after weaning age	104	11.2	0.023
Survived	701	75.5	
Total	929	100.0	

Table 2

Associations of Sex and Birth Weight of Calf with Calf Mortality Rate

Factors	Number at birth	Dead (%)	Survived (%)	*p* value
Over all	929	24.5	75.5	
Calf sex				
Males	701	75.5	929	0.026
Females	929	100.0	929	
BW of calf				
≤20Kg	286	11.2	19.6	0.041
21-25Kg	443	9.1	38.5	
>25 Kg	200	4.2	17.4	

Reproductive Performance

The overall mean values and standard errors of age at first service, age at calving, calving interval, days open, and gestation length of Ethiopian Borana heifers and cows at Dida Tuyura cattle breeding and improvement ranch were 42.52±1.02, 51.67±1.00, 20.67±0.57, 11.30±0.57, and 9.30±0.05 months, respectively (Table 3).

Table 3

Mean Reproductive Parameters of Heifers and Cows in the Study Site

Parameters	No. of observations	Mean±SE
Age at first service	70	42.52±1.02
Age at first calving	70	51.67±1.00
Calving interval	155	20.67±0.57
Days open	155	11.30±0.57
Gestation length	155	9.30±0.05

Calving interval and days open were significantly affected by parity ($p<0.05$) at Dida Tuyura Ranch. Gestation length was not significantly influenced ($p > 0.05$) by parity level, sex, or birth weight of the calf (Tables 4 and 5).

Table 4

Squares Means and Standard Error (LSM±SE) of CI and DO in Association with Parity

	CI (Months)	Days Open (Months)	*p* value
Parity level	Mean±SE	Mean±SE	
Overall	20.67±0.57 (n=258)	11.30±0.57 (n=258)	
1		12.64±0.77 (n=153)	
2	22.00±0.77 (n=153)	9.89±1.01 (n=72)	
3	19.31±1.00 (n=72)	8.99±1.68 (n=21)	<0.05
4	8.36±1.69 (n=21)	6.73±1.52 (n=12)	
5	16.12±1.54 (n=12)		

Table 5

Least Squares Means and Standard Error (LSM±SE) of Gestation Length and Its Association with Parity, Sex and Birth Weight of Calf

Factors	GL(Months)	*p* value
	Mean±SE	
Overall	9.30±0.05(n=427)	
Parity		
1	9.23±0.05(n=169)	>0.05
2	9.30±0.05(n=153)	
3	9.41±0.08 (n=72)	
4	9.33±0.12 (n=21)	
5	9.25±0.19 (n=12)	
Calf sex		
Male	9.33±0.72 (n=219)	
Female	9.26±0.60 (n=208)	>0.05
BW of calf		
≤20Kg	9.33±0.09 (n=118)	
21-25Kg	9.22±0.08 (n=190)	>0.05
>25Kg	9.38±0.58(n=119)	

DISCUSSION

The cumulative mortality rate of calves in the present study was 24.5%. Globally, a mortality rate over 5% is considered to be too high (Alemu & Teshome, 1987; Kifro & Tambira, 1990), and a mortality rate of 20% can reduce net profit by 38%. (Mekonin, 1998) The mortality rate was higher in pre-weaned than weaned calves, and this was found to be statistically significant. At an early age, the immune system of a young calf is under development. Colostrums can provide passive immunity only against those diseases for which the dam possesses antibodies (Blood et al., 1994). The pre-weaning mortality rate of the study was higher than the findings of Amuamuta et al. (2006; Kivaria et al. (2006) who reported 9.4% and 10%, respectively. This difference in the pre-weaning mortality rate might be attributed to the absence of individual pens and the poor housing system at the current study site. However, Lobago et al. (2006; Mortanet et al. (2010) reported higher pre-weaning mortality than the present finding, but within ranges of 15%–25% for dairy farms, which might be associated with a lack of colostrum and a poor management system in the farms studied. The post-weaning mortality rate was lower than previous reports (Fikadu & Tefera, 1993; Asseged & Birhanu, 2004; Amuamuta et al., 2006). The difference in postweaning mortality could be due to the difference in management, which includes timely vaccination, deworming, and proper feeding of the animals.

The present study also showed that calves with a lower birth weight had a significantly higher mortality rate compared to moderate-

and high-body-weight calves ($p<0.05$). This finding was in harmony with previous literature (Lopez, 1985; Radostits et al., 1994), which illustrated that calves with lower birth weight have poor vitality and high mortality. The sex-dependent study showed a lower mortality rate for females compared to males. This finding conforms well to the reports of Amuamuta et al. (2006), Debnath et al. (1990), and Mekonnen et al. (1993). This difference between sexes in mortality rate might be due to preferential care and management for females for the purpose of early growth and breeding.

The mean age at first service observed in the present study at Dida Tuyura cattle breeding and improvement ranch was 42.52 months. The current result was in line with the previous finding of Ali et al. (2006) who reported 42.45 months for non-descript Deshi/Indigenous cows in Bangladesh. The present finding was much greater than the published findings by Mureda et al. (2007) with 26.5 months in Dire Dawa town; Nuraddis et al. (2011) with 23.2 months in Gondar town; and Dinka (2012), with 24.9 months in Asella town for crossbreeds. However, the mean AFS obtained in the current study was lower than local Horro heifers (48.9 months, as indicated by Demissu et al. 2013). The variation between the Borana breed and other breeds of age at first service might be due to the difference in management, environment, and genotype (as evidenced by Gifawosen et al., 2003).

The AFC of the Borana heifer at Dida Tuyura Ranch was found to be 51.67 months. This finding is within the range expected for Bos indicus cattle in the tropics, and the reported values range from 35.1 to 53 months (Alberro, 1983; Mukasa-Mugerwa, 1989). In addition, the present finding was comparatively supported by Melaku et al. (2011) who reported 50.83 months for Fogera cattle. However, other authors indicated lower age at first calving (Mekuriaw et al., 2009) for Ogaden cattle; Shiferaw et al., 2003; Yifat et al., 2009) for crossbreeds. The obtained age at first calving in the current study was shorter than 58.3 months for cattle under smaller holder conditions in Zimbabwe, 59.73 months for Horro heifers, and 54.1 months for Kereyu Sanga cattle reported by Demissu et al. (2013), Masama et al. (2003), and Garoma (2014) , respectively. The longer average age at first calving reported for Borana cattle might be associated with scarcity of feed and shortage of water for the long dry season of the year in the study area. Regardless of the breed, the association of feed availability with attaining age at first calving for heifers was reported (Kiwuwa et al., 1993).

The calving interval found in this study was within estimates of 12.2 to 26.6 months for Zebu cattle reported by Abrha (2006) and also closely agreed with the finding of Yifat et al. (2012) for Borana cows at Tatesa cattle breeding centre, who reported 20.75 months. This finding was higher than 17.81 months found by Ababu (2002) for the Ethiopian Borana herd maintained at Abernossa Ranch and 15.00 months reported by Habtamu et al. (2010) for the Jersey breed at Wolaita Sodo dairy farm. In addition, ILCA (1985) for Borana cows at Mkwaja ranch in Tanzania, Shiferaw et al. (2003) for crossbreed cattle, and Habib et al. (2010) for Red Chittagong cattle at Nucleus herd in Bangladesh reported

a shorter calving interval than the present finding. But the finding was much lower than 26 months of traditionally managed Ethiopian high land in Zebu (Mukasa-Mungerwa, 1989). The variation in calving interval among the observations of different researchers might have resulted due to different sample sizes, genotypes, numbers of parities, and forage availability in any particular year, disease conditions, and days open.

The current study showed that the calving interval became shorter as the parity increased. Generally, a longer calving interval was seen in second parity, which might be due to the stress of sucking calf in young, growing animals in early parity, which thus delays the onset of postpartum heat. In later parities, there is physical maturity with the advancing age of cows. The report was consistent with the findings of Ibramhim et al. (2011) Negussie et al. (1998) on indigenous and crossbreeds. However, other scholars (Agyemang et al., 1990; Haile-Mariam et al., 1996) reported a non-significant effect of parity on the calving interval (CI).

The mean number of days open was 11.30 months, which is similar to the finding of the Yifat et al. (2012) report of 11.34 months. However, this finding was higher than previous reports (Haile-Mariam & Mekonnen, 1997; Haile et al., 2009). Relatively longer DO in the present study might be due to the sucking of calves up to weaning age, which may interfere with ovarian function. The interference of calves sucking until weaning age on ovarian function was indicated (Giday, 2001). A significant association between parity and DO was obtained in this study. The finding was in harmony with other authors (Goshu et al., 2007; Zafar et al., 2008), who reported a significant effect of parity on DO. However, Gifawosen et al. (2001), Yohannes et al. (2001) indicated the non-significance of calving parities on DO.

The overall mean gestation length in the current study was 279 days (9.30 months), which was in comparison with a report by Tegegne et al. (1981). Although gestation length is more or less constant within a given species (Hafez et al., 1993), relatively shorter GL has prevailed from studies (Swensson et al., 1981) for Arsi cattle. Slightly longer GL (291 days) was found by the studies of Alberro (1983) for Ethiopian high-land Zebu cattle.

In the current study, GL was not significantly affected by the parity level ($p > 0.05$). The result was in agreement with the report of Yifat et al. (2009; Habib et al. (2010) and there was an absence of a significant effect of parity on GL, as reported by Melaku et al. (2011; Munim et al. (2006), which indicated a significant effect of parity on GL. In addition, the present study also noted the non-significant effect of sex and birth weight of the calf on the GL. Likewise, the non-significant influence of calf sex on GL was reported by Melaku et al. (2011) Haile-Mariam et al. (1996), and Addisu (1999). However, (Mukasa-Mugerwa et al., 1991; Getinet et al., 2009) found a significant influence of the sex of calf on the GL. The significant effect of the birth weight of calf on the GL was reported by Mekuriaw et al. (2009) which was not supported by the present study.

CONCLUSIONS

From the result of this study, it could be concluded that the calf mortality rate and reproductive performance of Borana in

Ethiopian cattle are within the range of values reported for other tropical and Ethiopian cattle breeds. Given the fact that the study ranch raises their own replacement stock and distributes heifers and bulls to the community and other concerned bodies, the calf mortality rate and reproductive performance inefficiency seen in this study have great hindrances to fulfilling the demand of the community and concerned bodies for improved and pure Borana cattle for breeding and to improving productivity through the distribution of heifers and bulls. Considered factors associated with calf mortality and reproductive performance (parity) have a significant effect on traits and need great management effort towards mitigating the negative impacts of those factors associated with calf mortality and reproductive performance. Thus, the present study recommends that factors associated with calf mortality rate and reproductive performance is serious problems in achieving the objectives of the ranch. Therefore, a detailed study of the factors affecting calf mortality rate and reproductive traits, as well as management factors such as the availability of sufficient feed and water and efficient veterinary service, is mandatory to reverse the impacts of each factor on the calf mortality rate and reproductive performance of the ranch; especially, follow-up on calf health, mortality rate and reproductive performance is vital.

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