Reproductive performance of C*amelus dromedarius* kept under Afar pastoral management system using progeny history testing

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Abstract

A cross-sectional questionnaire survey was conducted to investigate the reproductive performance of camels and associated health problems in Afar pastoralist management system. A total of 293 female camels owned by 110 pastoralists or households were included in the study. The result revealed that the mean (±SD) age at first service and at first calving were 47.1±7.17 months and 64.71±8.93 months, respectively, with a gestation length of 12.12±0.33 months. The mean calving interval was 31.16±8.71 months. The calf mortality rate averaged 12.43% of camel calves, and this might even be higher since more than 26% of the animals are still in their early calf ages. More than 8.5% of the female camels experienced abortion and about 0.7% experienced abortion more than once. About 4.8% of them had conception problems despite repeated services and the mean service per conception was 1.63±0.85. Voluntary camel herd dynamics (Selling, slaughtering, buying) in the Afar pastoralists is very low and awareness creation is important to make use of their animals than just keeping large herd size. Improving reproductive performance by optimal early age service, shortening of the lengthy calving intervals, identifying and solving of major causes of abortion and calf mortality, and proper management for calves could enhance herd development.

Keywords: Abortion, Afar pastoralist, calf mortality, C*amelus dromedarius*, reproductive performance

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Introduction

Pastoralism is extensively practiced in almost two thirds of the land area of the Ethiopia (Rota and Sperandini, 2009). Farmers of hot arid and semi arid desert region relay heavily on livestock enterprises for their sustenance. Camels are an important livestock species in the arid and semi-arid zones in Africa and Asia that accounts for 60% of the land area in Ethiopia and inhabited by pastoralists. Ninety five percent of the 18.9 million camel population of the world are dromedary camels live in Africa, Middle East and 5% are Bactrian camels in Central Asia, China, and Mongolia (Tezera *et al*., 2010). Eighty two percent of the camel population of the world (15.4 million) is found in the African continent. The camel population of Ethiopia has been estimated to be 2.3 million heads which places 3rd in the world next to Somalia and Sudan (Tezera *et al*., 2010). They contribute significantly to the livelihood of the pastoralists and agro-pastoralists living in the fragile environments of (semi)-deserts of Africa and Asia.

Camel production could be a profitable venture for utilizing the vast arid and semiarid areas of Ethiopia where other animals thrive with difficulty especially due to the recurring drought conditions. Under such environmental conditions, camels are the best animals to convert scars feed resources to milk and meat especially during dry season. But full exploration of camels for milk and meat production would only be possible when their reproductive performance is properly understood and improved. Unfortunately, dromedaries are reported to have low reproductive efficiency compared to other domestic species (Faye, 2005; Kaufmann, 2005; Skidmore, 2005; Kalla *et al*., 2008; Hermans, 2009). Reproduction is a key factor for improved livestock performances; camel reproduction, however, is not as advanced as other livestock species. In addition to feed, water and diseases, the apparently low reproductive performances of camel is a major problem for camel production improvements. The low reproductive performances could be attributed to late age of puberty, long gestation length, poor management of pastoralists, environmental factor and other physiological and pathological reasons.

Only very few published research findings by Zeleke and Bekele (2000), Tefera and Gebreah (2001), Bekele *et al*. (2002), Biffa and Chaka (2002), Tezera and Kassa (2002), Mehari *et al*. (2007) and Megersa *et al*. (2008) have been

conducted which were not representative as neither of them represented the current study areas and most of them are conducted before 10 years. In addition, previous studies were conducted based on brief visits to generate production performance data and concerned more on milk production and identification of production constraints but not on the reproductive performances. The objective of this research was therefore to study reproductive performances of camels (*Camelus dromedarius*) kept under their natural pastoral management system using progeny history testing techniques.

Materials and methods

Study area and study animals

The study was conducted at selected camel rearing districts of Afar National Regional State (ANRS). Visits were made to the selected pastoral herds based on the pastoralists' willingness to participate in the study and to provide information. Much of Afar region is dry and rocky, unsuitable for cultivation. Out of the total area of the region, estimated area of 97, 250 km^2, cultivated and arable land constitutes 5.24%, forest 1.54% bush and shrub 18.62%, grass land 1.56% marshy land 2.74%, water bodies 0.63%, and degraded and rocky land 63.7% Central Statistical Authority (CSA, 2011). The altitude of the area ranges from a minimum of 166 m below sea level to a maximum of 1500 m above sea level. Temperature varies from 25 °C during the wet season to 48 °C during the dry season. Rainfall is erratic and scarce, and annual precipitation ranges from 200 to 600 mm. The region is frequently exposed to drought and is classified as one of the drought prone regions in Ethiopia. The pastoralists use a lunar calendar in which each year is identifiable by its name (CSA, 2011).

Camels were the study animals considered in this research and information about the reproductive parameters of the Afar camels were collected using progeny history testing technique (Kaufmann, 2005) on 293 female camels and 792 parturitions. This method relies on the herders' intimate knowledge of their camels and long lasting memory of their life history. Physiological status (dry, lactating or pregnant) and previous breeding history of the herd were obtained by using the progeny history questionnaire. Age of the camels was determined by examination of eruption of the permanent incisors and also most importantly by questioning of the herd owners. In almost all the cases our age determination coincides with the information from the owners. In

cases of differences between the two techniques, we go for dental information as the owners sometimes might forget the ages of some camels.

Methodology

Pastoral camel husbandry systems seem to be particularly suited for the use of the progeny history surveying technique due to the following reasons. Camels have a high status in the pastoral society, to the extent that their well-being may be valued equal to that of family members. With their long life expectancy they are members of the pastoral household for over two decades. In the systems under study, on average the herders possess in general only a small number of breeding female camels and identify them by names. Remembering events and histories is part of the pastoral culture often making use of a calendar-based recollection of events (Kaufmann, 2005). The progeny history surveying technique was originally developed in Ethiopia by a team from the Ministry of Agriculture and has been used extensively by International Livestock Research Institute (ILRI). For assessing animal production, the method has gained importance nearly during the last two decades and was used by Baumann and Zessin (1992), Scoones (1992) and Kaufmann (2005) in order to collect data for calculating performance parameters of camels. It has recently found its entrance in advisory books on field data collection in livestock systems from International Institute for Environment and Development and Food and Agriculture Organization (IIED and FAO) (Catley, 2000).

The progeny history questionnaire designed includes for the dam: her name, date of birth, acquisition (date, reason, location, age), breed, milk performance (good, average, poor), udder abnormalities, number of calves, occurrence of abortions and conception problems and current reproduction status. For every calf, date of birth, sex, and present whereabouts and at reason for death or selling were recorded. In the progeny history questionnaire, the dates were specified by year and season and later converted into months for the sake of data analysis. The questionnaire was adapted from Kaufmann (2005) and the progeny history testing technique questionnaire is presented in annex 1.

The data generated for the dam were compared with the data collected separately for the single calves in order to see whether the information was consistent. Some inconsistent questionnaires were excluded from analysis. The main reproductive parameters considered include: age at first calving, calving interval, abortion

rate, breeding life, numbers of services per calving, age at first service, gestation length, and other reproductive parameters. From the collected data, mortality rates were calculated as follows:

a) Crude death rate % = [number (No.) of deaths/ average herd size] x100;
b) Young stock death rate = (No. of deaths of animals <1 year/ No. of live births) x 100 (Kaufmann, 2005). Other aspects of reproduction considered include seasonally of breeding that includes mating, conception and calving.

Data analysis

The statistical program for social sciences (SPSS) for Windows version 15 was used to estimate the means and standard deviation (mean±SD) for the reproductive parameters considered. Frequency distribution figures were also calculated for relevant reproductive and some production parameters. Age at first calving was calculated as the time span between date of birth and date of first parturition for breeding females for both female camels born in the herd and these heifers acquired from known herds. Calving interval was calculated as the time span between two subsequent parturitions. Abortion rate was calculated as the number of abortions per number of all pregnancies recorded. Calf mortality was calculated as the number of calves born alive but died before weaning (at 12 months of age) per number of all calves born.

Results and Discussion

A total of 293 Afar breed female camels and about 792 parturitions were considered and the reproductive parameters were analyzed and presented as follows. It would have been important to include herd composition data, which actually was found to be very difficult for us to collect such data as the Afar pastoralists did not want to give such information because of some cultural hindrance

Herd demography is influenced by the reproductive parameters, age at first calving, calving interval, mortality and culling rate. An initial population has to be specified with sex, age and parity for each animal at herd level. The study faced difficulties to collect information about the number of camels owned in a herd because of the misunderstandings and cultural issues they believe as sensitive. This makes the simulation of herd dynamics difficult to estimate at annual basis.

Reproductive parameters

Reproductive parameters evaluation of camels in pastoral systems is difficult because of the absence of animal recording and the limitations to collecting long-term data based on memory of the owner. However, such long-term data can be collected from high animal numbers using the Progeny History surveying technique. Reproductive efficiency in Camelidae is considered low (Kaufmann, 2005).

1. Age at first service and age at first calving:

Mean age (±SD) at first service of the camels is 47.1±7.17 months (n=293). Afar camels' ages at first service ranged from 36 to 72 months with 63.48% <48 months and 1.37% >60 months.

The average age at first calving of Afar camels is found to be 64.71± 8.93 (Mean±SD) months. About 5.8% of the camels reach age at first calving less than 60 months, and late age at first calving of over 72 months of age occur in 6.48% of all first calvings. Frequency distributions for age at first calving are given in Figures 1a and 1b.

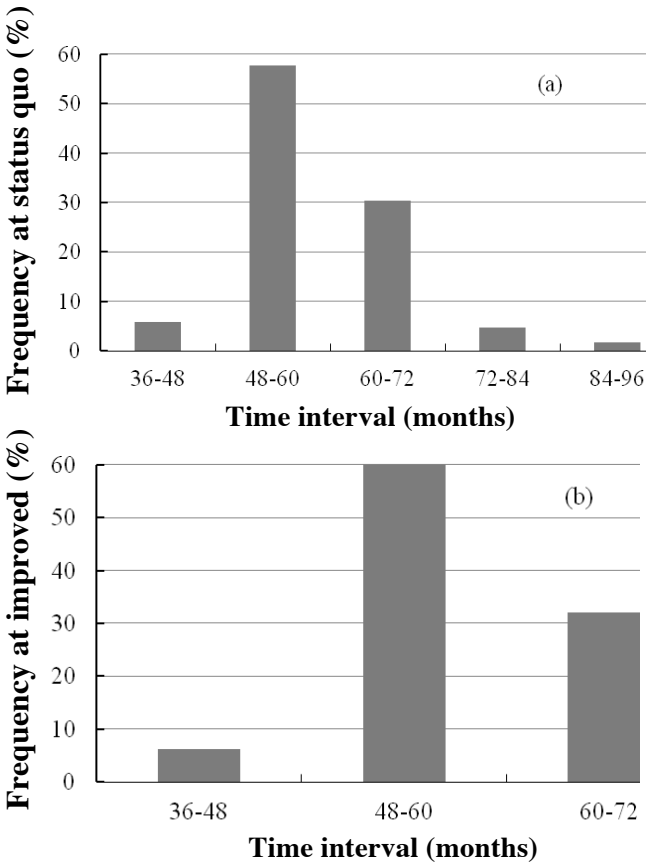

Figure 1. Age at first calving of Afar camels at status quo (a) and after reproductive improvement (b).

The mean age at first calving for the Afar camels agrees with that reported by Kaufmann (2005), Megersa *et al*. (2008) and Tura *et al*. (2010); however, our finding shows lower than the 84 months reported from Somalia (Baumann and Zassin, 1992). On the contrary, age at first calving is much higher than the report of Abbas *et al*. (2000), which was 52 months under intensive production system. This comparison really shows that management system clearly

affects the age at which the camels can reach for their first service and ultimately gives their first calves. This difference might attributed to the fact that in the intensive system of management, supplementation of minerals' and other feeds for young camels and calves lead to early maturity and early age of first calving.

2. Calving interval and gestation length of the Afar camels:

The mean calving interval is 31.16±8.71 months (mean±SD; n=293). The Afar camels are usually only mated after calves are fully grown up (mostly after 12 months of age) avoiding the stress caused by simultaneous gestation and lactation under the harsh production conditions. As the gestation period is 12 months a calving interval of approximately 2 years is considered to be normal in the Afar society. In the Afar camel population 49.49% of all calving intervals were between 18 and 24 months (Figure 2 a, b).

These long calving intervals can occur during droughts when neither female nor male camels restart sexual activity and eventually may lead to repeated service, conception problems and abortions. Kaufmann (2005) reported that the mean calving interval was approximately 27, 28 and 28 months for Rendille, Gabra and Somali camels, respectively. In Somalia, long calving intervals averaging 34 months were reported (Baumann and Zesssin, 1992). However it is very much higher than reports in more intensive camel husbandry systems in Saudi Arabia in that the mean age at first calving was 52 months and the calving interval was 20 months (Abbas *et al*., 2000).

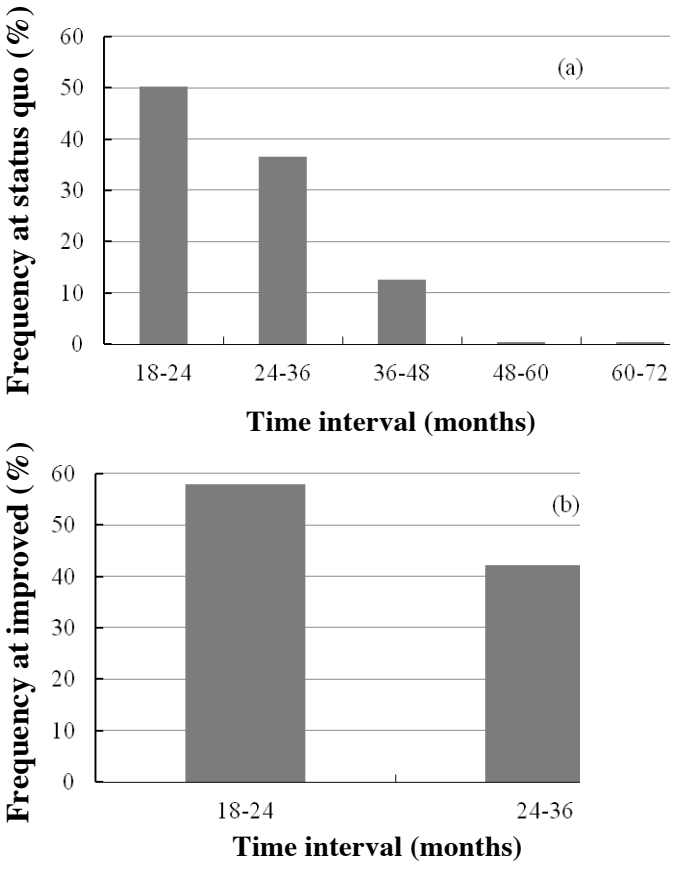

Figure 2. Calving interval of Afar camels at status quo (a) and after reproductive improvements (b).

Improvement of nutrition after dry season primarily stimulates to trigger the reproductive functions of camels in most reports (Bekele *et al*., 2002; Marai *et al*., 2009; Ali *et al*., 2010). The seasonality nature of *Camelus dromedarius* reproductive activity impairs their reproductive performances. This is because, if conception fails in that particular breeding season it is a must that it will be delayed until the next breeding season, hence prolonged calving interval, which eventually decreases the production and productivity of the camels that in turn affects pastoralists' livelihood. The gestation length of Afar camels ranges from 12-13 months with 12.12± 0.33 months (mean±SD; n=293). The camel owners raised the question why gestation length longer these days than earlier times with unknown reason. However, in the questionnaire we collected more than 87% of the camels have gestation length less than 12.5 months. The mean gestation length is in line with the reports of Al-Dahash and Sassi (2009) which ranged from 365-390 days. Previous pastoral systems study indicated that such reproductive parameters of *Camelus dromedaries* have seasonal reproductive functions, breeding and calving seasons which correspond to the biannual rainfall pattern (Kaufmann, 2005).

The Afar camels become sexually active in most of the cases during the months of September and December (Gilal) according to their local name which signifies relatively cool weather that can be related to better availability of feed?. However, the main and short rainy seasons are reported to be from July to August and from March to April, respectively. On the other hand, camels are known to show lactation anoestrus resulting in to the prolongation of calving intervals. According to the informants, early calf losses are mostly accompanied by cessation of lactation and those camels that have lost their calves in early lactation period are likely to conceive earlier and corroborate previous reports by Simpkin (1985) and Kaufmann (2005).

3. Abortion in camels:

From a total abortion cases reported in this study about 1.4% of the camels included in this study have aborted more than one time. Majority of abortion (68%) occurred at the early age of gestation and the rest at later age of gestation. For the abortion rate, it was very difficult to follow the recorded pregnancies since it is calculated as number of abortions divided by total number of pregnancies and this also holds true in the case of calving rate. Since herders normally do not notice early abortions, these

percentage abortions are likely to be underestimated. According to the camel owners, late abortions, lactation might start and dams can sometimes be milked by using the aborted fetus body remnants like skin to stimulate and make the dam to avail herself for milking whenever the need arises. They keep the skin of the calf and bring to her to lick while they milk or they prepare dummy calf by filling the skin of the calf with straw and put as the calf in standing position in front of the mother. The age classification of camel gestation length as early and late to signify the abortion time in this study was less than 7 months early and greater than or equal to 7 months was considered to be late. Seven months of gestation age was considered as cutting point since dams can lactate if they abort at 7 months of their pregnancy and above but not earlier age of this month.

4. Total mortality rate and calf mortality rate:

Of the total 740 camels, the total mortality rate and calf mortality rate of Afar camels is estimated to be 15.8% and 12.43%, respectively. The percentage of calf mortality from the total camel death rate in the region accounts for more than 78.67%. The percentage of calf mortality might even be higher than the calculated value since about 26.22% are still suckling calves of less than 1 year at the time of study. The major reasons of death for calves include ticks, respiratory problems, predators attack and diarrhea according to their order of importance. External parasites (ticks and camel mange) were the common problems of the young camel herds visited during the study period.

5. Number of services per conception and conception problem:

In almost all the camel mating, human assistance is mandatory for effective pregnancy. This makes the owners to exactly remember the number of mating the camel made for a single pregnancy. Accordingly, the mean number service per conception of the Afar camel is 1.63±0.85 (Mean±SD, n=293). The owners complained that about 4.8% of their camels showed conception problem after receiving several services.

Production parameters

The longevity of the Afar camels ranged from 14 to 29 years producing 1 to 10 calves throughout their life time. Of course only very few female camels were reported to give 8, 9 and 10 calves in their production time. The mean (±SD) age of life span is 21.74±3.84 years and mean number of calves they deliver is 2.7±1.77. The sex distribution of the

calves born showed that about 60:40 (Females: Males) ratio. Of the 299 total male calves born, about 3.34% are traditionally slaughtered just in few days of their calf-hood by the owners for the purpose of maximizing the milk yield they get from the dams due to the suckling loss of the male calves as the owners told and they eat the meat. In the Afar society, female camels are highly respected as one of the family members and in their tradition women are not allowed to milk the lactating camels just to show that female camels are respectful.

The physiological status of the dams during the study period showed that 62.5% were lactating, 30.4% were pregnant, 2.7% were both lactating and pregnant and about 4.4% were dry camels. This high number of camels' involvement in the production cycle at that period was because of the seasonal preferences of the owners to let their animals to breed during availability of pasture and water.

The herders themselves might intentionally postpone mating to extend the lactation length from the usual 12 months up to even 2 to 3 years. The alternating calving pattern has serious consequences for the stability of the production system. This effect is arisen because it increases production risk considerably since the herds whole calf crop out of 2 years might be lost at once, for example in a disease outbreak. Additionally, in years with low calving rates milk supply to the household is constrained. The off take rate of Afar camels due to voluntary culling of the owners (sell, slaughtering of male calves for better milking and slaughtering of old aged females and adult males) is 4.86%. In general, according for pastoralist perception concerning milk yield of their camels, about 84.3% are responded good, 12.6% are average and the rest 3.1% are poor milkers. However, despite the good milking ability of the camels, majority of the owners reported that about 10.6% of their camels have milking problems such as udder problems and mastitis.

Long-term herd development simulation

Simulations were conducted in order to estimate long-term herd development with the status quo parameters and with improved reproductive parameters for the Afar camel populations. Some hypothetical improvements were tested for age at first calving, calving interval and calf mortality rate. However, herd dynamics simulations were found to be difficult to calculate because of the difficulties in collecting important data for such analysis. Improvement of age at first calving and calving interval is conducted by excluding ages at first

calving older than 72 months of age and calving intervals longer than 36 months from the data set resulted in a mean age at first calving and mean calving interval given in Table 1. The cut points of exclusion for first calving chosen as older than 72 months of age and calving interval longer than 36 months are based on the fact that most of the data from the questionnaire survey perceived by the pastoralists as late beyond these values respectively. This actually leads us to choose longer than the mode values and this was also used by Kaufmann (2005).

Reduction of calf mortality can be possible by avoiding calf losses due to, tick infestation; diarrhea and predation seem feasible by certain management measures and would lead to a decrease of the mean calf mortality from currently 12.43% down to 7.7% for the Afar camel populations. The simulated effect of reproductive parameters improvement on herd demography is very important aspect of progeny history testing techniques (Elbashir *et al*., 2012). If we can make attempts to counteract this development, the simulation results show that measures to reduce mean age at first calving, calving interval and reduction of mortality rates will be effective (Sahani *et al*., 2003). The comparisons of Afar camels with the Kenyan three camel breeds (Rendille, Gabra and Somali) show us both similarities and differences among them depending on the different reproductive parameters.

Table 1: Age at first calving (means±S.D), calving interval and calf mortality rate (%) of dromedary camels

	Reproductive parameters	**Age (months)**	**(%)**
Status quo	Age at first calving	64.71±8.93	
	Calving Interval	31.16±8.71	
	Calf mortality rate		12.43
Improved state	Age at first calving (>72 months of age excluded)	63.15±6.78	
	Calving Interval (>36 months excluded)	29.01±5.92	
	Calf mortality rate		7.7

As clearly seen in table 1 and figures 1 and 2, one can easily compare the status quo level of reproductive performances with the improved and there is a clear indication that if those corrective intervention measures can be implemented there will be improved performances.

Conclusion and recommendations

Camels are important livestock species for the livelihood of the Afar pastoralists where other animals are of less adaptive and productive. Reproductive performance parameters of the Afar camels are found to be almost comparable to those of the Kenyan breeds. Generally, the present study shows that the productivity of the Afar camel is very much lower than it should be in terms of number of calves delivered in her life time and needs well studied management interventions. Under proper management intervention (feeding, health care, mineral supplementation and keeping proper bull to female camels' ratio) in to the reproductive parameters, it is possible to increase the performances of the camels. Pastoral areas have huge potential of research in the livestock sector in general and camels in particular as the unforeseen desertification widens. Researchers and funding agencies should give priority to such areas of research in order to solve the problems of livestock sectors. There has to be extensive study to evaluate the reproductive and production performances of camel breeds of the country, so that the outcomes will suggest which breeds should be kept for what purposes as to the demand of the society and for the national economy. Breeding management should be improved and proper records should be kept of births, mating and possibly of production and awareness creation among pastoralists.

Acknowledgments

The authors would like to thank Addis Ababa University, camel research thematic area from SIDA SAREC for funding this research. The authors extend their heartfelt thanks to the Afar camel owners for giving genuine information. Data collection would not have been possible without the contributions by the field assistants and staffs of the Semera veterinary regional laboratory for their all rounded help and participate as enumerators, thank you all.

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Annex I. Progeny history questionnaire to determine reproductive performances

First the names of all breeding females in the herd have to be listed. Thereafter, the enumerator chooses one breeding female at a time from the list and asks the following questions for each and every one of them.

A. Questions concerning the breeding female:

1. Name of the breeding female
2. Was she born in your herd or did you get her from somewhere else?
3. If born in herd, when was she born? (*Give date as "year/season")*
4. If acquired, when did you get her? (*Give date as "year/season"*)
    - Did you buy her, get her as gift or as dowry?
    - Was she a calf, heifer or adult at that time?
    - How old was she at that time?
    - Why did you get/buy her?

5. What breed is this dam?
6. Is this dam a good, average or poor milker?
7. Does she have any milking problems like udder abnormalities, mastitis, poor milk let-down or else?
8. How many calves did this dam deliver up to now? (*The complete number, alive as well as dead ones*)
9. Did this dam have any abortions?
    - If yes, were those early or late abortions?
10. Did this dam ever show difficulties to conceive?
    - If yes, what do you think was the reason?
11. Is the dam now pregnant (and since when), or is she lactating (and since when)?

B. Questions concerning the calves (to be asked for all calves, dead and alive ones, starting from the first)

1. When was the calf born? (*Give the date as "year/season"*)
2. Which was the sex of the calf?
3. Did the calf survive until weaning?
    - If no, when did it die? (*Give date as "year/season"*) or how old was it when it died?
    - If no, what was the cause of its death?
4. Where is the calf now? (In your herd, sold, slaughtered, given away, died after weaning)
    - If disposed, when was it disposed? (*Give date as "year/season"*) and why did you dispose it off?
    - If dead, when did it die (*give date as "year/season"*) and what did it die of?