FACTORS AFFECTING REPRODUCTIVE PERFORMANCE OF DAIRY CATTLE IN SMALLHOLDER HERDS IN ARUMERU DISTRICT, TANZANIA

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ABSTRACT

The objectives of the present study were to assess the reproductive performance, prevalence of reproductive disorders and to compare the the success of artificial insemination (AI) to natural service by handmating (NS) in dairy cattle kept in smallholder herds under a zero-grazing system in Arumeru district, Tanzania. Data on occurrence of all normal and abnormal reproductive events were collected for 215 adult animals belonging to 74 households. The median and range of the intervals: intercalving, calving to first service, and calving to pregnancy were 477 (335 to 860), 154 (38 to 486) and 206 (61 to 567) days, respectively. Breed and parity did not affect the reproductive parameters (P>0.05). However, cows in the milked group had a shorter median calving interval than those in the suckled group (P<0.001). The overall percentage pregnant and the percentage pregnant to first service were higher in the NS than in the AI group (49 vs 32 %; P=0.007) and (67 vs 25 %; P<0.001), respectively. The median numbers of services per pregnancy were not different between the AI (3) and NS (2) groups (P=0.17). The prevalence of abortion, dystocia, prolapse, retained fetal membranes, mastitis, milk fever and cyclic non breeders were 16.0, 1.7, 2.5, 4.2, 5.0, 1.7, and 6.1%, respectively. Hoof overgrowth (4.6%) and hoof deviation (4.6%) were the most-frequent digital problems. We concluded that reproductive parameters and high prevalence of abortion show suboptimal reproductive performance in rural-based, zero-grazed smallholder dairy herds in Tanzania particularly those using AI.

INTRODUCTION

There is some information on the reproductive performance of dairy cows kept in parastatal and government institutional farms in Tanzania (Kifaro 1985; Katyega 1988; Kanuya et al. 1997). However, data showing overall reproductive performance of dairy cows in zero-grazed, smallholder herds in rural areas of the country is limited. The little information available show the average calving interval in such herds to be 18 months (Donald 1985; FAO 1989). Such a long calving interval suggests existence of poor reproductive performance but does not pinpoint the underlying causes of the problem. Becauce no single parameter can adequately summarize reproductive performance, a panel of parameters must be evaluated. Analysing existing records of reproductive events (Gaines 1989) can determine the true reproductive performance of an apparently subfertile herd(s). However, in many smallholder farms, such records are either incomplete or not kept at all. The objectives of the present study were to determine reproductive performance, occurrence and prevalence of reproductive disorders as well as to compare success of AI versus NS in zero-grazed, rural based smallholder dairy herds. These basic data are necessary in the

planning of improvement strategies aimed at attaining optimal reproductive performance commensurate with the genetic potential of the dairy cattle available.

MATERIAL AND METHODS

The Study Site

This on-farm field study was conducted for one year in a rural area in Arumeru district which is located between 3°00'and 3°15'S, and between 6°15' and 36°55'E in Arusha Region, Tanzania. The study area extends from midland to highland zones of the district at an altitude of 1500 to 2000 and 2000 to 2500 m above sea level, respectively. The climate is tropical with a bimodal rainfall pattern (the short rains falling from November to January and the long rains in March to June). The mean annual rainfall varies from 1000 to 1500 mm depending on altitude. The lowest minimum temperature of 11°C occurs in July and the highest maximum temperature of 25°C is in February. The topography of the area is undulating and hilly, soils are volcanic and the relative humidity in the middle of the day ranges from 48% in October to 11% in May.

Field data collection

All households with cattle in three adjacent villages were enumerated and those utilized for the study were obtained by a formal random method (table of random numbers). All adult animals in a selected household were used for the study. A total of 215 animals (180 cows and 35 postpubertal heifers) belonging to 74 different households were included. This sample size of households was based on a minimum detectable difference of 30 days in calving interval at $\propto$=0.05. The parity of the cows ranged from 1 to 10. These dairy cattle were of Friesian (128), Ayrshire (84) and Jersey (3) breeds. In all households, animals were confined in a barn and stall fed for most of the time.

Structured questionnaires by interview were used to collect information on herdsize and structure, type of animal housing, feeding regimen, method(s) of breeding and calf-management practices. In addition, available reproductive data for each animal were also included. Thereafter, a detailed gynaecological examination was performed to ascertain the reproductive status and results recorded. All animals were examined for digital problems and lamenes. Those having problems were treated and recorded (Mgasa 1984). The animals were then prospectively followed at 2-moths intervals. During each of these scheduled visits, gynaecological examinations and assessment of occurrence of digital problems and lameness were carried out. Furthermore, previous technician-recorded occurrence of normal or abnormal reproductive events such as oestrus, AI, NS, calving, abortion and dystocia were checked for their biologic reasonableness and the information recorded. Visual detection of oestrus for AI or NS was carried out by the farmers and all AI in the area were performed by the same inseminator. The frozen-thawed semen used had been collected from different bulls of the respective breeds at the National Artificial Insemination Centre (NAIC). All NS was by handmating. Animals bred more than 6 weeks earlier were checked for pregnancy by rectal palpation at the bi-monthly visit, and results recorded.

Definition and calculation of reproductive parameters

Overall percentage pregnant was defined as the proportion of all services given to all cows and heifers over the study period which resulted in a pregnancy as diagnosed by rectal palpation (expressed as %). The percentage pregnant to first service was defined as the proportion of cows that became pregnant on the first postpartum or postpubertal service. Services per pregnancy was calculated by dividing the total number of services by the number of successful services or pregnant cows in the herd. Calving interval was defined as the average interval between the two most-recent consecutive calvings for all the cows in the herd. Days to first service was defined as the interval from calving to first service on all cows that were bred one or more times. Days to pregnancy was defined as the average interval from calving to pregnancy. Days open was defined as the sum of days from calving to conception oestrus for pregnant cows and from calving to end of study for open cows (divided by number of all cows in the herd). Abortion was defined as the expulsion of a calf < 271 d after NS or AI, either stillborn or lived for < 24 h. Foetal membranes were retained if they remained unexpelled for at least 12 h after calving/abortion.

Analysis

The prevalence of various reproductive disorders were calculated using the appropriate population at risk as denominator; each animal could have each disorder only once. Differences between risks were analysed using the chi-square test. Comparison of parameters of reproductive performance between the two main breeds in the study and between milked and suckled groups were performed using the Normal approximation to the Mann-Whitney rank-sum (2-tailed at $\propto = 0.05$; Zar 1984).

RESULTS

Disposition of Smallholder Herds and their Management

The percentage distribution of households according to herdsize and classes of animals kept were as shown in Table 1. There were a total of seven breeding bulls in the study area.

Table 1: Percent of 74 smallholder households in rural areas of Arumeru district, Tanzania that kept a specified number of dairy cattle, 1997/98

	Number of animals per household		
	1-3	4-6	≥7
Adult females	73	23	4
Heifer calves	39	3	0
Bull calves	38	3	0

NB: There were no heifer or bull calves (n=0) in 58% and 59% of the households, respectively

The percentage usage of AI, NS or a combination of both methods was 59, 24 and 17% of the households, respectively. In 68% of households, calves were bucket-fed; in 32%, calves were allowed to suckle to weaning which was done at around 12 weeks of age. Animals were

confined in a roofed shed with either concrete or rammed-stone floor for most of the day. Also, most households had an outside small enclosure where animals were allowed exercise each day.

Reproductive performance

Differences between breeds and parities in all reproductive parameters were not significant (Tables 2 and 3). Also, there was no difference in the interval from calving to first service between milked and suckled cows. However, there was a significant difference in median calving interval, days to pregnancy and days open between cows in the milked and suckled groups.

Success of AI when compared to NS was as shown in Table 4. The overall percentage pregnant and the percentage pregnant to first service were higher in the NS than in the AI group (49 vs 32 %; P=0.007) and (67 vs 25 %; P<0.001), respectively.

Table 2: Effect of breed (Friesian n=107 and Ayrshire n=73) and suckling on the reproductive performance of cows kept in 74 zero -grazed, smallholder herds in rural areas of Arumeru district, Tanzania, 1997/98

	Breeed		**Suckling**	
	Friesian	Ayshire	Milked	Suckling
Calving interval				
Minimum	335	353	335	353
Median	467	550 (p=0. 18)	456	510 (p=0. 00)
Maximum	860	831	831	860
Days to first service				
Minimum	38	64	38	63
Median	150	165 (0. 23)	145	158 (p=0. 28)
Maximum	486	389	486	449
Days to pregnancy				
Minimum	87	61	61	87
Median	202	225 (p=0. 11)	207	252 (p=0. 00)
Maximum	486	489	489	567
Days open				
Minimum	61	83	61	127
Median	232	246 (p=0. 25)	243	348 (p=0. 00)
Maximum	576	489	486	567

Table 3: Effect of parity on the reproductive performance of cows (Friesian=107 and Ayrshire=73) kept in 74 zerograzed, smallholder herds in rural areas of Arumeru district, Tanzania, 1997/98

Parameter	Parity*						P value (χ^2 test)
	1	2	3	4	5	6	
Calving interval							
Minimum	409	342	335	348	370	382	
Median	634	459	526	464	478	426	0.61
Maximum	860	802	810	831	779	489	
Days to first service							
Minimum	61	70	38	93	75	104	
Median	127	157	164	232	173	165	0.23
Maximum	486	389	300	330	363	240	
Days to pregnancy							
Minimum	61	83	128	188	140	104	
Median	206	257	188	246	190	155	0.28
Maximum	567	525	489	425	363	336	
Days open							
Minimum	61	83	128	188	140	104	
Median	202	257	204	265	190	185	0.13
Maximum	567	525	489	425	363	336	

* There were only 8 cows with parities between 7 and 10

Table 4: Success of artificial insemination (AI) vs natural service (NS) in 215 dairy cattle kept in 74 zero-grazed, smallholder herds in rural areas of Arumeru district, Tanzania, 1997/98

	AI	NS	Test	P value
Total services	209	81		
First services (all cows)	114	51		
Number of pregnant cows	66	40		
Number pregnant to first service	28	34		
Overall pregnancy %	32	49	χ^2	0.007**
Percent pregnant to 1st service				
All cows	25	67	χ^2	0.000***
Pregnant cows only	42	85		
Number of services per pregnancy				
All cows	3	2	RS	0.17
Pregnant cows only	2	1	RS	0.14

RS = the Normal approximation to the Mann-Whitney rank-sum test

Table 5 shows the prevalence of various reproductive disorders and digital problems. Of the 17 cows that aborted, 6 had a history of abortion: five had previously aborted once and one

had aborted twice. Of the 5 cases with retained foetal membranes, 3 occurred following an abortion. Both hoof overgrowth and deviation occurred together in 6 animals with digital problems.

Table 5: Dairy herd dynamics, occurrence and cumulative incidence risk of reproductive disorders and digital problems in 74 smallholder households located in rural areas of Arumeru district, Tanzania, 1997/98

	Number of animals	% of animals at risk
a) Herd dynamics:		
Total number of cattle	215	-
Sold for breeding	33	15.4
Died	7	3.3
Slaughtered	4	1.9
Reproductive disorders/diseases:		
Abortion	17	16.0
Dystocia	2	1.7
Prolapse	3	2.5
Retained fetal membranes	5	4.2
Metritis/endometritis	1	0.8
Mastitis	6	5.0
Milk fever	2	1.7
Cyclic non breeders	10	6.1
Fetal mummification	1	0.9
Freemartins	1	0.8
c) Digital problems:		
Hoof overgrowth	10	4.6
Hoof deviation	10	4.6
Foreign body	1	0.5
Lameness	2	0.9

*Most cases of hoof overgrowth affected the medial digit; deviation was more common in the lateral digits of the hindlimb

DISCUSSION

The rather high proportion of animals sold for breeding (15.4%) during this study, emphasizes the economic importance the smallholder farmers attach to their dairy animals which serve as a living bank for household's savings to be drawn upon whenever need arises.

The median calving interval of 477 days was longer than that previously reported for cows kept in government institutional farms in Tanzania (Shekimweri 1982; Kifaro 1985; Katyega 1988; Kanuya et al. 1997) as well as those reported from other tropical (Shehata et al. 1995) and temperate parts of the world (Aeberhard et al. 1997). Such a long calving interval implies that farmers' income suffers because cows spend a greater portion of their lactation at low production levels. The calf crop is also reduced.

In agreement with a report by Slama et al. (1976) there were no differences in reproductive performance between the two *Bos taurus* dairy breeds. However, lack of breed difference in reproductive performance as shown in the present study, is contrary the findings of a study by Venkatasubramanian and Fulzele (1996) who compared crossbred and indigenous cattle. It is generally accepted that there is a tendency for the first calving interval to be longer than the subsequent ones (De Kruif 1978). This is attributed to young age of such cows. In contrast, cows that have calved three or four times have the shortest calving intervals. Then, as the animals age further, the intercalving period increases. In the present study however, cows with different parities did not show a significant difference in reproductive performance (Table 3). This could partly be a result of the small sample size involved. Overall, cows that were milked showed better reproductive performance than those that were suckled. Cows in both groups showed similar interval from calving to first service but milked cows became pregnant earlier than those that were suckled (Table 2). This finding suggests that suckling contributes to poor postpartum reproductive performance including increased days to pregnancy in smallholder dairy herds. This is in agreement with several previous reports (Oxenreider and Wagner 1971; Salcedo et al. 1977; Pimentel et al. 1979; Wells et al. 1985) but contrary to others (Maree et al. 1974; Alberio et al. 1984; Lishman and Harwin 1985).

This report is the first to show a comparison between routine use of AI and NS in smallholder dairy herds kept in a rural area of Tanzania. When all cows are considered, the overall percentage pregnant, percentage pregnant to first service and services per pregnancy were sub-optimal (Gaines 1989). The overall percentage pregnant to first service was lower than earlier reported for a handmated herd at Morogoro (Kanuya et al. 1997) and in artificially inseminated animals in other parts of the world (Ki-YueMing et al. 1994; Verkerk et al. 1997). It was also lower the normal average (Williamson 1987). In the present study, the lowest percentage pregnant to first service was in the artificially inseminated animals which leads to suspicion of accuracy and efficiecy of oestrus detection, semen handling and deposition techniques.

The number of services per pregnancy was higher than reported in some studies (Aeberhard et al. 1997; Kanuya et al. 1997) but comparable to that reported by Venkatasubramanian and Fulzele (1996). Again, the highest number of services per pregnancy was in the artificially inseminated group. This suggests existence of problems in the accuracy and efficiency of oestrus detection leading to animals being inseminated at non-optimal time or poor semen-handling techniques. However, it could also be a result of inherent poor bull fertility.

The prevalence of abortion in the present study (16%) was higher than reported in previous studies (Murray 1990; Wright and Fernando 1993; Debnath et al. 1995; Baxter and Ward 1997) but lower than that reported by Day et al. (1995). It was also higher than the up to 5% level that is considered normal (Gaines 1990). The actual cause(s) of abortions in the present study were not ascertained. Differences in abortion risks reported by different researchers could be a result of differences in sample size, duration of study, occurrence of infectious diseases and other factors that are locally important.

The prevalence of hoof overgrowth in the present study was consistent with two previous reports conducted in the East and Central African region (Ndikuwera and Zishiri 1990; Gitau et al. 1996). We do not have an explanation for the higher occurrence of hoof overgrowth in the medial digit and hoof deviation in the lateral digits of the hindlegs. Perhaps this could be attributed partly to the shape and size of the modern dairy cow (Webster 1991). Lack of or

limited exercise for zero-grazed animals could also contribute to development of digital problems.

CONCLUSIONS

We concluded that the current situation in rural-based, zero-grazed smallholder dairy herds is characterized by suboptimal reproductive performance. Factors contributing to this situation include delays in re-breeding cows after calving, suckling, low percentage pregnant to first service, high number of services per pregnancy particularly in the herds using AI and a high risk of abortion.

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