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Influence of Restricted Suckling and Level of Feed Supplementation on Postpartum Reproductive Performance of Zebu and Crossbred Cattle in the Semi-Arid Tropics

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Das SM, Forsberg M, Wiktorsson H: Influence of restricted suckling and level of feed supplementation on postpartum reproductive performance of zebu and crossbred cattle in the semi-arid tropics. Acta vet. scand. 1999, 40, 57-67. – This study was carried out in central Tanzania on a group of 45 Zebu and 37 crossbred cows which were 4 to 10 years old. At calving time, the animals were allocated to one of the 4 treatment groups. In addition to free access to grazing for all cows in the study, in group H:AR (n = 18), cows were fed a high level of concentrate supplementation (4kg/day) and calves were artificially reared; in group H:RS (n = 24), cows were fed a high level of concentrate supplementation (4kg/day) and calves were only allowed restricted suckling up until the weaning age of 6 months. In group L:AR (n = 23) cows were fed a low level of concentrate supplementation (2kg/day) and calves were artificially reared; and in group L:RS (n = 17) cows were fed a low level of concentrate supplementation (2kg/day) and calves were only allowed restricted suckling up until the weaning age of 6 months. Milk progesterone was used as a means of determining the postpartum resumption interval (PRI) and the interval from parturition to conception (PCI). The overall PRI was 47.4 ± 0.4 days and was significantly affected by breed but not by calving season, with crossbred cows exhibiting a shorter PRI than Zebu cows. The effect of the treatments was significant, with cows in the group H:AR displaying a significantly shorter PRI than those in the other groups, while cows in group L:RS showed a significantly longer PRI than those in the other groups. The overall PCI was 149.5 ± 3.7 days, and was not significantly affected by breed or calving season. The effect of the treatments was significant, with cows in the group H:AR having a significantly shorter PCI than cows in the other groups, while cows in group L:RS showed a significantly longer PCI than those in the other groups. Crossbred cows had higher live weights at calving (299.4 kg) than Zebu cows (272.6 kg), while all cows gained weight during the first 3 months after calving. The treatments had a significant effect on weight gain, with cows in the group H:AR gaining significantly more weight than those in the other groups. Cows which had high live weights at calving exhibited significantly shorter PRI and PCI than the lighter cows. Animals which had gained more than 5 kg during the first month after calving, or which had gained more than 8 kg during the first 3 months after calving, showed significantly shorter PRI and PCI than cows which had gained less weight. The results show that the calf rearing system and the level of feed supplementation interact with each other and can influence the postpartum anoestrous period in Zebu and Zebu crossbred cattle. Increasing the level of nutrition in restricted suckling cows tended to improve the postpartum anoestrous period, but the positive effects of supplementation could not completely compensate for the negative effects of suckling.

cow-weight; ovarian activity; conception.

Introduction

Short calving intervals are essential for both efficient milk production and for maintaining a long economically productive life in a dairy cow. The long period of ovarian inactivity after parturition is one of the major obstacles in improving the reproductive efficiency of both Zebu (*Bos indicus*) and Zebu crossbred (*Bos taurus*×*Bos indicus*) cattle in the tropics. Various factors have been identified as effective constraints on the resumption of ovarian activity, e.g., age, parity, under-nutrition, calving season, milk yield and management system (*Izaike* 1990). One major factor which delays the resumption of postpartum ovarian activity is suckling (*Chamberlain* 1989, *Orihuela* 1990, *Williams* 1990). Although mastectomised cows whose calves had been removed at parturition exhibited shorter postpartum anovulatory intervals than those that were weaned intact (*Short et al.* 1972), mastectomised cows that were pseudo-suckled by their calves have been shown to exhibit anovulatory periods that are similar to those of cows that were suckled intact (*Vicker et al.* 1989). This suggests that the mere perception of being suckled is sufficient to prolong the postpartum anovulatory interval, and that the mother-calf bond may be involved in regulating the length of this period (*Silveira et al.* 1993). Studies have also shown that the rearing of calves in restricted suckling systems produced both long postpartum and long calving intervals. This is accentuated when the age is increased at weaning (*Ugarte* 1989, *Little et al.* 1991). The positive effects of adequate nutrition for reducing the postpartum anoestrus interval have been stressed in several reports (*Dunn & Kaltenbach* 1980, *Rutter & Randel* 1984, *Richards et al.* 1986). These findings indicate that cows in good bodily condition at calving will return to oestrus earlier than cows in poor bodily condition at calving.

In the semi-arid areas of Tanzania, calves are allowed to suckle their dams while grazing in the herds of Zebu cattle. On small holder dairy farms, the artificial rearing of calves and, in some instances, restricted suckling, is practised for Zebu and crossbred cattle. However, little or no emphasis is given to the nutrition of cows at calving or during the early postpartum period. Consequently, prolonged postpartum anoestrous intervals and long calving intervals have been reported (*Das et al.* 1986, *Mukasa-Mugerwa et al.* 1991).

The present study was undertaken to further investigate the effects of both the calf rearing system and the level of feed supplementation on the postpartum reproductive performance of Zebu and crossbred cows in the semi-arid tropical climate of central Tanzania.

Materials and methods

Animals and management

The study was carried out on a group of 82 Zebu and crossbred cows that ranged from 4 to 10 years of age. The animals belonged to the Livestock Production Research Institute, Mpwapwa, which lies in the semi-arid area of central Tanzania. Mpwapwa is situated at latitude 6°21′ S, and longitude 36°32′ E, at an altitude of 1100 m above sea level. The average rainfall is 660 mm annually, with great variances in the distribution and amount from year to year. The animals in the study consisted of 45 Zebu and 37 crossbred cows that calved during both the wet season (December 1994 to February 1995, n = 40) and the dry season (June 1995 to August 1995, n = 42). The Zebus consisted of 41 Mpwapwa (*Das et al.* 1986) and 4 Sahiwal cows, while crossbred cows were of Bos taurus×Mpwapwa crosses, having >35% *Bos taurus* genes, mainly Friesian, Ayrshire and Jersey. All cows were hand-milked both in the morning (06.00 h) and in the afternoon (14.00 h). The calves were weaned at 6 months of age. Two months

after parturition, all cows were kept in mating groups, which consisted of 15-20 cows and one bull (Mpwapwa breed) in each group. All of the bulls in the study were semen-tested and physically examined to ensure that there were no structural abnormalities of the testes, sheath or penis. Bulls were rotated fortnightly between treatment groups to minimise any possible effects of sire fertility on conception rates. Bulls had access to cows continuously from the time of calving until the end of the trial. The study commenced from mid December, 1994 to mid May, 1995 in wet season and from mid June, 1995 to mid December, 1995 in the dry season. Immediately after calving, the cows were assigned randomly to one of the 4 treatment groups:

Group H:AR (n = 18) Cows were fed a high level (H) of concentrate supplementation during milking (4kg/day), and calves were artificially reared (AR). The group consisted of 9 Mpwapwa, 1 Sahiwal and 8 crossbred cows .

Group H:RS (n = 24) Cows were fed a high level (H) of concentrate supplementation during milking (4 kg/day), and calves were only allowed restricted suckling (RS). The group consisted of 12 Mpwapwa, 1 Sahiwal and 11 crossbred cows .

Group L:AR (n = 23) Cows were fed a low level (L) of concentrate supplementation (2 kg/day) during milking, and calves were artificially reared (AR). The group consisted of 12 Mpwapwa, 1 Sahiwal and 10 crossbred cows.

Group L:RS (n = 17) Cows were fed a low level (L) of concentrate supplementation (2 kg/day) during milking, and calves were only allowed restricted suckling (RS). The group consisted of 8 Mpwapwa, 1 Sahiwal and 8 crossbred cows.

Cows in the study were kept in paddocks of mixed pasture, which consisted mainly of *Chloris gayana, Cynodon* and *Hyperrenia* species. Concentrate supplementation in all of the groups was continued for 90 days postpartum. The concentrate mixture consisted of ground Acacia tortilis pods (60%), maize bran (30%) and sunflower seedcake (10%). Bone meal was also added to the concentrate mixture at a ratio of 4:1000. Chemical analysis of the feed ingredients and the concentrate mixture showed that the mean crude protein content was 14.1% for Acacia tortilis pods, 10.1% for maize bran and 24.5% for sunflower seedcake, with an overall crude protein content of 12.8% in the concentrate mixture.

Artificial rearing of calves

Calves remained with their dams for the first 5 days after birth. Thereafter, calves in the H:AR and L:AR groups were separated from their dams and kept in separate grazing paddocks for the next 6 months, where they were provided with drinking water and a concentrate mixture *ad. lib.* They were also fed 4 litres of milk daily by bucket, 2 l at 07.00 h and 2 l at 15.00 h.

Restricted suckling of calves

Calves in the H:RS and L:RS groups were separated from their dams 5 days after birth and kept in separate grazing paddocks where they were provided with drinking water and concentrate mixture ad. lib. The calves stimulated milk letdown by suckling each of the cow's teats for 30 seconds before the cow was hand-milked. Milk in the rear right quarter of the udder was reserved for the calf to suckle for 30 min, at 07.00 and 15.00 h. The calves were also allowed to strip the residual milk from the already milked quarters.

Data collection, milk sampling and analysis

Milk production was recorded daily. The lactation yield of each cow was calculated for 6 months following parturition. Calves and cows were weighed both at calving and at the end of each month for a total of 6 months postpartum.

In order to monitor the ovarian activity, 10mL milk samples were collected twice weekly beginning at 20 days postpartum. Milk samples were preserved by adding bromopol and then placed in a cool box until the end of the collection on each day. The samples were centrifuged in order to remove the milk fat. The skim milk thus obtained was then stored in a deep freezer and later analysed for progesterone content by using radioimmunoassay (Coat-A-Count, Diagnostic Products Corporation (DPC), Los Angeles, CA, U.S.A.) at the Faculty of Veterinary Medicine, Sokoine University of Agriculture, Morogoro, Tanzania. The International Atomic Energy Agency (IAEA), Vienna, Austria, supplied the milk progesterone standards. The intra- and inter-assay coefficients of variation were 5.1% and 12.3%, respectively.

The following parameter definitions were used:

- Interval from parturition to resumption of ovarian activity (PRI): The interval from parturition until the sampling day before the milk progesterone exceeded 2.5 nmol/L on 4 consecutive occasions.
- Interval from parturition to conception (PCI): The interval from parturition until the sampling day before the milk progesterone exceeded 15 nmol/L for 4 consecutive samplings.

Statistical analysis of data

The design of the experiment consisted of a factorial arrangement in which treatments consisted of 2 calving seasons (wet, dry), 2 cow breeds (Zebu, crossbred) and 4 treatment groups (H:AR, H:RS, L:AR and L:RS). The statistical analysis was done using the least squares analysis of variance according to the GLM procedure in the Statistical Analysis System (*SAS Institute Inc.* 1987). All statistical tests having a p-value <0.05 were considered to be significant. When a significant effect was found, the obtained means were tested using a Tukeys test. Results are reported as least square mean ± standard error (s.e.m).

Results

From the initial number of 82 cows in the study, 5 cows from 3 of the groups (H:AR = 2, L:AR = 1, and L:RS = 2) were excluded during the first 2 weeks due to various reasons (anaplasmosis, East Coast Fever and chronic mastitis). The overall PRI was 47.4 days and was significantly affected by breed but not by calving season (Table 1), with crossbred cows exhibiting a shorter PRI than Zebu cows. The effects of treatment were significant, with cows in group H:AR having a significantly shorter PRI than cows in the other groups, while cows in group L:RS showed a significantly longer PRI than those in the other groups. In the H:AR group, 9 of the 16 animals resumed ovarian activity before 40 days postpartum, while after 40 days the PRI was observed 3 cows in group H:RS and 6 animals in group L:AR. None of the cows in the L:RS group had resumed ovarian activity after 40 days had elapsed from parturition (Fig. 1).

The overall PCI was 149.5 ± 3.7 days, and this number was not significantly affected by either breed or calving season (Table 1). Most of the cows (93.7%) in group H:AR were pregnant by 120 days after parturition. The percentage of cows that were pregnant after the same time period in the other groups was 50.1% (H:RS), 40.9% (L:AR) and 6.7% (L:RS). One animal from the H:RS group and 5 from group L:RS were not pregnant by the time the study was completed and instead conceived in the next breeding season. The effects of the treatments were significant, with cows in the group H:AR showing a significantly shorter PCI than cows in the other groups, while cows in the group L:RS exhibited a significantly longer PCI than

Table 1. Effects of calving season, breed of cow, and group (calf rearing system and supplementation level) on interval to resumption of ovarian activity (PRI), and to conception (PCI).

Factor	N	PRI (days) LS mean ± s.e.	PCI (days) LS mean ± s.e.
Calving season			
– Wet	39	46.8 ± 0.9a	148.5 ± 2.8a
– Dry	38	47.6 ± 0.9a	151.3 ± 2.9a
Breed of cow			
– Zebu	43	49.6 ± 0.9a	150.2 ± 2.9a
– Crossbred	34	44.8 ± 1.0b	149.7 ± 3.1a
Group			
– H:AR	16	37.4 ± 1.4a	126.6 ± 4.5a
– H:RS	24	48.9 ± 1.1b	143.1 ± 3.8b
– L:AR	22	45.2 ± 1.2b	144.2 ± 4.0b
– L:RS	15	57.3 ± 1.5c	186.1 ± 4.3c

a,b,c Means with different letters in the same column within a factor differ significantly ($p<0.05$);
H:AR – High level feed supplementation and artificial rearing of calves;
H:RS – High level feed supplementation and restricted suckling of calves;
L:AR – Low level feed supplementation and artificial rearing of calves;
L:RS – Low level feed supplementation and restricted suckling of calves.

Table 2. Effect of liveweight at calving and liveweight gain at 1 and 3 months postpartum on interval from parturition to resumption of ovarian activity (PRI) and to conception (PCI) .

Factor	N	PRI (days) LS mean ± s.e.	PCI (days) LS mean ± s.e.
Liveweight at calving(kg)			
<250	23	56.5 ± 1.2a	165.7 ± 4.3a
≥250 – <280	21	49.8 ± 1.5b	152.1 ± 4.9a
≥280 – <310	17	47.3 ± 2.0b	144.4 ± 5.1b
≥310	16	38.1 ±2 .1c	128.6 ± 5.4c
Liveweight gain (kg) (1- month)			
<1	14	54.7 ± 2.1a	168.6 ± 5.8a
≥1 – <3	24	47.4 ± 1.2b	152.9 ± 4.2b
≥3 – <5	21	46.4 ± 1.4b	135.2 ± 4.7c
≥5	18	44.6 ± 1.5c	131.9 ± 5.2c
Liveweight gain (kg) (3 – month)			
<4	24		167.5 ± 4.2a
≥4 – <6	23		152.4 ± 4.5b
≥6 – <8	19		140.3 ± 4.7b
≥8	11		127.2 ± 5.0c

a,b,c Means with different letters in the same column within a factor differ significantly ($p<0.05$).

those in the other groups. The difference between the mean PCIs' in the restricted suckling groups (H:RS and L:RS) was 43 days compared to 22 days between the mean PCIs' in the artificial rearing groups (H:AR and L:AR).

Crossbred cows showed higher live weights during calving (299.4 kg) than those in Zebu cows (272.6 kg), while all cows in the study gained weight during the first 3 months after calving. The treatments had a significant effect on the weight gain, with cows in group H:AR gaining significantly more weight than those in the other groups. Table 2 shows the effects of the live weight at calving and the live weight change at 1 and at 3 months postpartum on both the PRI and PCI. Cows, which had high live weights at calving, exhibited significantly shorter PRI and PCI than those by the lighter cows. Animals which had gained more than 5 kg during the first month after calving, or which had gained more than 8 kg during the first 3 months after calving, showed significantly shorter PRI and PCI than cows which had gained less weight. The relationships between the PRI and the liveweight of the cows at 1 month postpartum and between the PCI and the liveweight of the cows at the first and third months postpartum are shown in Fig. 2 (a,b). The regression coefficients of the PCI on the liveweight of the cows at 1 month ($b = -0.225$,

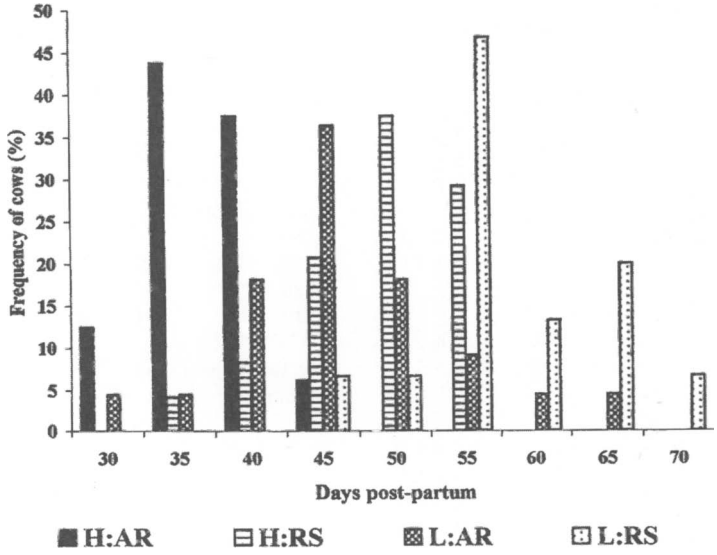

Figure 1. Frequency of resumption of ovarian activity of Zebu and crossbred cows according to calf rearing and feed supplementation level.

$R^2 = 0.15$) and on the liveweight of the cows at 3 months postpartum ($b = -0.226$, $R^2 = 0.16$) were higher than the regression of the PRI on the liveweight of the cows at 1 month postpartum ($b = -0.07$, $R^2 = 0.07$).

Discussion

Several studies have examined the negative effect of suckling on the postpartum reproductive activity in Bos taurus (*Carruthers & Hafs* 1980, *Edwards* 1985) and *Bos indicus* breeds (*Bastidas et al.* 1984, *Wells et al.* 1986, *Mukasa et al.* 1991) as well as in their crosses (*Escobar et al.* 1984, *Little et al.* 1991, *Mejia* 1994, *Sanh* 1994). This is consistent with the results obtained in the present study. Cows which were subjected to restricted suckling management (H:RS and L:RS) had longer intervals from parturition to the resumption of ovarian activity and to conception when compared with cows which were given equal feed supplementation and whose calves were reared artificially soon after birth (H:AR and L:AR). This confirms the negative influence of suckling on follicular maturation and ovulation. It has been suggested that the early resumption of ovarian activity in non-suckled cows is a result of increases in both the frequency and amplitude of pulsatile LH release (*Carruthers & Hafs* 1980, *Randel* 1981). It has also been reported that suckling interferes with ovulation by impairing the LH-release (*Williams et al.* 1987). The behavioural component of suckling (cow-calf interaction) also appears to contribute to the delayed resumption of ovarian activity (*Peters et al.* 1981). It has been reported that Zebu cows were capable of initiating cyclic activity as early as 2 weeks postpartum when submitted to total calf weaning at parturition (*Toribio et al.* 1995), the PRI in the present study was longer for both Zebu and crossbred cows. The difference between the results may have resulted in calf staying with their dams for 5 days after parturition in the present

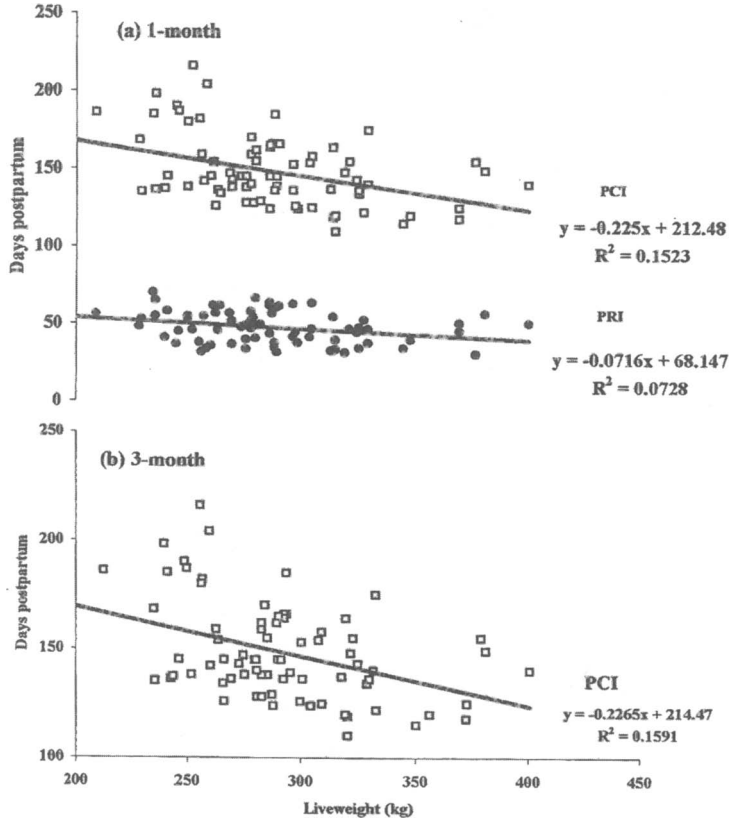

Figure 2. Regression of PRI and PCI on liveweight of Zebu and crossbred cows at (a) 1 month and on PCI (b) at 3 months postpartum (n = 77).

study compared to the calf removal immediately after birth.

Postpartum nutrition is an important factor which influences the reproductive performance of cattle (*Carstairs et al.* 1980, *Dunn & Kaltenbach* 1980, *Richards et al.* 1986). In the present study, postpartum sexual functions were restored faster in cows which were on a high level of feed supplementation. Early ovarian activity has been reported in cows which were given concentrate supplementation after calving (*Rutter & Randel* 1984, *Eduvie* 1985, *Tegegne et al.* 1992). Detrimental effects of under-nutrition on ovarian activity could be due to influences on any of the components of the reproductive axis, so that cows which lose their body weight as a result of restricted diets show decreased plasma progesterone concentrations, which could be due to lower output by the corpus luteum or to increased liver catabolism (*Schrick et al.* 1992). Reports have also shown that strategic concentrate supplementation usually improves the rate of conception (*Voh et al.* 1984). In the present study, cows which were fed a high level of supplementation were observed to have shorter PRI and PCI than cows that were given a low level of supplementation. The high difference in the mean PCI between

the 2 restricted suckling groups in this study may have resulted from the persistence of the second dominant ovulatory follicle in the L:RS group (*Mihm et al.* 1994), which then resulted in a longer interval to conception.

Both the body weight at calving and the subsequent weight changes during the postpartum period influence the onset of postpartum reproductive functions (*Rutter & Randel* 1984, *Doren et al.* 1986). Both losses in body weight and poor body condition are associated with delays in the initiation of normal postpartum reproductive cyclicity (*Butler et al.* 1981, *Garcia & Edqvist* 1988a, *Bolanos et al.* 1996). This is consistent with the present results, where cows which had higher weight gain during the postpartum period resumed sexual function and conceived earlier than those which had lower weight gain. Furthermore, the weight gains recorded in this study were shown to be a consequence of concentrate supplementation. Lower regression coefficient of the PRI on the liveweight of cows at 1 month postpartum was due to the little influence of cow's liveweight on PRI when compared with the higher effect of body gain on PRI. Cows that were in groups with high supplementation, regardless of management system, exhibited significantly higher weight gains and resumed sexual functions earlier when compared with cows which were given low supplementation. Similarly, it has been reported that weight gains up to 3 months following postpartum in both crossbred and Zebu cows affect both the interval to the resumption of ovarian activity and the interval to conception (*Garcia et al.* 1990, *Tegegne et al.* 1992).

Crossbred cows displayed a shorter interval to the resumption of ovarian activity than Zebu cows when subjected to same management and diet, which confirms earlier results obtained by Garcia et al. (1988). Zebu breeds have been reported to have longer postpartum anoestrous intervals than those of *Bos taurus* breeds (*Bastidas et al.* 1984, *Wells et al.* 1986). *Reynolds et al.* (1979) reported differences between calving to first oestrus and in pregnancy rates between Zebu and Zebu-cross cattle. The effect of genotype on the postpartum ovarian resumption interval may be due to true physiological differences among breeds with confounding factors such as differences in the amount of milk produced, appetite or feed intake. The present results showed that cows that calved in the wet season tended to have lower PRI and PCI compared to cows that calved in the dry season. This supports earlier reports on the effect of climate (wet versus dry season) on postpartum reproductive performance of cattle in the tropics (*Zakari et al.* 1981, *Eduvie* 1985).

In this study, we have shown that both the calf rearing system and the level of supplement interact and can influence the postpartum anoestrus period in Zebu and Zebu crossbred cattle. Although an increase in the level of nutrition in restricted suckling cows was found to be effective in reducing the postpartum anoestrus period, the positive effects of supplementation could not completely compensate for the negative effects of suckling. Increasing the postpartum body weight of cows through high feed supplementation was found to improve the reproductive performance.

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Sammandrag

Inverkan av begränsad digivning och utfodringsnivå på fertiliteten efter kalvning hos zebu- och blandraskor i Tanzania.

Studien genomfördes i Tanzania på en grupp av 45 zebu och 37 blandraskor mellan 4-10 år gamla. Efter kalvning delades korna in i fyra gupper. I den första gruppen (H:AR) supplementerades korna med 4 kg koncentrat per dag och kalvarna föddes upp artificiellt. I den andra gruppen (H:RS) supplementerades korna med 4 kg koncentrat per dag och kalvarna tilläts dia 2 gånger per dag. I den tredje gruppen (L:AR) supplementerades korna med 2 kg koncentrat per dag och kalvarna föddes upp artificiellt. I den fjärde gruppen (L:RS) supplementerades korna med

2 kg koncentrat per dag och kalvarna tilläts dia 2 gånger per dag. Samtliga djur hade fri tillgång till bete. Koncentrationen progesteron i mjölk användes för att bestämma när den cykliska äggstocksaktiviteten började efter kalvning och hur långt intervallet var mellan kalvning och dräktighet. Korna började cykla i genomsnitt 47.4 ± 0.4 dagar efter kalvning. Renrasiga zebukor startade senare än blandraskor. Effekten av behandling påverkade när äggstocksaktiviteten startade. Kor i gruppen H:AR startade signifikant tidigare än övriga grupper och kor i gruppen L:RS startade signifikant senare än de övriga grupperna. Det genomsnittliga intervallet mellan kalvning och dräktighet var 149.5 ± 3.7 dagar och ingen skillnad registrerades mellan raser. Effekten av behandling påverkade intervallet. Kor i gruppen H:AR hade ett signifikant kortare intervall mellan kalvning och dräktighet än kor i de andra grupperna och djur i grupp L:RS hade ett signifikant längre intervall än kor i de andra grupperna. Blandraskor vägde mer vid kalvningen (299.4 kg) än zebukor (272.6 kg). Samtliga djur ökade i vikt de första tre månaderna efter kalvning. Behandlingen påverkade viktökningen Kor i gruppen H:AR ökade signifikant mer i vikt än djur i de övriga grupperna. Ett samband registrerades mellan vikt vid kalvning och fortplantningsparametrarna. Ju högre vikt desto kortare var intervallet till återupptagen cyklicitet och dräktighet. Kor som hade ökat mer än 5 kg den första månaden och mer än 8 kg de första tre månaderna efter kalvning visade signifikant kortare tid till återupptagen äggstocksaktivitet och dräktighet. Studien visade att en förbättrade utfodringsregim kan förkorta tiden mellan kalvning och nästa dräktighet men den positiva effekten av förbättrad utfodring kan inte helt kompensera den negativa effekten av digivning.

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