SUCKLING BEHAVIOUR AND FERTILITY IN BEEF COWS ON PASTURE

Iona B. Stewart

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by

Iona Boles Stewart

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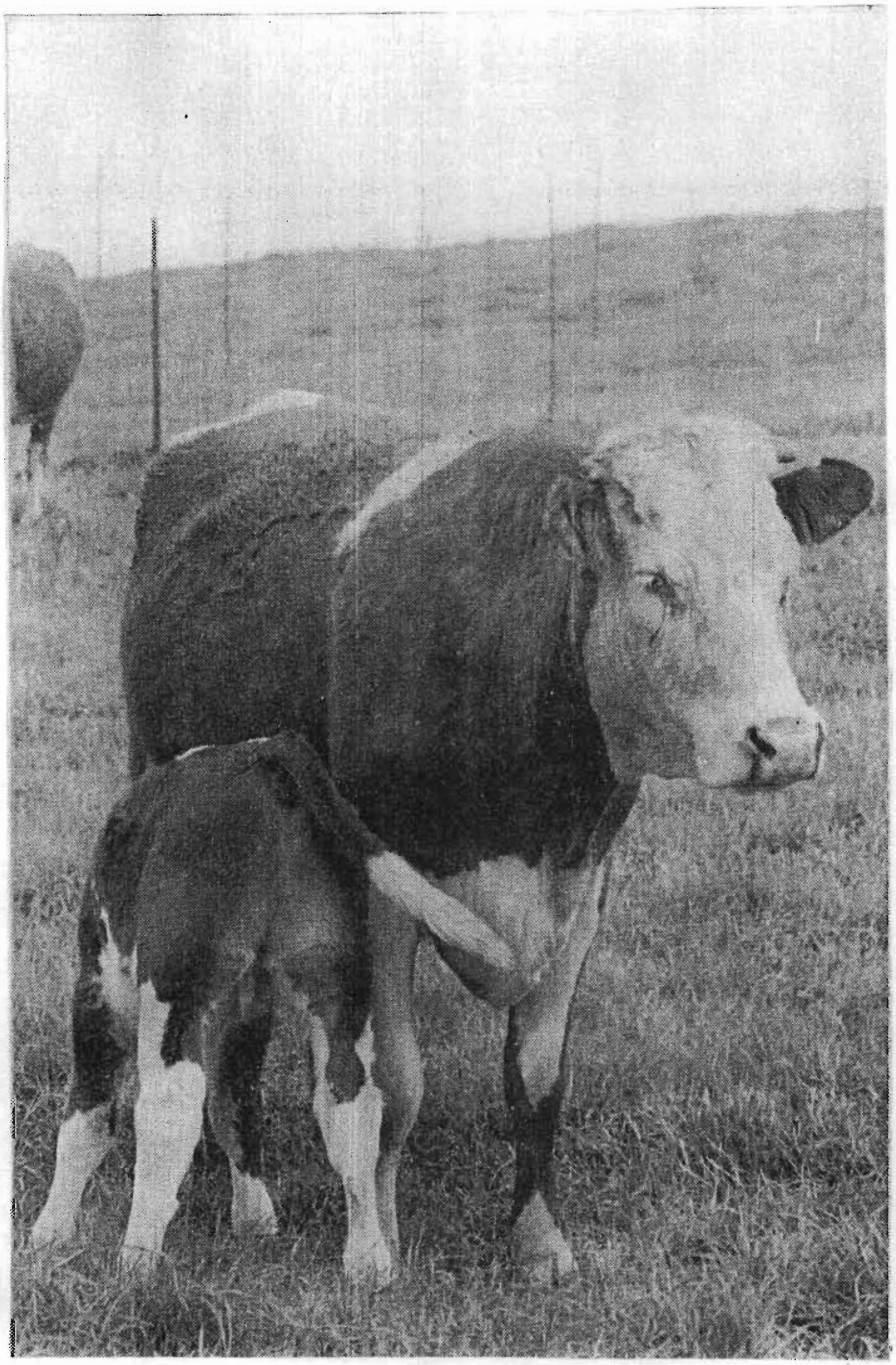

DECLARATION

I hereby declare that the results contained in this thesis are from my own original work and have not been previously submitted by me in respect of a degree at any other University.

Iona B. Stewart.

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I am deeply indebted to many people who helped me with this study, particularly:

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CONTENTS

ABSTRACT

The suckling behaviour of 66 Hereford and Simmentaler cows was studied. The average frequency of suckling in 24 hours was four times, and the average duration of each suckling bout was 10 minutes. Suckling events were not evenly distributed throughout the 24 hour period. Regardless of suckling frequency or days post partum, the most favoured suckling period was between 04:00 and 06:00, i.e. dawn. The lowest incidence of suckling was recorded in the period from midnight to dawn. The longest interval between two suckling bouts over the 24 hours always occurred before the dawn and became longer as the calf grew older ($p<0,01$).

Once the mating season commenced, the onset of oestrus was positively correlated ($p<0,01$) to the length of the longest inter-suckling period. Suckling behaviour was not affected by the milk yields of the cows studied.

In a follow up investigation, 88 cows were separated from their calves for 12 hours out of 24, for the fortnight prior to the start of the breeding season. Fifty-six percent of the 44 cows which were separated from their calves from 18:00 to 06:00 (dayfeeders) exhibited oestrus within 28 days of the breeding season, compared to 22% of the group separated from 06:00 to 18:00 ($p<0,01$).

It was concluded that not only the suppression of suckling may be involved in the onset of ovarian activity. The specific time period during the 24 hours when suckling is prohibited may also play a role.

GENERAL INTRODUCTION

In 1989 the total number of non-dairy breeding cows in South Africa was estimated to be 2,4 million. (RSA Livestock and Meat Statistics, 1990). Calculated on the basis of the number of calves born (1,6 million), the calving rate of the beef cows would be 66%.

An unknown proportion of the females, less than two years of age, do in fact produce calves. Therefore, the reproductive rate of the national herd must be lower than the aforementioned figure and may approach the 50% quoted by Lishman (1988).

In a survey by Boulle (1986), beef farmers claimed calving percentages ranging from 67 to 80 percent. A study of the records kept by the farmers revealed that the calving percentages were as low as 44% in some areas, and only 73% among the very best breeders. The average for Natal was 58%. Whichever way it is derived, the calving percentage of beef breeding herds in South Africa could be improved to advantage.

Ideally the beef cow should calve every 12 months. If the breeding season, and hence the calving season, is limited to 65 days, and assuming all the cows are already cycling at the onset of the breeding season, there will be enough time for 85% of the cows to exhibit oestrus at least three times. In dairy herds, a 60% conception rate to a single service is considered to be the norm and less than 50% to be a problem (MAFF, 1984). Applying this standard to a beef herd with a 65 day breeding season means that at 60 % conception, a 95% pregnancy rate should be achieved, at 50% conception, 89% pregnancy, and at 40% conception an 82% pregnancy. The fact that these rates are not achieved, suggests that during the breeding period, for various reasons, either the cows are not being bred as expected or the conception rate is not as anticipated.

It is generally recommended that beef farmers should strive to have the majority of the cows calving during the early part of the calving season. This allows for a compromise between factors that favour good pre-weaning growth of the calves and high re-conception rates amoung the cows. In practise, however, the opposite situation holds, with a large proportion of the cow-herd calving toward the end of the calving season. This situation is the consequence of interaction between two factors that control the time of onset of first oestrus, viz., nutritional level, particularly during late gestation, and the inhibitory effect of suckling a calf.

Assuming nutritional needs are satisfied, the suckling of a calf is a major cause of an extended post partum interval and hence poor calving rates. The problem lies with the later calvers in a herd. The early calvers will be at least 60 days post partum when the breeding season begins, whereas those calving in the latter half of the season are more likely to be in anoestrus as the end of the breeding season approaches.

It is well documented that the cow which suckles a calf has a longer post partum interval to oestrus than the cow from which the calf has been removed (Short *et al.*, 1972; Wetteman *et al.*, 1978; Williams, 1989). Many studies have been undertaken to investigate this problem and its causes, with investigators focusing on the endocrine mechanisms involved as well as the associated effects of suckling.

RESUMPTION of BREEDING POST PARTUM:

In the spontaneously cycling cow, oestrus is the result of complex interactions between the hypothalamus, the pituitary and the ovaries, which are in turn affected by external and internal stimuli. The growth and maturation of follicles within the ovary is brought about by the action of gonadotropins, (FSH and LH), synthesised and released from the pituitary (Spicer & Echternkamp, 1986). The developing follicles produce the oestrogens, which result in oestrus (Arije *et al.*, 1974). When a ripe follicle erupts (ovulation), the *corpus luteum* which forms in its place acts as an endocrine gland, producing progesterone. This hormone aids in the maintenance of pregnancy if that ovum should be fertilised. If not, progesterone declines, while more follicles are stimulated, leading to another ovulation (Lamming *et al.*, 1979; Walters *et al.*, 1982; Spicer & Echternkamp, 1986; Guilbert *et al.*, 1987b). Any deficiency or interruption to this sequence of events, including pregnancy, will lead to anoestrus.

The release of LH, and possibly that of FSH, are controlled by an episodic and surge centre in the hypothalamus (Lamming *et al.*, 1979). At parturition and immediately thereafter, peripheral levels of LH are low. The low levels of serum LH are the result of a low frequency pulsatile secretion pattern of the LH, which is characteristic of post partum anoestrus (Carruthers & Hafs, 1980; Carruthers *et al.*, 1980). Before oestrus and ovulation recommences in the lactating beef cow, the frequency of LH pulses will gradually increase to about 1 pulse every 2 hours, which is the pattern preceding oestrus. This intense secretory activity lasts for 2 or 3 weeks and causes waves of follicular development within the ovaries (Peters & Lamming, 1984; Walters *et al.*, 1982). At oestrus, a surge of LH occurs peaking about 27 hours before ovulation and then declines, until the approach of the following oestrus (Arije *et al.*, 1974).

DELAY of the ONSET of BREEDING due to SUCKLING:

Suckling is an external stimulus which plays a major role in governing the reproductive cycles in female mammals (Edgerton, 1980). Carruthers & Hafs (1980) suggest that it is the decreased frequency and amplitude of the LH secretion and the pituitary's inability to respond to LH releasing hormone that explains the suckling-induced delayed ovulation. According to Hinshelwood *et al.* (1985), it would appear that suckling actually exerts its effect on the pituitary or hypothalamus, (or both), by affecting the receptors to GnRH in the pituitary. By removing the suckling stimulus, pulsatile LH release in fact increases (Walters *et al.*, 1982). Thus, in the cow suckling a calf, the low levels of basal LH prevail for longer than in the non-suckling cow (Radford *et al.*, 1978).

It has also been suggested that when a cow suckles her calf, hormones are released that may depress gonadotrophin release and/or inhibit ovarian activity (Convey *et al*, 1983). To test the hypothesis that oxytocin, released by the posterior pituitary, may affect gonadotrophin secretion, Stewart & Stevenson (1987) administered oxytocin to milking dairy cows, simulating a calf sucking six times a day. This investigation was prompted by the fact that nerve impulses, stimulated by suckling or milking, are transmitted to the hypothalamus and pituitary where they could directly affect the hypothalamic-pituitary axis (Goodman & Grosvener, 1983; Hinshelwood *et al.*, 1985). However, they found no difference in ovarian activity in response to oxytocin, concluding that physiological doses of oxytocin alone do not inhibit ovarian cyclicity (Stewart & Stevenson, 1987). Nevertheless, they suggested that oxytocin may be an important component of neuro-endocrinal factors, originating in the hypothalamus and/or pituitary which inhibit ovarian activity.

A further suggestion has been that neural connections in the mammary tissue affect the GnRH receptors and hence the LH pulse generator by transmitting stimuli along somato-sensory pathways to the hypothalamus or higher brain cells (Williams, 1989). The teat could contain somato-sensory nerves which are able to distinguish between suckling and other forms of milk extraction. This is supported by the finding that in cows where the udder was removed, there was only a 12 day delay to first oestrus compared to 25 days in cows which did not suckle their calves (Short *et al.*, 1972). Cows, suckling their calves normally, had an anoestrous period averaging 65 days (Short *et al.*, 1972).

It would thus seem that suckling-induced anoestrus is a neuro-endocrine response, a concept to be considered when applying treatments to reduce the post partum interval.

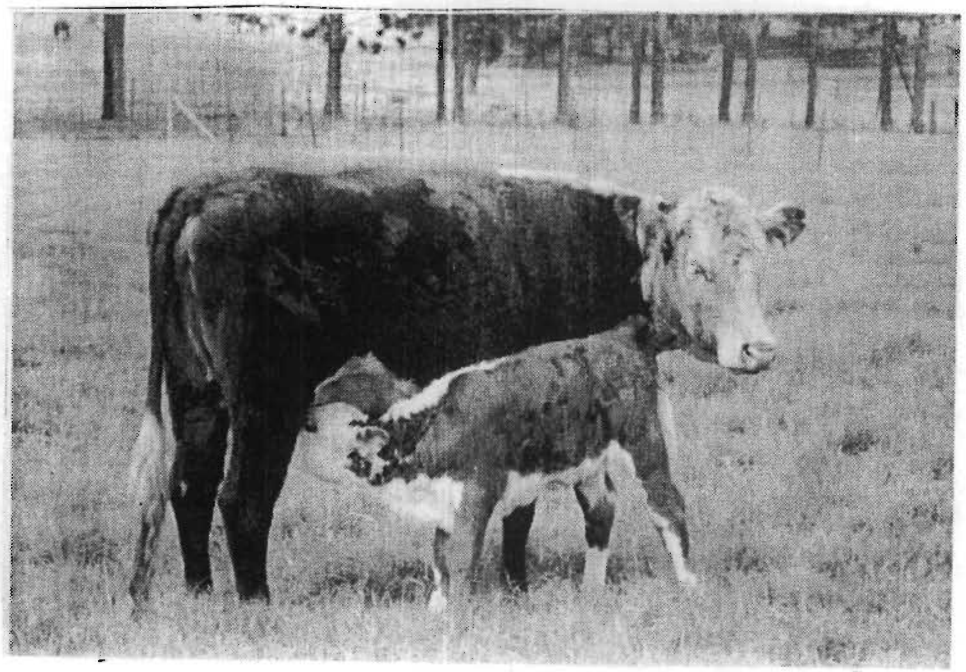
The aim of this study was to determine the normal suckling behaviour patterns exhibited by beef cows and their calves during the first 100 days post partum in an effort to establish whether there is any relationship between suckling behaviour and the onset of oestrus.

However, there were many other facets to this investigation, prompted by the following questions. These are:-

1) What is the normal suckling behaviour pattern of beef cows? Does it vary between breeds and is it affected by milk production? Is suckling behaviour influenced by management practises such as extensive ranching on natural veld or intensive grazing on cultivated pastures?
2) Is there a certain behavioural characteristic with regard to suckling patterns that inhibits ovarian activity?
3) Is there a way in which suckling behaviour can be manipulated to induce ovarian activity and hence reduce the post partum anoestrous period without

having to administer drugs or wean the calves?

4) If the suckling behaviour is manipulated to stimulate ovarian activity, how does that affect the calf and does that distress the cow? It was hoped that answers would be obtained to some of these questions.



Hereford cow suckling her month old calf.

CHAPTER ONE

SUCKLING BEHAVIOUR PATTERNS AS RELATED TO MILK PRODUCTION AND ONSET OF FIRST OESTRUS DURING THE MATING PERIOD

INTRODUCTION

SUCKLING BEHAVIOUR

As long ago as the early sixties, the need to have a good basic knowledge of cow suckling behaviour was recognised, the motivation being to more accurately assess and analyse results where cows and calves were part of the experiment (Walker, 1962).

There are certain characteristics of calf suckling behaviour that can be observed. The more general characteristics are the frequency of suckling bouts per 24 hour period, the length or duration each of suckling bout, the diurnal pattern of and the total time spent suckling in 24 hours.

Walker (1962), Nicol & Sherafeldin (1975) and Odde *et al.*, (1985) noted a breed effect on the duration of each suckling bout, while Day *et al.*, (1987) observed a decrease in the frequency of suckling as the calf became older.

Odde *et al.* (1985) have described the pattern of suckling activity over a 24 hour period, but details of the suckling process exhibited by the calf have apparently been studied and reported by only one researcher (Wells, 1987). He described two main phases i.e., the extraction phase and the stripping phase, and associated with these, the butting action of the calf and the frequency with which a calf changes from one teat to another. Characteristic of the extraction phase was the fewer teat changes exhibited (i.e. 24) as compared with the stripping phase.

Consistent with all investigators thus far is the fact that there is some variation in suckling behaviour patterns between individual cow/calf pairs. Perhaps herein lies the clue to the reason why some cows exhibit longer suckling-induced post partum anoestrous periods than other cows.

MILK PRODUCTION

In view of the effect the nursing calf has on its dam's post partum anoestrous interval, the level of milk production of beef cows may be of importance. Investigators have considered the beef cow's milk yield, as it affects the calf's growth rate (Clutter & Nielsen, 1987), and also in relation to suckling behaviour (Day *et al.*, 1987).

Odde *et al.* (1985), concluded that cows giving more milk, suckled their calves less frequently, but Day *et al.* (1987), found no relation between level of milk production and frequency of suckling bouts.

A commonly used method to estimate milk production is the weigh-suckle-weigh system. (Clutter & Nielsen, 1987). This same technique has been used by other researchers, (Boggs *et al.*, 1980; Day *et al.*,1987).

INITIATION of BREEDING after PARTURITION

First full oestrus after calving occurs on average in beef cattle between 52 and 88 days post partum (Dobson & Kamonpatana, 1986). However, there is a high incidence of silent heat followed by short cycles earlier than this. Silent oestrus is associated with a small *corpus luteum* forming after ovulation and hence lower levels of progesterone secretion (Short *et al.*, 1974; Lishman *et al.*, 1979). In fact, the oestrus behaviour symptoms, may be very weak and are thus usually unnoticed (Wells, 1987). Conception can occur only with a full ovulation which is accompanied by a full oestrus (Wells, 1987).

The stage post partum that oestrus is observed is an indication of ovarian activity, and hence denotes the time that suckling is no longer inhibiting oestrus.

By studying the suckling behaviour patterns of a herd of beef cows and their calves, it was hoped to ascertain

(1) How consistent these behaviour patterns may be;
(2) Whether they are influenced by the milk production of the cows;
(3) Whether there is a relationship between one or more of the suckling behaviour characteristics and the onset of oestrus.

Although many studies on calf suckling behaviour have been done and data on frequency of sucking and duration of each sucking bout and total sucking time for a 24 hour period have been published, there appears to be no information on the distribution of these suckling bouts that emphasises the time interval between suckling bouts.

MATERIALS AND METHOD

SUCKLING BEHAVIOUR

All observations were made at Broadacres, the beef research unit of the Department of Agriculture in the Natal midlands. The cows, which were either Hereford, Simmentaler or Hereford/Simmentaler crosses, calved down between mid-August and mid-October. The cows grazed kikuyu (*Pennisetum clandestinum*) throughout this study period, at a stocking rate of 4,12 cow and calf pairs per hectare. The animals rotated through an eight camp system, each camp being about 0,5 ha. The composition of the herds used in this study is given in Table 1.

Table 1: The number of cow-calf pairs studied during daylight and for 24 hours, at different stages post partum.

Breed type of dam & parity	STAGE POST PARTUM: < 45 days Day light	24 hours	46 - 90 days Day light	24 hours	> 90 days Day light	24 hours
Hereford:						
1st lact.	1	1	2	0	1	1
>1st lact.	4	13	6	6	9	6
Simmentalers:						
1st lact.	0	0	2	0	2	1
>1st lact.	6	9	12	7	8	8
Crosses:						
1st lact.	0	1	0	1	0	1
>1st lact.	3	4	6	3	4	4
n	14	28	28	17	24	21

Because primiparous cows show longer post partum intervals than multiparous cows, the data was categorised into first lactation cows and others. The stages postpartum were selected on the basis of (i) probability of cow still being anoestrus (<45 days), (ii) likely onset of first oestrus and (iii) cows should have been rebred by this time.

During this investigation, which covered three calving seasons, a total of 332 suckling events were observed and recorded.

The cows to be observed at any one time were marked by painting the number of her calf in large figures on her side or rump, using an aerosol can (Fig 1). A pen and clip-board with a standard record sheet (see Appendix 1) and a time-piece indicating seconds were used to record the relevant data. Usually, observers worked in pairs, monitoring up to 16 cow/calf pairs at a time. Binoculars were occasionally used to read the eartags of the animals if the nursing cow and her calf were closely surrounded by other cows.

Initially, suckling behaviour only during daylight hours was monitored and 16 cow/calf pairs were watched on different occasions from dawn to dusk. It was suspected that much information was lost by not monitoring the animals through the night, and therefore, during the second calving season, the observations included a full 24 hours. Observations were made in the spring when the calves were between one and three months old. At times the weather was cloudy, cold and misty, so the moon was of little help. Consequently, a 55 watt spot lamp was used at night. A stationery vehicle, parked in the middle of the camp (which was less than 0,5 ha), provided power for the spotlight, and shelter for the observers, necessary during the night. The spotlight was essential to scan the herd during the hours of darkness. This needed to be done every five minutes at least, to detect when a cow and her calf were approaching each other.

In the second season, i.e. September, October and November 1988, 15 more cow/calf pairs were observed, but for 24 hours each time.

Each calf watching session began at about 10:00 when the animals were generally "loafing" and not grazing or suckling calves. This gave the recorders a chance to organise themselves and for the cattle to satisfy any curiosity they may have had in the recorders/observers.

The time that a calf mouthed its mother's teat, to the time it stopped suckling was noted to the nearest second and recorded on the record sheet. This constituted a suckling bout or event. From these records, all necessary calculations could be made, viz. duration of suckling, frequency of suckling bouts, diurnal distribution of suckling events and the length and variation of the intervals between each event.

ESTIMATING MILK PRODUCTION

Estimates of milk yield were obtained using a modified weigh-suckle-weigh system (Boggs *et al.*,1980; Odde *et al.*, 1985; Day *et al.*, 1987).

The cows and calves were removed from pasture and brought to the handling pens on an afternoon as close to a calf-watching day as practicable. At 15:30 the cows and calves were separated. The cows were allowed access to hay and water, but the calves were placed on drylot with no feed or water. At 06:00 the following morning, a group of calves (no more than 8 in a group), were weighed and then immediately paired with their dams. While they were feeding, another group was weighed and the calves placed with their dams. Suckling ceased after about 10 minutes of nursing. The calves were then removed from the cows and re-weighed. They remained separated from their mothers until 15:00 when the whole process was repeated, after which the cows and their calves returned to the pasture. The difference in calf mass, prior to and subsequent to, suckling provided an estimate of the milk consumed and thus the yield of the cow.

OESTRUS DETECTION *and A.I. PROCEDURE*

Rebreeding in the beef herd, by artificial insemination, commenced on November 1 and ceased on January 1 each year. Four heat spotters/inseminators, working in pairs, were involved in the breeding programme. Two persons started at 06:00 when the cows were herded to one end of the field and observed for any sign of a bullstring, ruffled hair on the tail-head or of one cow riding another. These observations were made for about 30 minutes. Any cow seen to be in season was inseminated that afternoon. At 17:00 the process was repeated by the other pair of workers and any cow in season at this time was inseminated the following day .

Some of the cows were used for observations for two or three seasons, but others could be studied for one season only, either because they had left the research station or because they had been placed in another experiment.

WEIGHING COWS and CALVES and CONDITION SCORING

Cows and calves were weighed once a fortnight on a standard cattle scale, measuring to the nearest kilogram. At the same time the condition score of the cows was estimated, using a scale of from one to five, emaciated cows scoring a one and obese cows scoring a five.

STATISTICAL ANALYSIS

The frequency with which a cow suckled her calf was the number of times this occurred within a 24 hour period. The duration of each suckling event was the time in minutes that a calf suckled, calculated from the two times recorded (in the field) for each bout. Since the exact time was recorded, the diurnal distribution of the suckling bouts and the length of the intervals between them could be determined. Averages and standard deviations for frequencies and duration of suckling for the various cow/calf categories were calculated.

The effect of breed-type of cow and stage post partum on the suckling behaviour charateristics was tested by simple linear regression and where correlations were found, further analysed by multiple regression.

Correlations were examined between the frequency, duration and longest interval between suckling. Regression analyses determined the significance or otherwise of the results obtained.

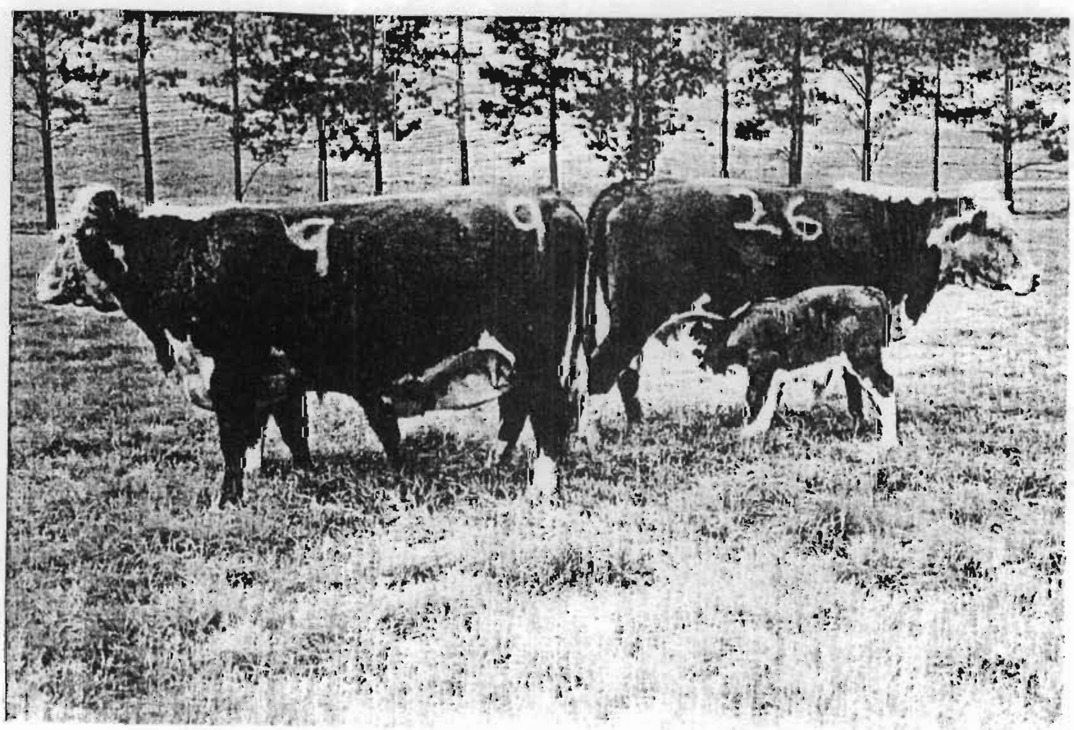


Fig 1. Suckling cows and calves with identification numbers painted on their flanks.

RESULTS

SUCKLING BEHAVIOUR

Frequency

Dawn to Dusk Observations: When the effect of the age of the calf was ignored, (i.e. stage post partum), the most common frequency of suckling was four times during daylight hours (Fig. 2). This corresponds to the average of 4,08 ±1,66 per day. It appeared that as the calf became older, so the frequency of suckling tended to decrease (Fig. 3).

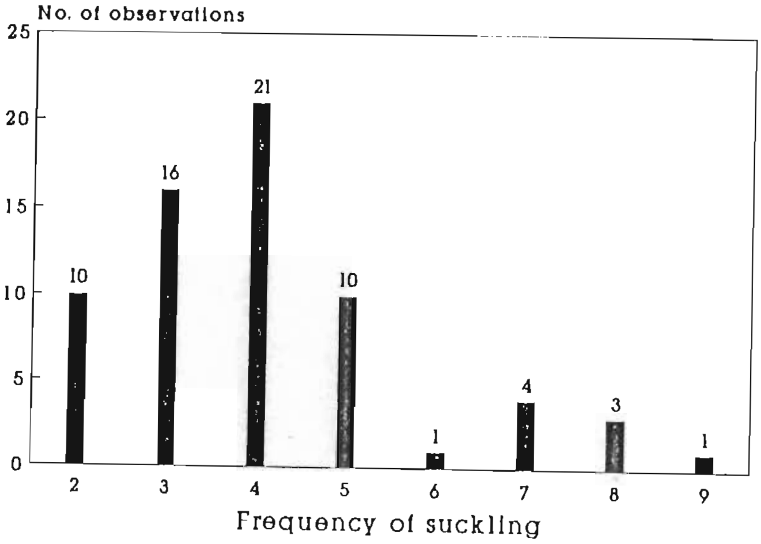


Fig. 2. The frequency with which calves of all age groups suckled during daylight hours.

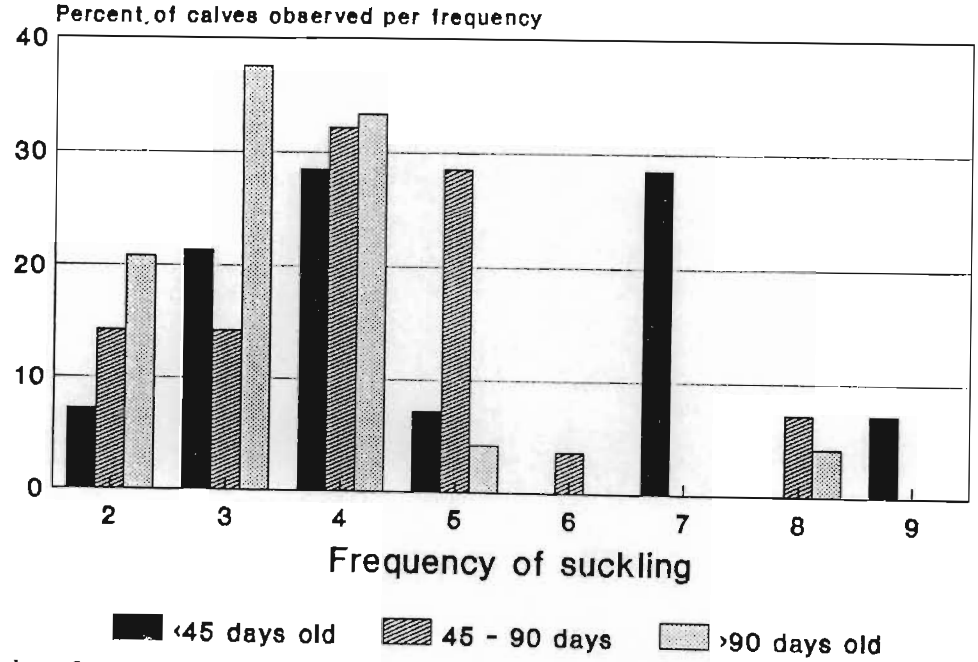


Fig. 3. The frequency with which calves of different age groups suckled during daylight hours.

Twenty four Hour Observations: Extension of observations, to include the hours of darkness, showed that the average suckling frequency increased only slightly to 4,95 ±1,86 (Figs 4 and 5). The most common frequency of suckling was again four times per observation period. Calves less than 45 days old suckled more frequently than the older calves ($p<0,01$; Fig. 6). The analyses of variance are given in Appendix III.

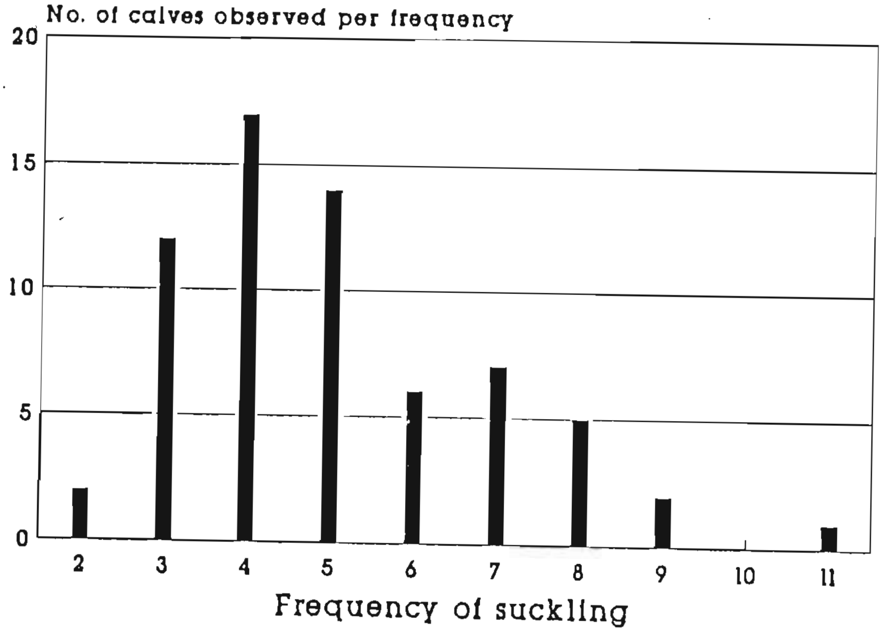


Fig. 4. The frequency with which calves of all age groups suckled, over a twenty four hour period.

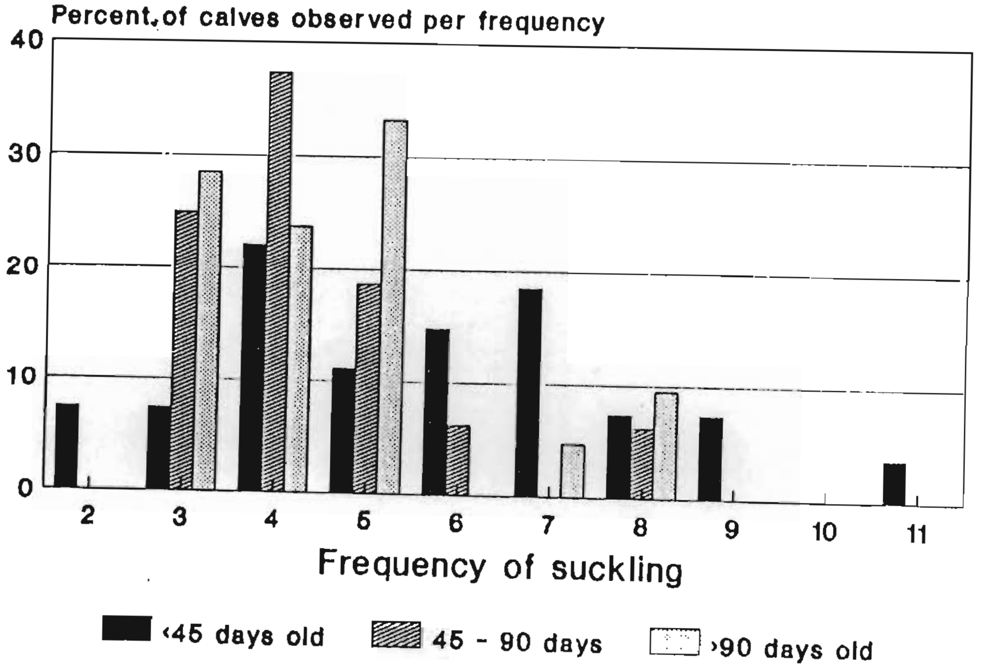


Fig. 5. The frequency with which calves of different age groups suckled over a twenty four hour period.

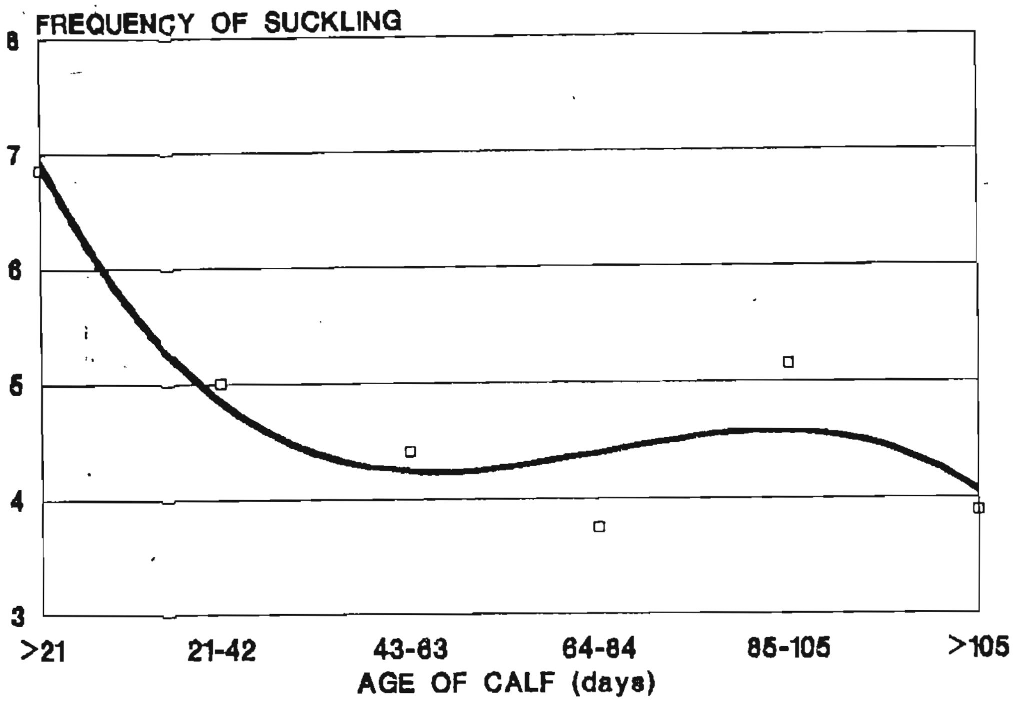


Fig. 6. Relationship between age of calf and frequency of suckling (r^2= 0,23; p<0,01).

The frequency with which a cow suckled her calf was not affected by her breed, mass or her lactation number, though there was a relationship between the frequency of her suckling bouts and her condition score, calf mass, p.m. milk production and days post partum (Tables 3a and 3b).

Table 3a: The frequency of suckling bouts observed during daylight or over 24 hour periods at various stages post partum.

Group	Dawn to Dusk		24 hour observations	
	ave. frequency	n	ave. frequency	n
All cows	4,08 ± 1,66	66	4,95 ± 1,86	66
1st lact.	4,9 ± 2,7	8	5,2 ± 2,07	6
2-5th lac	3,9 ± 1,5	42	4,7 ± 1,75	43
>5th lact.	4,0 ± 1,46	16	5,34 ± 1,54	16
<45 days	4,9 ± 2,09	14	5,8 ± 2,14	28
46-90 days	4,2 ± 1,5	28	4,4 ± 1,27	17
>90 days	3,4 ± 1,29	24	4,6 ± 1,54	21

Table 3b: Correlation Coefficients for Frequency of Suckling bouts vs Cowmass and other parameters.

Parameters	n	C.coeff.	Significance
Cowmass	36	0,011	NS
Cond.score	36	0,141	$p<0,05$
Lactation	51	0,108	NS
am milk	45	0,001	NS
pm milk	45	-0,284	$p<0,05$
calf mass	52	-0,245	$p<0,05$
calf sex	53	0,082	NS
calf age	143	-0,167	$p<0,05$

C.coeff - correlation coefficient

Duration:

Dawn to dusk observations: The average duration of each suckling bout was 10,8 minutes (651 secs). This varied from 16,1 to 3,6 mins; cows with calves <45 days old suckled for shorter periods than older calves, though the difference was not significant (Tables 4a and 4b).

Table 4a: The duration of suckling bouts.

	Dawn to dusk		24 hour observations	
Group	Ave.duration (mins)	n	Ave.duration (mins)	n
All cows	10,8 ±2,54	66	9,59 ±2,2	66
1st lact.	10,1 ±2,3	8	8,7 ±2,79	6
>1st lact.	10,9 ±2,8	58	9,69 ±2,08	60
<45 days pp	9,7 ±2,66	14	9,9 ±2,41	28
46-90 days	11,2 ±2,75	28	8,7 ±2,02	17
>90 days	11,1 ±2,12	24	9,9 ±1,93	21

Table 4b: Regression Coefficients for Duration of Suckling bouts vs Breed and other parameters.

Parameter	n	r^2	Significance
Breed	257	1,3	$p<0,05$ *
Cowmass	181	3,3	$p<0,01$ **
Cond.score	178	0,3	NS
Lactation	246	#	NS
am milk	201	#	NS
pm milk	201	#	NS
Calf mass	251	1,7	NS
Calf age	257	#	NS
Calf sex	257	0,7	NS
Frequency	257	3,9	NS

Residual variance exceeded variance of Y-variate.

Twenty four hour observations: Over all stages post partum, the average duration of the suckling events for individual cow/calf pairs varied from 5,6 to 14,8 mins, the overall average duration being 9,47 mins (568 secs).

Although first lactation cows suckled for shorter periods than multiparous cows, the difference was not significant. Calves 46 to 90 days old suckled for slightly shorter periods than calves younger or older than that group, though the difference was not significant.

The variation in duration of suckling times for all animals observed over 24 hour periods is shown in Fig.7. There was a significant correlation between duration of suckling, and breed and mass of the cow. The duration of suckling was negatively correlated with the frequency of this event ($p<0,01$).

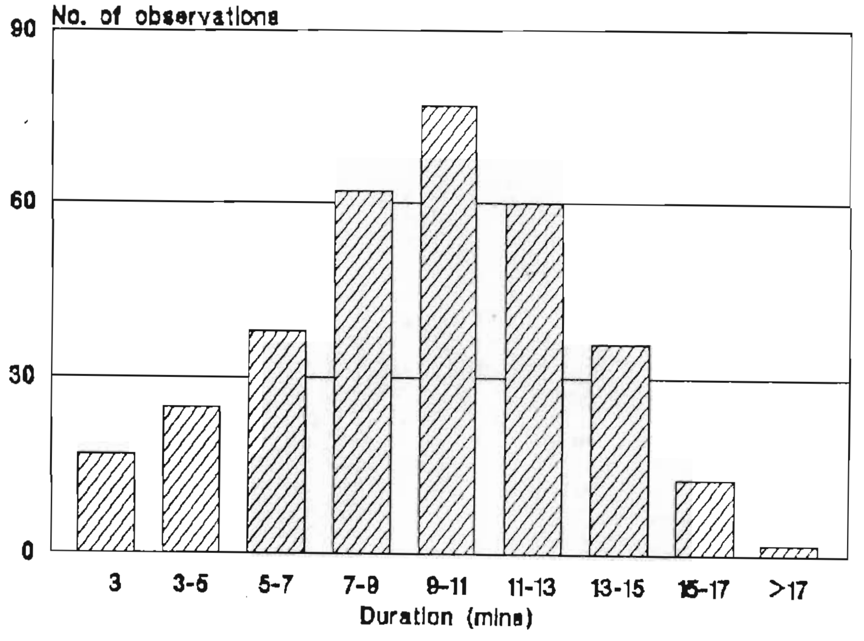


Fig. 7. Variation in the duration of suckling bouts.

A comparative summary of the frequency and duration of suckling is presented in Table 5.

Table 5: The frequency and the duration of suckling bouts categorised according to age of cow and age of calf.

Group	Ave. freq.		ave. duration (mins)		n
All cows	4,95	± 1,86	9,59	± 2,2	66
1st lact.	5,2	± 2,07	8,7	± 2,79	6
>1st lact.	4,9	± 1,65	9,6	± 2,12	60
Calf age					
<45 days	5,8	± 2,14	9,88	± 2,41	28
45-90 d	4,4	± 1,27	8,72	± 2,02	17
>90 days	4,6	± 1,54	9,92	± 1,93	21

Total Suckling Time:

The frequency with which a calf suckles in a 24 hour period, multiplied by the duration of each suckling bout, yielded the total suckling time. Although the average total time spent suckling was 47,4 minutes, (Table 6), the range was widespread, i.e. from 28 mins to 80 mins. Twenty percent of the cows suckled for less than 30 mins, another 20% suckled for 40 to 50 mins and a further 20% suckled for 50 to 60 mins (Fig. 8).

Table 6: Total time spent suckling in 24 hours.

GROUP	AVERAGE mins	n
All cows observed	47,4	66
< 45 days old	55,1	28
46 to 90 days old	37,6	17
> 91 days old	46,5	21
1st lactation	44,5	6
> 1st lactation	47,7	60

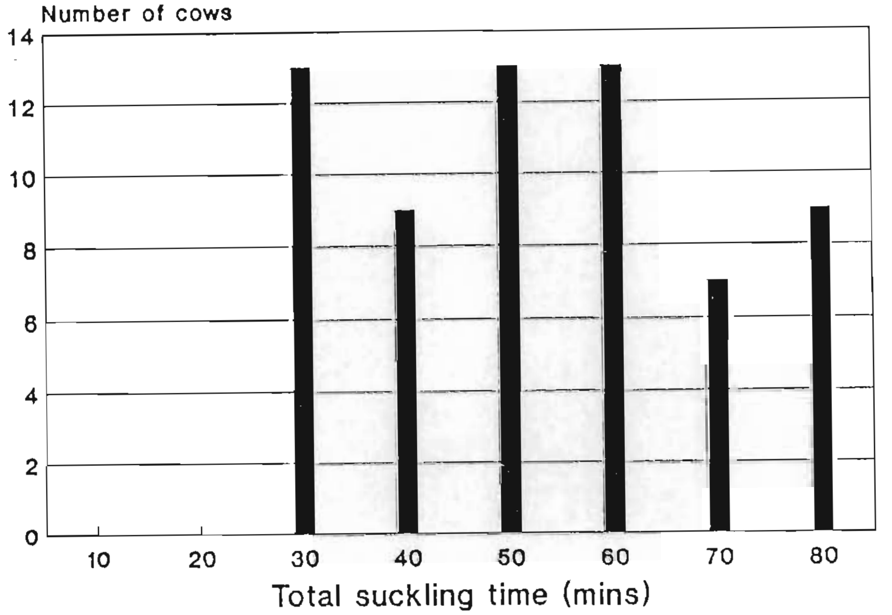


Fig. 8. Variation in the total time spent suckling over twenty four hour observation periods.

Distribution of Suckling Bouts:

On the 15th September, sunrise in the Natal midlands occurs at 05:54, but by the middle of October it occurs 26 minutes earlier. Sunset for these dates was at 17:44 and 18:12 respectively, a difference of 40 minutes. The most common feeding time was between 04:00 and 05:00 (17,57%), in other words, at dawn (Fig. 9). The next most common suckling time was dusk, i.e. at about 18:00 (16,1%). A pattern of the distribution of the suckling bouts throughout the 24 hour period for all cow/calf pairs observed, and the younger and older age groups, is given in Figures 9 and 9a.

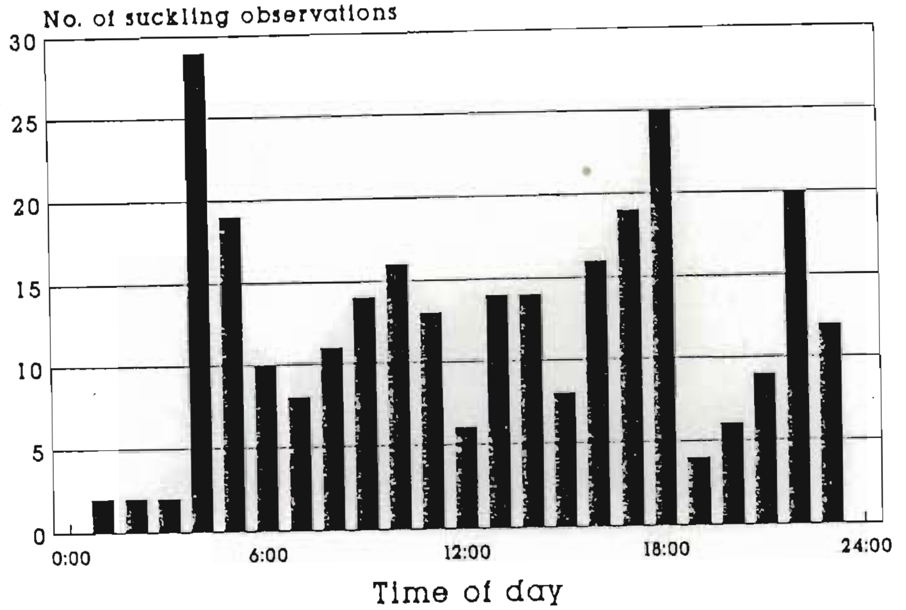


Fig. 9. Distribution of suckling bouts, over a 24-hour period exhibited by beef cows grazed under intensive conditions on cultivated pasture.

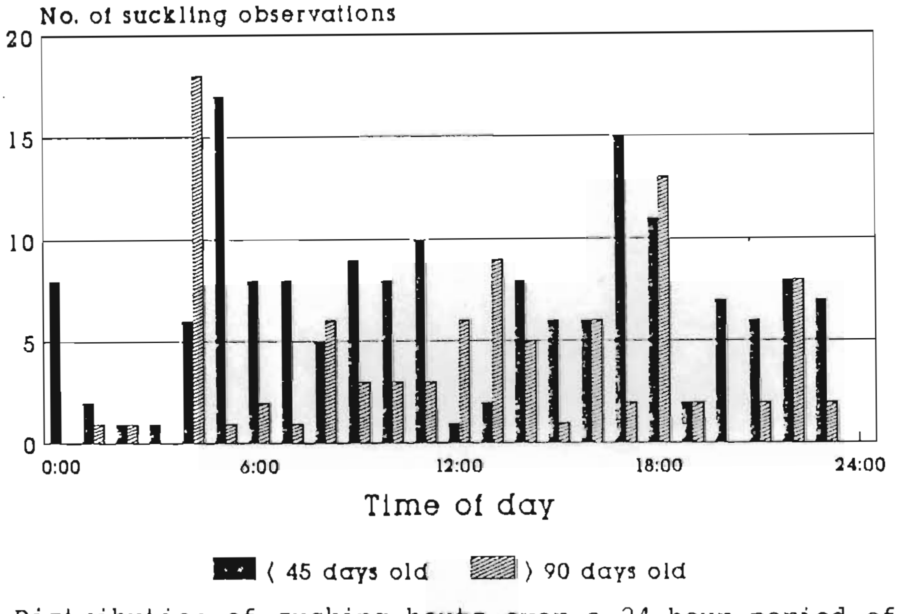
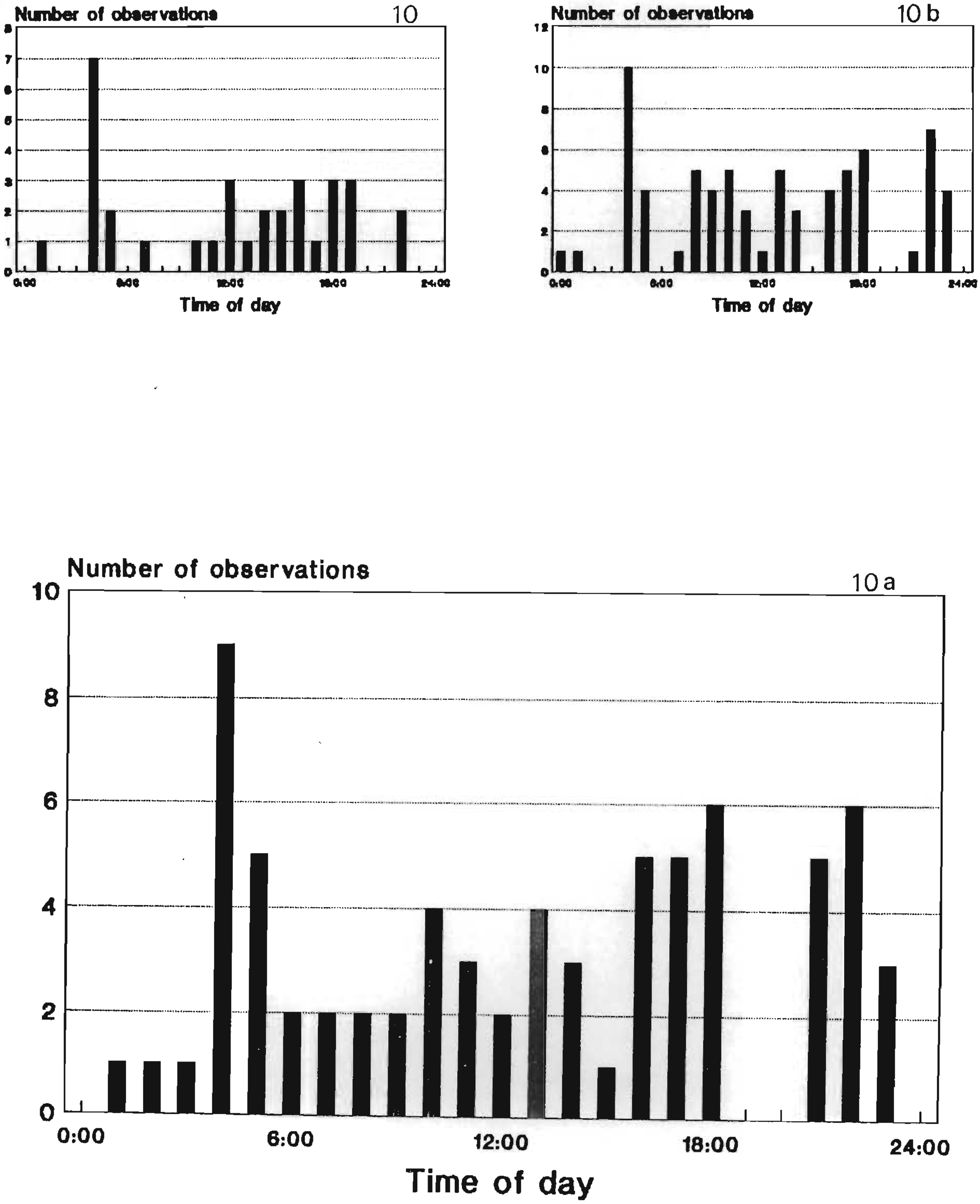


Fig. 9a. Distribution of sucking bouts over a 24-hour period of beef calves prior to forty-five and subsequent to ninety days.

Despite the difference in frequency of suckling bouts when observations were extended to cover 24 hrs, the greatest concentration of nursing still took place at dawn. Figs 10, 10a and 10b represent the distribution of the suckling bouts corresponding to frequencies of suckling of three, four and five events per 24 hour period. Of the eleven cows that suckled their calves three times a day, 27,3% of the 33 suckling bouts



Figs 10, 10a and 10b. The distribution of the suckling bouts corresponding to frequencies of suckling, respectively, of three, four and five events per 24 hours.

concerned, occurred at dawn (Fig. 10). Eighteen cows had suckling frequencies of four times a day and 19,4% of these occurred at dawn (Fig. 10a). Similarly, cows with suckling frequencies of five times a day, exhibited 20% of their suckling bouts at dawn, i.e., between 04:00 and 06:00 (Fig. 10b). The remaining suckling events in these three categories took place at various times through the 24 hours, greater concentrations being seen at about dusk and before midnight, regardless of the frequency of suckling, but not as marked as the concentration at dawn.

Intervals between suckling bouts

The expected interval between each suckling bout was calculated on the basis of (1) the assumption that cows suckle their calves at regular intervals throughout the 24 hour period, (2) the average duration of suckling bouts is 9,5 minutes and (3) the average frequency with which cows suckle their calves is 4,95 in 24 hours (Table 5). This yielded an expected interval of 4,6 hours between suckling events. It is evident (Figs 9 and 9a) that the distribution of suckling bouts was not evenly distributed, because the calves tended not to suckle between 01:00 and 04:00. Furthermore, this time period, which constituted the longest interval between suckling bouts, became longer as the calf grew older (Table 7a).

Table 7a: The average longest interval between suckling bouts.

Age Group	Long interval length (mins).	n
All calves	380 ±105,25	57
<45 days	345 ± 69,8	25
46 to 90 days	363 ± 32,25	13
>90 days	458 ±140,5	19

Neither the breed, mass, condition score, lactation number nor the level of milk production of the cow affected the length of the longest interval between suckling events (Table 7b). However, with an increase in the age of the calf, the longest interval was extended ($p<0,01$). There was also a significant correlation ($p<0,01$) between calf mass and length of longest interval between two suckling bouts (Appendix III). This was probably due to the age of the calf rather than its mass *per se*.

The frequency of suckling was negatively correlated with the longest interval between two suckling bouts ($p<0,01$; Appendix III).

Table 7b: Regression Coefficients for Longest Interval between suckling bouts vs Breed and other parameters.

Parameter	n	r^2	Significance
Breed	203	#	NS
Cowmass	143	#	NS
Cond. score	140	0,4	NS
Lactation no.	193	1,8	NS
am milk	153	#	NS
pm milk	153	1,0	NS
Calf mass	196	6,0	p<0,01 **
Calf sex	202	0,3	NS
Calf age	202	4,2	p<0,01 **
Frequency	203	33,5	p<0,01 **

Residual Variance exceeded variance of Y-variate.

MILK YIELDS

Neither breed nor milk production of cow was shown to have an effect on suckling behaviour patterns in this study (Table 7b). The cows calved down with a condition score of 3 or higher (on a scale of one to five), and they were on lush pasture, which could account for this result.

Nevertheless, the milk production records of Herefords and Simmentalers have been presented separately (Table 8).

Table 8: Estimates of the cows' milk yields (kg).

Herefords	<45 days	(n)	Mid lact.	(n)	Late lact.	(n)
1st calvers	9,5	(1)	-	-	7,0	(1)
2 + calvers	9,2	(15)	9,8	(13)	8,1	(11)
All cows	9,2	(16)	9,8	(13)	8,0	(12)
Simmentalers						
1st calvers	7,7	(1)	11,6	(2)	8,3	(2)
2 + calvers	11,4	(13)	12,2	(22)	10,4	(20)
All cows	11,1	(14)	12,1	(24)	10,2	(22)

The average milk yield estimate for all Herefords in this study was 8,4 kg/day (n=23; S.D.= 1,99), while that for the Simmentalers was 11,2 kg/day. (n=23; S.D.=2,75). The total yield is calculated as a.m. yield + 2(p.m. yield). The lactation curves for Herefords and Simmentalers are compared with frequency and duration of suckling in Fig. 11.

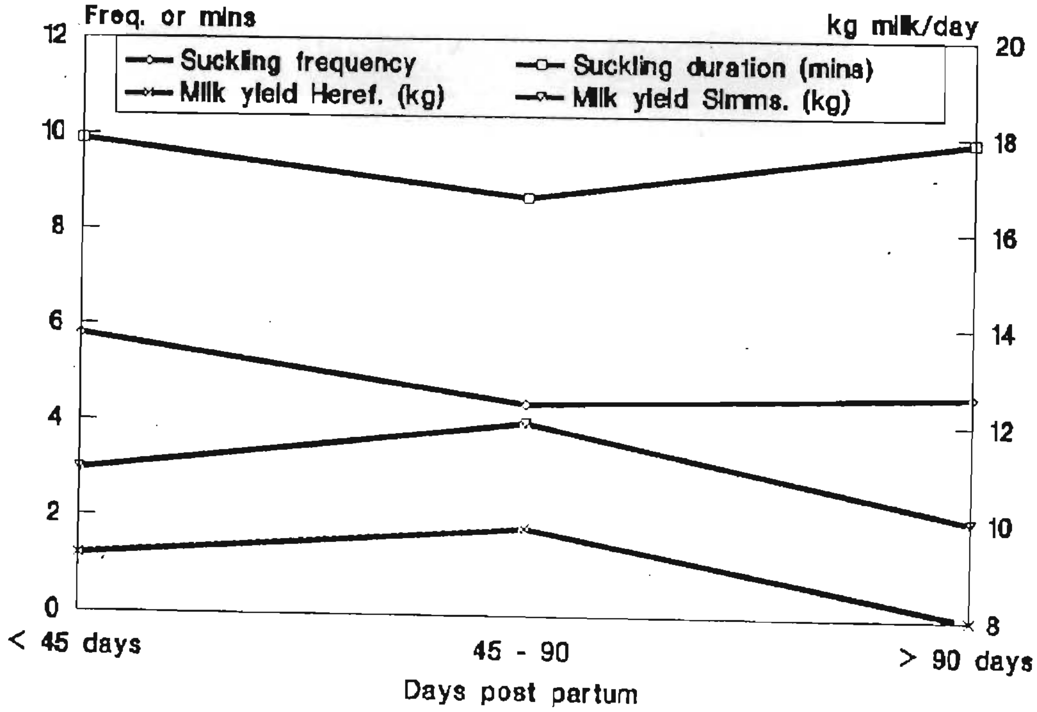


Fig. 11. A comparison between the frequency and duration of suckling, and relative milk yields of Herefords and Simmentalers.

OESTRUS

For the last five years, the same heat spotters/inseminators have been responsible for the breeding of the herd. During this time, on average, 34% of the cows were bred within the first three weeks of the season. This suggested that in the previous years the cows had started cycling prior to the onset of the annual mating period. All these cows had calved at least 60 days before the start of the breeding season and were not expected to be "problem" cows. The remaining 66% of the cows were apparently anoestrus at the start of the breeding season. Of all first inseminations that were unsuccessful, (i.e. the cow apparently did not conceive), 4% were not detected as being oestrus three weeks later. From these figures it is evident that the heat-spotters could obtain reliable information regarding the cyclicity of cows during the breeding season.

In the present study, due to a shortage of people with the necessary expertise in this field, no rectal examinations were made to determine ovarian activity, the only record of cycling being the detection of oestrus from the beginning of the breeding season.

The average number of days from parturition to first A.I. was 72,5 days (n = 33). The relationship between post partum interval to oestrus and suckling behaviour parameters is described in Table 9.

Table 9: Comparison of suckling patterns and post partum interval to oestrus.

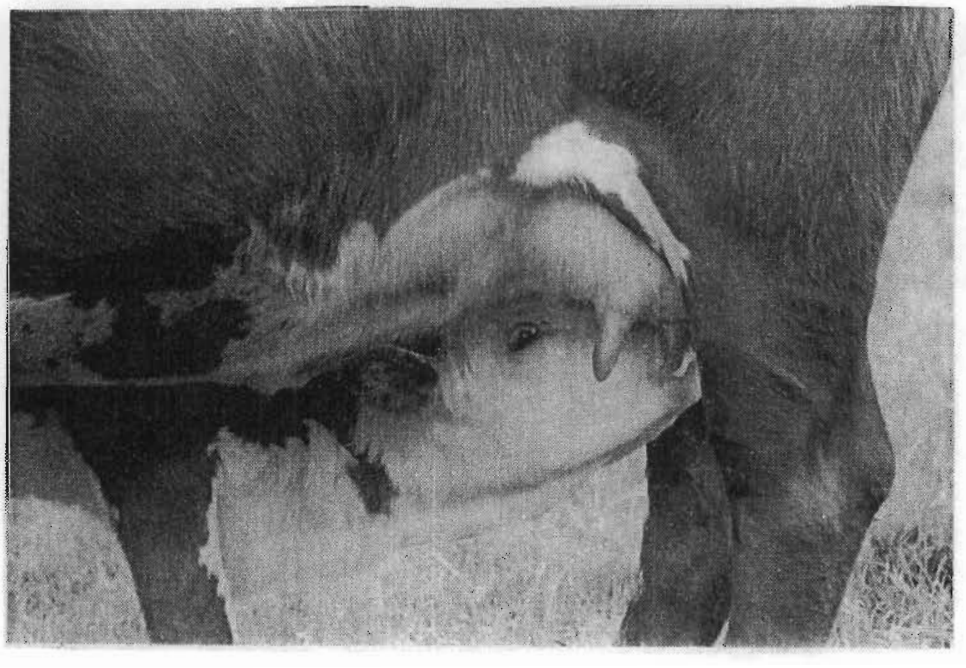
	SUCKLING PATTERNS			
Ppi to oestrus	Average freq.	Average duration mins	Average long int. mins	n
<55 days	4,8 ± 1,39	10,97 ± 1,31	406 ± 135,8	8
55 - 80	4,8 ± 1,95	8,56 ± 2,44	422 ± 130,7	12
81 - 100	4,2 ± 1,12	9,33 ± 2,63	433 ± 140,8	12

Suckling behaviour patterns on the day nearest the A.I. day, could be obtained for 12 cows (Table 10).

Table 10: Suckling Behaviour patterns for twelve cows near oestrus.

Suckling parameter	Average	Range
Frequency	4,2 ± 1,62	3 to 8
Duration	8,6 ± 1,73 mins	5,9 to 12
Total suckling time	35,5 ± 18,84 mins	–
Long interval	421 ± 103,4 mins	–

The average length of the longest interval between two suckling bouts (421 mins), coincides with the average length of the longest interval exhibited by cows that had started to cycle whether they were <55 days or >81 days post partum; Table 9).



DISCUSSION

At the outset, the reasons for conducting this investigation into the suckling behaviour of beef cows, were to establish whether there is such a phenomenon as a "normal" pattern of suckling behaviour, and if so, whether there was any practical relationship between suckling behaviour patterns or milk production and the onset of oestrus.

It was hoped that a management strategy could then be derived whereby cows and their calves could be separated to stimulate ovarian activity with as little disruption to the animals as possible.

Wells (1987), expressed the opinion that from the limited amount of data compiled from his study on suckling behaviour characteristics, frequency of suckling per 24 hour period was the only component likely to be correlated with post partum reproduction.

When these studies were begun, attention was focussed on the intensity with which a calf suckles. Initially, the calf pulled on one teat for as many as 30 pulls before changing teats, but had reduced this to as few as three pulls per teat by the end of the suckling bout.

Although Wells (1987), and his assistants were able to discern a change in the suckling intensity of a suckling event and described an extraction and a stripping phase, in this investigation it was not practicable to discriminate that accurately between the two phases. Furthermore, Wells worked with Zebu type cattle, which may show a clearer difference between the two intensities than was noticeable in <u>Bos taurus</u> cattle. Since such an investigation would have required more people in the field to collect the large sample of data needed, it was decided not to investigate this further in this study.

The most important fact learnt from the dawn to dusk observations was that observations during daylight hours only, led to a considerable loss of data. By extending the observations to include the hours of darkness, it was evident that the third most common suckling time in the 24 hours was the period before midnight. The results of a dawn to dusk calf watch could easily be adjusted by adding one to the frequency. However, the long interval between midnight and dawn, and associated with it, very little activity, would have been missed if only dawn to dusk observations had been made in this study. Nevertheless, the results are valuable in that trends could be determined within the cow/calf pairs (Figs 2 and 3).

SUCKLING BEHAVIOUR PATTERNS

There was no significant difference in the frequency of suckling events between the breeds. Younger calves suckle more frequently until nearly two months of age ($p<0,01$). There was an inclination for older cows i.e. over 8 years of age (beyond the 5th lactation), to suckle more frequently, (Figs 5 and 6 and Table 3), which coincided with a drop in milk production. In any suckling cow/calf population, as the calf grows older, its mass increases, the cow's milk yield begins to decline and the cow's condition improves. Since the results have shown that frequency of suckling is greater during the first 45 days post partum (Table 3a), the relationship between the frequency of suckling occurring over a 24 hour period and the cow's condition score, her calf mass, her milk production and days post partum, is to be expected.

The average duration of suckling bouts, observed from dawn to dusk, was 10,8 minutes, but the average over a 24 hour period was 9,47 minutes. This shorter duration, during daylight, leads to the question, "Is there a difference between duration of suckling bouts in the daytime and at night?" The dawn feed on average lasted for 11,16 mins, while the average of all other feeds was 9,05 minutes. All the dawn to dusk figures included the dawn feed but not the shorter night time feeds and hence the difference. Consequently, the dawn to dusk figures for duration could not be pooled with the 24 hour data.

The duration with which cows suckled their calves was less variable within cows (S.D.= <1,9) than between them (S.D. = 2,2). In randomly selecting cows that had been observed on three occasions in the one season and again the following (or previous) season, the duration of suckling bouts varied between cows from 7,6 minutes to 10,14 minutes, but their S.D.s were less than 1.9. The individual details pertaining to these particular cows are given in Appendix II.

The negative correlation between frequency and duration of suckling bouts is to be expected. The longer a cow suckled her calf, the less frequently she did so (p<0,01). Cowmass and duration of suckling were also correlated (p=<0,01), the lighter cows suckling for shorter periods. Herefords suckled their calves for shorter periods than Simmentalers (p<0,05) which supports the correlation between duration of suckling and cowmass.

The total time spent suckling over a 24 hour period was very variable. Although the calculations were done and tabulated in the results, it is a parameter not considered of great importance.

The whole question of time spent suckling by the calf is complex. It is a mammal, therefore it is instinctive to suck.

Once the cow has received the correct stimulation for milk ejection, which is effected by the release of oxytocin, the oxytocin can only operate for three or four minutes (Velitok, 1977). Hence it can be assumed that after five or six minutes of suckling, the calf is no longer actually receiving any milk. And yet, the average duration of each suckling event is about ten minutes and total time spent suckling, divided by frequency (9,6 mins), also reveals 4 or 5 extra minutes suckling but not drinking. The latter part of the suckling process, as described by Wells (1987), is the stripping phase, when calves in fact change from one teat to another more frequently, the first stage of the suckling process being called the extraction phase. At this time, the suckling is characterised by longer and more numerous pulls on each teat at a time, obviously drawing the bulk of the milk that has been ejected, while the stripping phase is punctuated with udder butting, possibly eliciting a second release of oxytocin.

The question which needs to be asked is why does a calf persist into the stripping phase, and why are there variations to this behaviour? Are the longer-sucking calves, in other words, cows with suckling durations of over 6 minutes, hungrier? Or is this stripping phase simply satisfying their mammalian need to suck? Results show that such calves are not obtaining more milk. (Table 8a; Fig.11).

Dairy calves, even if they are fed with a "calf bar" which allows them to suck their milk ration (as opposed to drinking it from a bucket), and where science and experience have correctly offered them sufficient milk for their nutritional needs, will try and suck the ears of other calves. Presumably this is an effort to satisfy their sucking needs. During all the hours that cows and calves were being watched, not once was there even a suspicion of a calf trying to suckle anything other than a cow's teat.

The total time spent suckling, within cows, follows a similar pattern to frequency and duration. Cows that had been studied 2 or 3 times in a season tended to have less total suckling time nearly 2 months into their lactation than earlier or later. But, as total suckling time is a product of frequency and duration, this trend would be expected.

Considering the negative correlation between duration and frequency, it would seem that at a given age, a particular calf has its own suckling need which is reduced at 2 months and then increases a little as it gets older. By this time, its diet is significantly augmented by grass, so hunger is not likely to be the reason for the persistent suckling. This trend is very clear in the cows' data tabulated in Appendix II. At about a month, calves suckle for longer, reduce their duration at about two months of age and then increase it again at three months.

The negative correlation between frequency of suckling bouts and the longest interval between two bouts, is logical, the less frequent the suckling events, the greater the time interval between them.

DISTRIBUTION OF SUCKLING BOUTS

The diurnal pattern, or distribution of suckling bouts throughout the 24 hour period, warrant careful evaluation.

Firstly, as shown in the results (Figs 8 and 9), within the herd the most obvious pattern was the concentration of suckling cows at dawn and then at dusk, followed by late night (20:00) and then more variably, late morning (10:00). These results are very different from those of Odde *et al* (1985) and others who reported a concentrated nursing time at dawn, but the next most intensive time being 20:00, and then at about noon. Those studies were made in the Northern hemisphere which may account for the difference. Perhaps prevailing weather conditions or a greater day:night ratio had their effect. The reasons for the difference in the two findings can only be conjecture at this stage.

Nevertheless, in this study, the intensity of the dawn feed was very marked (17,3% of all observations), followed by 15,8% at dusk. Cows with differing frequencies of suckling events for a 24 hour period, i.e. three, four or five times a day suckling, showed a higher concentration of suckling at dawn (≥20%). The time period of least activity was between midnight and 04:00 (2,2% of sucking events observed). The data in Fig 9 indicates the behaviour changes made as a calf grows older. The younger calves (<45 days old) who feed a little more frequently (5,8 times a day) than older calves, have a more even distribution of suckling events throughout the 24 hour period, dawn still being the most favoured time, however. Looking at the three month old calves who have a slightly lower suckling frequency (4,9), a more marked diurnal pattern emerges. With the exception of two calves out of 95, no suckling occurred from between midnight and dawn.

OTHER OBSERVATIONS

During the course of this investigation, and while analysing the results, other issues and topics of interest have emerged which may not be related to the potential fertility of the cow. Neveretheless, these aspects are discussed in case they are of value in further studies of this nature. In any event, the more a stockman understands the behaviour of his/her animals, the greater the chances of better stockmanship, and hopefully more efficient animal production.

On two occasions, a cow with twins was amoung the cows being observed and monitored. The first cow apparently had insufficient milk as her twins spent most of their time following behind her, trying to suckle, unlike other calves that settled to play or sleep after a feed. After the one twin had been removed at two weeks of age, the other calf settled to a "normal" suckling pattern, similar to the other calves in the herd. Although the results from this whole study did not reveal a correlation between milk production and suckling behaviour, perhaps if the milk production is below a certain minimum, then the calf's suckling patterns would be affected. It can be assumed that the surviving twin was then receiving enough milk not to alter the normal suckling patterns.

Because cows with twins were not pertinent to this study, there being too few of them to be of importance anyway, they were not included in the detailed study and hence their milk yields were not estimated. They happened to be in the herd when the other observations were being made.

The second cow with twins, (a first calver), invariably suckled both calves simultaneously, but with the "normal" frequency and duration exhibited by other cows. However, her calves supplemented their feed by suckling another cow while she was suckling her own calf. The choice of donor cow was determined by opportunity. If a cow realised she had been feeding two calves at once, and hence rejected the scavenging twin, the twin waited for another suckling cow from which to steal a drink. Otherwise, during the many hours of calf watching, except for the occasional short-lived mistakes, no other calves were seen sharing a feed with another calf. Yet, under the same management conditions in the same locality, a mixed herd of Zebu type cattle were frequently seen to feed more than one calf at a time. It appeared that when a calf started drinking from its mother, that was the cue for one or two others to join it. The calf belonging to the suckling cow drank from the side of the cow, while the visiting calf fed from behind. In this way the cow apparently could not see she had a visitor.

The occurrence of a suckling event is very positive in that it is quite difficult to interrupt the process. On one occasion a reedbuck cantered through the pasture which caused all the cows to chase after it, except those cows that happened to be suckling their calves at that momment. The same occurred when dogs appeared amoung the cows. If a herd of cows and their calves were being moved from one camp to another and this should coincide with a cow suckling her calf, it took a certain amount of force to interrupt this event and keep the cow and calf moving with the herd.

A frequent question asked is "who initiates the suckling, the cow or the calf?" There is no definite answer. Most suckling events just seemed to happen. Nonetheless, there were occasions when it was very clear that the cow approached her calf. Late afternoon is a favoured playing time for the calves, when they run and romp in a group. More than once, a cow was seen to try and follow the romping calves, calling but with no apparent response from the calf at all. After as long as ten minutes, by which time the calf game was coming to an end, the cow was able to suckle her calf. Similarly, there were occasions in the early morning when a sleeping cow was nudged and worried by her calf for as long as 15 minutes, (though the time varied) in an effort to persuade her to stand so that the calf could feed.

A Hereford cow which had a stillborn calf was given a Friesland calf to foster. During the initiation process, cow and calf were placed in the handling race three times a day so that the calf could feed and a bond develop between them. Once the cow had accepted the calf, (after about a week), and they had joined the rest of the herd, they no longer followed the routine imposed on them initially, but adopted normal suckling behaviour patterns, as described in this document, i.e. four or five times suckling a day for about ten minutes at a time.

ESTIMATED MILK YIELDS

The milk yields given are considered only estimates as no milk was actually extracted and measured. At times the value of these estimates were suspect. On one occasion, the calf supposedly drank 12 kgs of milk. It was the only impossible value and so was disregarded, assumed to be a recording error. The next surprisingly high values were 7 kg at one drinking, but the calves in question weighed 70 kgs, so perhaps such a measurement was possible. All the same, the reason for making milk yield estimates was for comparative purposes.

From the results, it is evident that Simmentalers yield more milk than Herefords, which is to be expected. Furthermore, both Simmentalers and Herefords showed higher milk production between 2 and 3 months than in the first month and later in their lactation, describing a fairly normal lactation curve.

Accepting then that these reults are estimates and to be used for comparisons, the results in Fig 11 reveal some very interesting trends. The curves depicting frequency of suckling and duration of each bout are the opposite to milk production; in other words, as more milk becomes available, the calf sucks for shorter periods. The frequency curve levels off which is in accordance with its significant correlation with age of calf. At about two months, calves have settled down to a regular frequency of suckling events each day.

OESTRUS

It has been established that the post partum interval to oestrus exhibited by suckling cows is between 52 and 88 days (Short *et al*, 1972; Dobson & Kamonpatana, 1986).

Part of the motivation for this study was to try and relate suckling behaviour patterns to the onset of oestrus. It is indeed unfortunate that due to the limited manpower available, this aspect received only cursory attention. If there is any relationship between the suckling behaviour elements of beef cows and their measure of fertility, the exhibition of these near the onset of oestrus revealed no trend or pattern here. The results show the suckling behaviour patterns which are exhibited for certain post partum anoestrous intervals (Table 9). The frequencies of suckling and the duration exhibited by the cow/calf pairs with any particular post partum interval (ppi) appeared to be random. Looking at the 12 cows who were inseminated very close to an observation day, it would seem their frequency of suckling was below average, but close to the median, and the duration of suckling slightly shorter than normal. Statistically, these few results are inconclusive.

It must be borne in mind that factors initiating post partum ovarian activity may do so some time before the onset of oestrus is observed.

Of all the suckling behaviour characteristics examined, the longest interval between suckling bouts was the most significant when comparing or relating suckling behaviour patterns to the onset of oestrus in the cow.

This leads to the possible importance of the intervals between suckling bouts. These intervals varied greatly between and within cows and obviously the fewer the suckling bouts over the 24 hour period the longer the long intervals between ($p<0,01$). With the exception of two cow/calf pairs, all longest intervals exhibited by the cows in this study, occurred in the early hours of the morning. The younger calves, i.e., cows less than 45 days into their lactation, averaged long intervals of 345 minutes. This time span increased over time until at three months and over, the average length of the longest interval was 458 minutes, significantly longer than 345 minutes ($p<0,01$). (The long interval lengthens as the calf grows heavier, $p<0,01$, but this is explained as a function of age).

The 12 cows from whom suckling behaviour statistics were measured close to their A.I. day, had an average long interval of 421 minutes.

Earlier researchers in the field of suckling-induced anoestrus established that once a day suckling promoted ovarian activity (Odde *et al*, 1986; Wells, 1987). This raises a number of questions, viz.

(1) What is the minimum length of time required for no suckling to trigger ovarian activity?

(2) Is the longest interval between suckles a natural clue (cue) to the answer?

(3) If this longest interval was artificially manipulated and made longer just before the breeding season, would that evoke ovarian activity?

(4) Is it significant that the longest interval is always before the dawn, and is it significant that unlike other intervals between suckling bouts during the day when cows grazed or loafed, the pre-dawn interval was a very quiet time?

The calves slept and so did their mothers for most of the time. Occasionally a cow lay chewing the cud but for four or five hours there was marked inactivity, not seen at any other time of the 24 hour period.

CHAPTER 2

TWELVE HOUR COW/CALF SEPARATION; DAYFEEDERS OR NIGHT FEEDERS

INTRODUCTION

It is widely recognised that a cow which suckles a calf has a delayed post partum oestrus. Accordingly, attempts have been made to improve the fertility of cows by restricting the calf's access to it's mother (Eduvie & Dawuda, 1986; Wells, 1987). By removing calves from anoestrous cows at three weeks of age or older, an immediate change in tonic LH secretions have been observed (Walters *et al.*, 1982).

Some researchers have tried removing calves temporarily before the breeding season, with variable results. Alberio *et al.* (1985) weaned Aberdeen Angus calves at 40 days for 48 or 72 hours, achieving conception rates of 67% or 72%, respectively, as opposed to 50% in the control group. However, Wright *et al.* (1987) could find no beneficial effect on the post partum anoestrous period due to temporary calf removal.

Another approach has been to limit calf suckling per day. When calves nursed once and twice daily, starting 11 days before the breeding season, the number of cows exhibiting ovarian activity was 75 and 78,6% respectively, compared with 51% in the control group (Odde *et al.*, 1986). Wells (1987), found that conception rates in Afrikaners increased by 40% if the suckling was reduced to twice a day, starting on day 28 post partum and then once a day from day 42 pp.

When the inhibitory effect (on ovarian cycles) of the suckling calf is artificially removed, then increased frequency of LH surges triggers the first ovulation (Carruthers *et al.*, 1980; Walters *et al*, 1982). However, in the cow that suckles her calf normally, ovulation will occur eventually. Thus it would seem reasonable to assume that the period of time, during which the cow is not exposed to the inhibiting effect of suckling, has increased to a level which will allow cycles to recommence spontaneously.

From the observations of the suckling behaviour (in the first part of this study), it was evident that as the calf grew older, so the interval between the suckling bouts from midnight to dawn lengthened. This interval has lengthened significantly by the time the cow resumes cycling. A natural form of temporary calf removal thus appears to facilitate ovarian activity.

The question arises whether there is a minimum length of time required between two suckling bouts before cyclicity recommences?

A trial was conducted to investigate the significance or otherwise of the pre-dawn long interval between two suckling bouts discussed in Chapter 1 of this study. The long interval was extended to a 12 hour period of no suckling in an attempt to answer the following questions;

1) How would this separation affect the onset of oestrus?

2) Would the normal suckling behaviour patterns of the cows and calves be changed? In other words, would the calves compensate for the reduction in hours with its dam and suckle more often during the hours they are together than in calves not separated from their dams?
3) Is there any significance to the fact that the longest interval between two suckling bouts always occurs at night?

PROCEDURE

Over a period of three seasons, a total of 88 suckling cows were blocked according to stage post partum and then randomly allocated into two treatment groups. The one group was to be separated from their calves during the night (dayfeeders), and the other during the day (nightfeeders). Two weeks before the start of the breeding season, the dayfeeders were separated from their dams from 18:00 to 06:00, while the night feeders were separated from 06:00 to 18:00. During the process of separating the cows and calves, the cows were taken out of the pasture, leaving their calves behind, and placed in an adjoining paddock. Thus there was no change to the forage or herbage component of their diets.

Suckling behaviour patterns were monitored as in Chapter 1, and observations began at 06:00 when the dayfeeders were joined by their mothers, and similarly at 18:00 for the nightfeeders.

At the end of the two week period, the cows and calves remained together as one herd and breeding, by artificial insemination commenced. Heat spotting was done at 06:00 and at 18:00 (Chapter 1).

RESULTS

The behaviour patterns observed after the cows and their calves had been rejoined after 12 hours of separation, are summarised in Table 11.

Table 11: Frequency and duration of suckling of day and night feeders.

	Dayfeeders	Nightfeeders
n	44	44
No. of suckling bouts	3,3 ±0,96	2,4 ±0,49
Range in no. of bouts	2 - 5	2 - 3
Ave. duration (mins)	12,6 ±2,19	11,4 ±1,7
Range	10,1 - 15,5	8,7 - 14,0
Long interval (+ 12 hrs)	2,4	1,2
Range	5,3 - 0,0 hrs	1,8 - 0,1 hrs
Total suckling time	40,2	27,2
% cycling in 30 days	56,8	29,5

The net length of the longest interval between two suckling events for the nightfeeders was the imposed 12 hours plus the short time from the dawn feed to 06:00 (1,16 hrs) when separation took place. The dayfeeders were separated from their dams for as long as 12 plus 5,3 hours (for those that had had a feed at about 12:30, then separated at 18:00) or as short as 12 hours only, having just had a feed.

There appeared to be no attempt to "make up for lost time" in that calves feeding at night nursed less often than those during the day, and their total sucking time was much shorter (27,22 mins cf 40,19 mins).

Of the 44 cows in the day-feeder group, 25 were inseminated within the first month of the breeding season whereas 13 out of the 44 in the night feeding group were inseminated during that same time. Eighty one and 66%, respectively, subsequently calved. These calving percentages only refer to 30 cows in each group as it is still too soon to establish pregnancy rates in the present season's cows. The average post partum period to first insemination in those cows which exhibited oestrus in the dayfeeder and night feeder group respectively, was 72,4 days and 71,1 days.

As cows and calves were within sight and hearing of each other, there were very few signs of distress, e.g. restlessness, until about an hour before they were due to be combined, when many started to call and wait at the gate. On the appointed hour, i.e. at 06:00 or 18:00, the gate to the cows' paddock was opened, the cows ran straight to the calves' gate which was then opened and the calves proceeded to drink. By the second or third day, the cows had become used to the routine and showed very little reluctance to leave their calves, a possible indication that they did not feel under stress.

DISCUSSION AND CONCLUSION

Using the suckling behaviour characteristics monitored in Chapter 1 as the norm, and then comparing them with the characteristics observed in this part of the study, it is evident that the cows and calves showed no change from their normal suckling behaviour patterns as a result of a twelve hour separation. The dayfeeders nursed more frequently in 12 hours than the nightfeeders. This was a reflection of the normal daytime suckling behaviour of calves who are with their dams continuously, suckling three times or more. Similarly, the nightfeeders reflected a night-time suckling behaviour pattern seen in normally suckled calves. This was less frequent than during the day. Apparently, calves running with their dams for only 12 hours out of the 24, do not compensate for the period they are not with their mothers.

The two groups of cows were separated from their calves for just over 12 hours each day. If only the length of time of no suckling was the important trigger to the onset of oestrus, a similar response would have resulted within the two groups. This was not so. A higher percentage of the dayfeeders were seen to exhibit oestrus within the first month of the breeding season than the nightfeeders ($p<0,01$), even though their total suckling time was nearly twice as long (41 mins vs. 27 mins). Associated with this was the difference in suckling behaviour observed between the two groups.

It is possible that the dayfeeder cows had altered their pattern of oestrus, coming into season during the day when they were more readily heat-spotted. This shifting of oestrus display could have been evoked simply by eliminating the near midnight feed.

In a study of Afrikaner cattle which were intensively observed from 05:00 to 19:00, it was recorded that normally suckling cows displayed 50% of their oestrus behaviour between 19:00 and 05:00. However, when the calves were partially weaned, oestrus was shifted, only 17% occurring between 19:00 and 05:00 (Wells,1987).

Research has shown that 70% of sexual activity of dairy cows occurs at night (Hartman, 1990). The indications are that there is a diurnal pattern to the reproductive physiological functions in the cow, supported by the day and night-time suckling effects on cows being inseminated within the first month of the breeding season.

There is another possible explanation to the difference in a response to day vs night suckling:

It is known that an episodic release in LH is necessary to restore ovarian cyclicity in post partum cows and that this can be evoked by removing the suckling stimulus (Walters *et al.*, 1982; Williams *et al.*, 1982. Furthermore, there is evidence that a control pathway exists involving endogenous opioid peptides which suppress LH secretion in suckling cows (Whisnant *et al.*, 1986; Short *et al.*, 1986; Gregg *et al.*, 1986; Malven *et al.*, 1986). It is known that endogenous opioids suppress LH secretion in suckling cows, since an administration of an antagonist will increase the LH concentrations (Whisnant *et al.*, 1986).

Also, melatonin has an affect on the onset of post partum ovarian activity in cattle (Sharpe *et al.*, 1986), indicating the possible role of photoperiod in the onset of post partum cyclicity.

Work done on ovariectomised heifers has indicated that photoperiod alters the circulatory concentrations of LH, and pulsatile release of LH and melatonin. LH levels and pulse amplitude were higher in bloodsamples taken during the night than those taken in the light. Similarly for melatonin concentrations, though melatonin pulse amplitude was higher during periods of light stimulation (Crister *et al.*, 1987b). Melatonin injections given at 16:00 tended to inhibit a decrease in LH concentrations (Crister *et al.*, 1987a).

In fact, Short *et al.*, (1988), are excited about recent additions to available options for further study of ovulation control using CNS-related hormones, e.g. endogenous opioids, oxytocin, melatonin, or their antagonists.

The sensory stimulation of the teat by suckling is being investigated by Williams, (1989) and his colleagues, who are focussing their attention on the neural pathways which affect hypothalamic function. Not only do calves suckle less frequently at night compared with during the day, but from midnight to dawn is a very quiet and inactive period when cows and calves alike rest and sleep, whether they are together for 12 hours or for 24 hours.

It would appear from this trial that there could be an association between the onset of oestrus and the longest interval between suckling bouts and its regular occurrence before dawn.

The cumulative effects of suckling, endogenous opioids, melatonin and possibly oxytocin secretion, discussed in Chapter 1, result in low releases of pulsatile LH. As the calf grows older, in other words, post partum day increases, the intensity of suckling is reduced by a lengthening of the longest interval between two suckling bouts. This takes place during the hours of darkness. The inhibitory effect of the endogenous opioids are reduced and melatonin, with higher nocturnal concentrations, influence the LH concentrations in the anoestrous cow until a point is reached where a LH surge is sufficient to initiate the onset of oestrus.

The importance given to the longest interval between two suckling events in relation to the onset of oestrus is not a contradiction of Well's theory that frequency was the only component likely to be correlated with post partum reproduction. The lower the frequency of suckling, the longer the interval between two bouts is likely to be.

It is suggested from the results of this study that it is the long pre-dawn interval between two suckling bouts that holds the clue to the suppressive effects of suckling on post partum oestrus.

Calves temporarily separated from their dams.

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Date 4·10·89. Cool, cloudy turning to mist + rain.

(3) S 9-18	10·20·49 – 10·23·15 12·36·10 – 12·53·12 14·45·13 – 14·52·19 17·17·24 – 17·26·06	18·38·05 – 18·48·31 23·45·30 – 23·54·30 5·25·13 – 5·34·24 8·10·14 – 8·19·30	
(12) S 3-74	11·29·41 – 11·46·10 14·34·14 – 14·45·05 18·22·40 – 18·35·20	23·35·00 – 23·46·00 5·15·19 – 5·27·09 9·20·06 – 9·32·20	
(16) X 4·38	10·07·24 – 10·11·59 11·58·38 – 12·06·43	1·05·23 – 1·10·59 6·07·17 – 6·11·35	
(17) H 1-70	12·35·07 – 12·45·33 17·12·03 – 17·25·21 21·09·40 – 21·23·06	5·38·25 – 5·51·10	
(18) H 4-61	11·09·15 – 11·18·43 16·20·33 – 16·30·11	5·00·00 – 5·09·26	
(25) X 313	15·03·20 – 15·18·50 18·30·00 – 18·52·00 23·39·45 – 23·49·52	5·45·01 – 5·58·20	
(35) S 1-51	10·52·45 – 11·03·54 17·47·13 – 17·58·40 22·40·31 – 22·52·52	4·48·09 – 5·02·00	
(42) X 3-191	11·04·27 – 11·14·26 13·57·48 – 14·07·46 18·21·05 – 18·29·36	23·12·55 – 23·21·43 5·11·28 – 5·23·23 10·11·25 – 10·25·50	
(41) S 3-29	10·09·35 – 10·22·52 14·39·02 – 14·52·30 18·23·18 – 18·36·14	4·26·13 – 4·40·30 9·07·18 – 9·19·10	
(48) S 0-19	11·03·57 – 11·15·45 16·22·11 – 16·37·15 4·30·00 – 4·42·00	8·39·41 – 8·54·06	
(49) H 2-53	11·09·15 – 11·15·35 17·46·20 – 17·55·07 00·19·30 – 00·23·41	5·37·08 – 5·42·00 9·53·09 – 10·01·12	
(51) S -75	13·33·08 – 13·40·02 17·30·44 – 17·36·29 22·05·58 – 22·12·13	4·48·49 – 4·56·10	
(53) H	10·26·38 – 10·33·15 16·19·33 – 16·28·19	4·19·03 – 4·33·24 8·47·[illegible] – 9·00·[illegible]	

APPENDIX II

Cow no.	Breed	frequency	Av.dur.	S.E.	calf age	lact.
3/74	S	(5)	8,59	0,87	> 3 mth	2
		(7)	8,67	1,86	< 1 mth	3
		(5)	5,57	1,99	1 mth	3
		(4)	6,6	0,65	2 mth	3
		(7)	8,13	4,2	1 mth	4
8/75	S	(3)	12,75	1,97	> 3 mth	5
		(7)	9,59	4,04	1 mth	6
		(5)	10,3	3,15	2 mth	6
0/19	S	(4)	13,35	1,69	3 mth	3
		(6)	10,13	3,59	1 mth	4
		(3)	9,43	3,45	2 mth	4
		(5)	11,07	2,11	3 mth	4
3/29	S	(4)	14,51	2,28	>3 mth	2
		(2)	10,13	0,88	<1 mth	3
		(4)	10,69	1,65	2 mth	3
271	S	(5)	10,1	5,41	>3 mth	8
		(7)	10,39	2,91	<1 mth	9
		(5)	9,87	1,23	2 mth	9
4/38	X	(5)	10,5	1,02	1 mth	2
		(5)	7,4	2,5	2 mth	2
		(3)	8,25	2,13	3 mth	2
		(8)	9,72	4,6	1 mth	3
5/119	X	(6)	8,86	1,58	1 mth	1
		(3)	6,0	0,5	2 mth	1
		(3)	7,06	2,56	3 mth	1
313	X	(6)	12,12	3,25	3 mth	2
		(4)	10,76	4,94	<1 mth	3
		(5)	6,54	1,86	<2 mth	3
		(4)	12,77	2,21	1 mth	4
1/2	H	(3)	9,5	1,21	>3 mth	4
		(6)	8,1	1,67	1 mth	5
		(4)	6,3	2,6	2 mth	5
		(4)	8,4	3,0	3 mth	5
0/73	H	(3)	10,8	0,82	>3 mth	4
		(8)	9,48	1,9	<1 mth	5
		(4)	5,7	1,77	>1 mth	5
		(4)	8,1	0,83	>2 mth	5
1/85	H	(3)	9,2	1,4	>3 mth	4
		(2)	11,6	4,4	<1 mth	5
		(4)	8,3	3,9	2 mth	5
9/135	H	(4)	14,76	1,33	1 mth	7
		(3)	9,92	2,19	2 mth	7
		(6)	10,89	4,45	<1 mth	8

APPENDIX III

ANALYSIS OF VARIANCE
VARIATE; FREQUENCY

SOURCE OF VARIATION	DF	SS	SS5	MS	VR	F PR
Age of calf	2	173.951	17.8	86.976	27.607	<.001
Residual	255	803.382	82.2	3.151		
TOTAL	257	977.333	100.0	3.803		
GRAND TOTAL	257	977.333	100.0			

S.E.±1.775 CV% 33.3

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CORRELATION MATRIX

DF = 256				
	DURATION	1	1.0000	
	FREQUENCY	2	-0.2068	1.0000

ANALYSIS OF VARIANCE
VARIATE; DURATION

SOURCE OF VARIATION	DF	SS	MS
REGRESSION	1	429521	429521
RESIDUAL	256	9613125	37551
TOTAL	257	10042646	39076
CHANGE	-1	-429521	429521

PERCENTAGE VARIANCE ACCOUNTED FOR 3.9

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CORRELATION MATRIX

DF = 201				
	INTERVAL	1	1.0000	
	AGE	2	0.2167	1.0000

ANALYSIS OF VARIANCE
VARIATE; INTERVAL

SOURCE OF VARIATION	DF	SS	MS
REGRESSION	1	181872	181872
RESIDUAL	201	3690456	18360
TOTAL	202	3872328	19170
CHANGE	-1	-181872	181872

PERCENTAGE VARIANCE ACCOUNTED FOR 4.2

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ANALYSIS OF VARIANCE
VARIATE; FREQUENCY

SOURCE OF VARIATION	DF	SS	SS%	MS	VR	F PR
Longest Interval	1	45.155	5.70	45.155	12.141	<.001**
Residual	201	747.535	94.30	3.719		
TOTAL	202	792.690	100.00	3.924		
GRAND TOTAL	202	792.690	100.00			

S.E.±1.928 CV% 35.2