

## Reproductive Characteristics of Indigenous Zebu Cattle in Sri Lanka

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**ABSTRACT.** A study was carried out during April 1990 and June 1992 at three locations in the dry zone of Sri Lanka, namely Anamaduwa, Bandagiriya and Kandalama to examine the reproductive pattern, birth weight, growth rate, age at puberty, postpartum and gestation length of indigenous zebu cattle. Fifteen herds at Anamaduwa were selected and farmers were trained to record herd information to study the reproductive pattern. Birth weight measurements from 50 calves were taken by using a weighing balance. Body weight measurements of 10 heifers were taken monthly using a weigh band to determine the prepuberal growth rate. Blood samples were collected at appropriate intervals from 44 heifers and 58 postpartum cows for puberty, postpartum and gestation length studies. Plasma was assayed for progesterone by radioimmunoassay technique. Calvings were seasonal with the majority of calvings (66%) occurring during the months of October to January. The mean calving interval was  $338.0 \pm 36.6$  days. The mean birth weights of calves were  $15.8 \pm 2.5$  kg and  $15.6 \pm 2.6$  kg respectively for Anamaduwa and Bandagiriya. The average prepuberal growth rate of heifers was  $88.3 \pm 26.7$  g/day. The average ages at puberty were  $845.7 \pm 138.8$ ,  $870.9 \pm 92.8$  and  $854.7 \pm 85.4$  days, respectively for Anamaduwa, Bandagiriya and Kandalama. The average length of gestation was  $281.8 \pm 5.2$  days. The age at first calving for Anamaduwa and Kandalama was  $1248.1 \pm 130.2$  and  $1159.9 \pm 63.5$  days. The lengths of calving to first elevation of plasma progesterone concentrations were  $41.7 \pm 39.3$  and  $62.1 \pm 27.1$  days in trial I and II respectively at Anamaduwa and the values for Bandagiriya and Kandalama respectively were  $94.5 \pm 16.6$  and  $64.2 \pm 27.3$  days. A majority of the animals conceived at the first postpartum oestrus. The lengths of calving to first elevation of plasma progesterone, calving to first observed oestrus and calving to conception of cows at Bandagiriya were greater ( $P < 0.05$ )

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than those at Anamaduwa and Kandalama. This may be due to the differences in management practices.

## INTRODUCTION

Sri Lanka has an estimated cattle population of 1.7 million of which more than 90% are of indigenous *Bos indicus* type (Ministry of Rural Industrial Development, 1986/87). Almost all these animals are found in the dry zone, reared by rural subsistence farmers (Dirksen, 1986; Rajaguru, 1986). The animals are reared as large herds, feeding on communal grazing lands during the day time and paddocking in the night near the farmers dwellings (Ozawa *et.al.*, 1978; Abeygunawardena *et.al.*, 1990). The milk production potential is low, ranging from 180 litres to 398 litres for 233 to 243 days of lactation (Mahadevan, 1952; Tilakaratne, 1980; Richards and Agalawatte, 1981). The mature body weight was reported to be about 181.8 to 272.7 kg at 40 to 56 months (Mahadevan, 1952) and provides 53.6% of body weight as edible meat (Tilakaratne, 1974). Even at this level of low production potential, these animals provide 23% of the total milk collected by the organized sector (Soni *et.al.*, 1991) and they are the major source of meat in the country (Rajaguru, 1986).

Apart from the initial reports by Mahadevan, (1953); Buvanendran and Mahadevan, (1975) and Wijeratne, (1970), very few studies have been done to characterise the reproductive performance of this valuable animal. This information is required to assess the appropriateness of ongoing breeding programmes which were launched in the 1950's to upgrade the local zebu cattle to a desired exotic blood level in order to improve the production potential.

The objectives of this study are to determine the reproductive pattern and postpartum reproductive functions and also estimate the birth weight, growth rate, age at puberty and gestation length of indigenous zebu cattle.

The study was conducted in three different locations in the dry zone of Sri Lanka, namely at Anamaduwa (North Western province), Bandagiriya (Southern province) and Kandalama (North Central province).

## MATERIALS AND METHODS

### Reproductive pattern

The study was conducted during August 1990 to May 1992 in the dry zone village of Anamaduwa, with 15 herds having an average herd size of 53 cattle. The farmers were trained to enter herd information on a formatted record sheet.

### Birth weight, growth rate and age at puberty

Birth weight measurements were taken from a total of fifty calves from Anamaduwa ( $n = 33$ ) and Bandagiriya ( $n = 17$ ) between the months of November 1991 and January 1992 using a weighing balance (Budry, Singer Company Limited, Sri Lanka) with a sensitivity of 0.5 kg.

For growth rate and age at puberty studies, a total of 44 heifers were selected from Anamaduwa ( $n = 10$ ), Bandagiriya ( $n = 19$ ) and Kandalama ( $n = 15$ ). This study was conducted from April 1990 to June 1992. The approximate ages at the time of commencement of the study at the three locations were 12 to 16, 20 to 31 and 25 to 30 months, respectively for Anamaduwa, Kandalama and Bandagiriya. Body weight measurements were taken using a weigh band at monthly intervals. The onset of puberty was monitored by taking blood samples for plasma progesterone measurements at ten days apart and at two months intervals at Anamaduwa and at ten days apart, at monthly intervals from Bandagiriya and Kandalama.

### Postpartum ovarian functions

A total of 58 cows at calving were selected at Anamaduwa (Trial I;  $n = 10$  and Trial II;  $n = 12$ ), Bandagiriya ( $n = 32$ ), and Kandalama ( $n = 18$ ) respectively. The studies were conducted during the period April 1990 to December 1991.

Management of cows was similar in all three locations except the suckling practices. At Bandagiriya and Anamaduwa, animals were milked once a day in the morning and fed on communal grazing lands. At Kandalama, calves were allowed to suckle twice a day while at

Anamaduwa, calves were allowed to suckle only once a day after morning milking. At Kandalama, animals were not milked. At Anamaduwa and Kandalama, the calves below 3 months were left behind in a shed near the farmers dwellings while the adults were taken to grazing lands. At Bandagiriya, both adult animals and calves were allowed to go for grazing during day time after morning milking and only adult animals were allowed to go for night grazing while the calves were kept in a paddock and hence ad-libitum suckling was practised. The cows were examined rectally at seven days post-calving and blood samples were collected at weekly intervals until the pregnancy was confirmed by rectal examination.

#### Gestation length

Eighteen animals used for the postpartum study at Anamaduwa (Trial I and II), were monitored following confirmation of pregnancy until calving. Blood samples were taken at monthly intervals until parturition took place.

#### Blood samples collection

Blood samples were taken from the jugular venepuncture using heparinized vacutainers (Becton Dickinson Vacutainer Systems Europe, England) and it was kept in ice soon after collection and centrifuged at 3000 rpm for ten minutes within 30 to 45 minutes after collection. Plasma was separated and stored at  $-4^{\circ}\text{C}$  until transported to the laboratory at Peradeniya where it was stored at  $-20^{\circ}\text{C}$  until assayed for plasma progesterone.

#### Plasma progesterone measurements

Plasma progesterone was quantified by radioimmunoassay technique using antibody coated tubes and progesterone- $^{125}\text{I}$  as the tracer. The assay was performed as described in the IAEA manual and Abayawansa *et.al.*, (1991).

The sensitivity was 0.1 ng/ml and the intra- and inter-assay coefficient of variations were 9.7% and 13.7%, respectively.

### Statistical analysis

The ANOVA technique was performed using the SAS programme to detect the difference of parameters studied at the three locations.

## RESULTS

### Reproductive pattern

The average herd size was  $53.3 \pm 28$  animals per herd. The cattle herds consisted of 75.4% females and 24.6% males. The ratio of female to male was 1:1 until about 24 months of age and it was 3:1 at the age of 25 to 36 months. After 36 months, over 90% of the animals found in the herds were females. Total of 696 calvings were recorded. The calvings were seasonal with the majority of calvings (66.1%) occurring from October to January. The peak was in December (Figure 1) while the calving season commenced with the commencement of the North East monsoon rains. The occurrence of calvings was highly correlated with the rainfall ( $r = 0.85$ ). The total number of calving intervals studied was 254. The average calving interval was  $338.0 \pm 36.6$  days with a range of 298 to 515 days. The majority of calving intervals (81.1%) were less than 365 days (Table 1).

Table 1. Cumulative relative frequency of calving intervals of indigenous zebu cattle.

Range (days)	Cumulative Relative Frequency
< 300	0.39
300 - 325	52.36
326 - 365	81.10
366 - 400	94.49
401 - 450	97.64
> 450	100.00

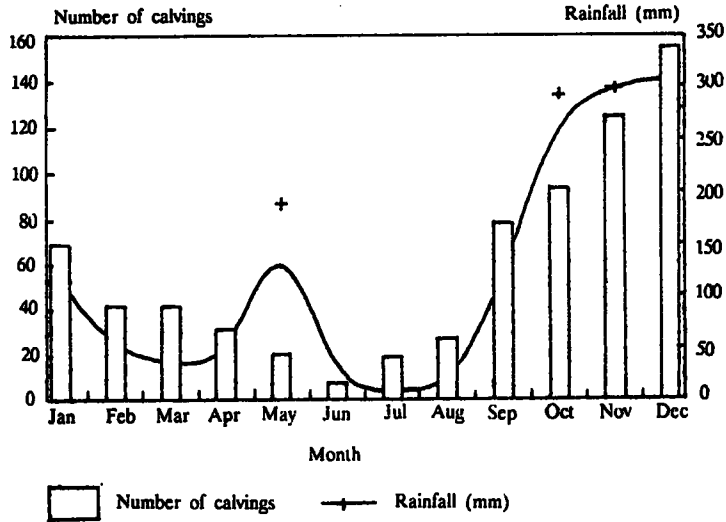


Figure 1. Calving pattern of indigenous zebu cattle in the dry zone.

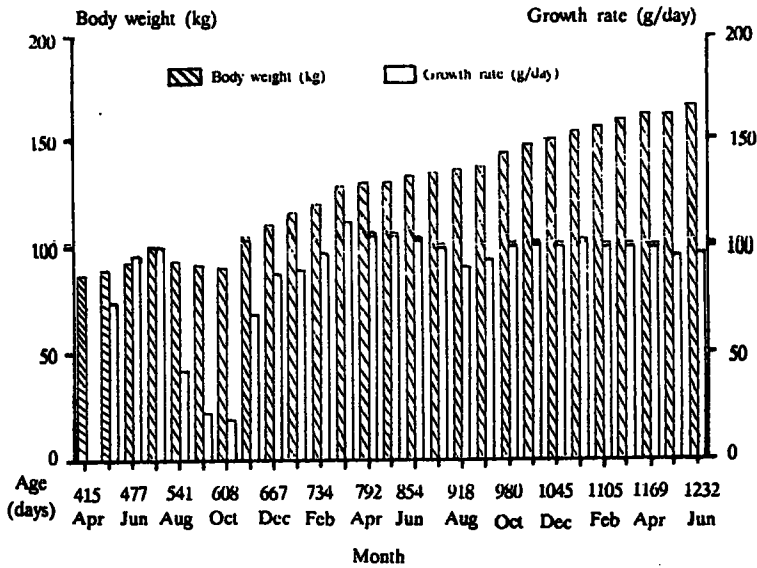


Figure 2. Body weight and growth rate variations during prepubertal period of indigenous zebu heifers in dry zone.

### Birth weight, growth rate, age at puberty and length of gestation

The mean birth weight, growth rate and age at puberty in each trial are given in Table 2. The mean body weight of calves at birth at Anamaduwa was  $15.8 \pm 2.5$  kg with a range of 10.1 to 20.2 kg and at Bandagiriya this was  $15.6 \pm 2.6$  kg with a range of 12.5 to 22.6 kg. There was no difference ( $P > 0.05$ ) between average birth weights of calves at these two locations.

The average prepuberal growth rate of heifers at Anamaduwa from 415 days to 1207 days of age was  $88.3 \pm 26.7$  grams per day with little variation of growth rate during different ages except the lower growth rates recorded during the period from August through October 1990. This slow growth rate coincided with a severe drought experienced during that time. The growth rates were 40.9 gms/day, 27.3 gms/day and 19.2 gms/day, respectively for the months of August, September and October 1990. The average body weight of indigenous animals at the time of first oestrus was  $147.9 \pm 23.5$  kg.

The average ages at puberty as determined by the first elevation of plasma progesterone with or without observed oestrus at the three locations were  $845.7 \pm 138.8$ ,  $870.9 \pm 92.8$  and  $854.7 \pm 85.4$  days respectively, for Anamaduwa, Bandagiriya and Kandalama and there were no differences of these values ( $P > 0.05$ ) at the three locations. The ages at first observed oestrus were  $972.7 \pm 124.2$ ,  $907.4 \pm 113.3$  and  $936.4 \pm 107.8$  days respectively for Anamaduwa, Bandagiriya and Kandalama. Seventy percent of animals at Anamaduwa, 57.9% at Bandagiriya and 60% of animals at Kandalama showed an increase in plasma progesterone prior to the observed oestrus. The age at first calving for Anamaduwa and Bandagiriya were  $1248.1 \pm 130.2$  and  $1159.9 \pm 63.5$  days. At Kandalama the study is still in progress.

A total of 18 gestations were studied. The average length of gestation was  $281.8 \pm 5.2$  days with a range of 276 to 291 days.

### Postpartum ovarian activity

The results are shown in Table 3. The time taken from parturition to first elevation of plasma progesterone at Anamaduwa in Trials I and II were  $41.7 \pm 39.3$  and  $62.6 \pm 27.1$  days respectively. At Bandagiriya

Table 2. Birth weight, growth rate, and age of puberty of indigenous zebu cattle.

Parameter	Location		
	Anamaduwa	Bandagiriya	Kandalama
Birth weight (kg)	15.81 <sub>-02.48</sub>	15.64 <sub>+02.58</sub>	—
Growth rate (g/day)	88.28 <sub>+26.65</sub>	—	—
Age at 1st plasma	—	—	—
P4 elevation (days)	845.07 <sub>+138.80</sub>	870.90 <sub>+92.78</sub>	854.66 <sub>+85.43</sub>
Age at first oestrus (days)	972.71 <sub>+124.20</sub>	907.44 <sub>+113.34</sub>	936.36 <sub>+107.87</sub>
Age at first calving (days)	1248.10 <sub>+130.18</sub>	1159.92 <sub>+63.53</sub>	—
Percentage of animals with progesterone elevation prior to observed oestrus	70.0	57.9	60.0

Table 3. Characteristics of postpartum ovarian function of indigenous zebu cattle.

Parameter	Location			
	Anamaduwa		Bandagiriya	Kandalama
	Trial I n = 10	Trial II n = 12	n = 32	n = 18
First postpartum P4 elevation (days)	41.67 <sub>+39.25</sub>	62.06 <sub>+27.06</sub>	94.45 <sub>+16.56</sub>	64.22 <sub>+27.26</sub>
First observed postpartum oestrus (days)	56.67 <sub>+47.90</sub>	54.50 <sub>+26.69</sub>	86.91 <sub>+15.51</sub>	60.33 <sub>+27.11</sub>
Calving to conception interval (days)	63.00 <sub>+55.08</sub>	54.70 <sub>+26.64</sub>	101.00 <sub>+28.70</sub>	74.88 <sub>+38.48</sub>
Percentage of animals with progesterone elevation prior to observed oestrus	40.00	0	0	11.11
Percentage of animals conceived at the first postpartum oestrus	87.50	100.0	68.75	60.0



and Kandalama, they were  $94.5 \pm 16.6$  and  $64.2 \pm 27.3$  days respectively. The mean length from calving to first observed oestrus at Anamaduwa in Trial I and II were  $56.7 \pm 47.9$  and  $54.5 \pm 26.7$  days respectively, while at Bandagiriya and Kandalama, they were  $86.9 \pm 15.5$  and  $60.3 \pm 27.1$  days. In all three locations a variable percentage of animals showed elevation of plasma progesterone preceding visible oestrus (Table 3). The mean length of calving to conception at Anamaduwa in Trials I and II respectively were  $63.0 \pm 55.1$  and  $54.7 \pm 26.6$  days while at Bandagiriya and Kandalama respectively they were  $101.5 \pm 28.9$  and  $74.9 \pm 38.5$  days. In all three locations a majority of animals conceived at the first oestrus (Table 3). The lengths for calving to first elevation of plasma progesterone, calving to oestrus and calving to conception at Bandagiriya were greater ( $P < 0.05$ ) than those at Anamaduwa and Kandalama.

## DISCUSSION

The herd size of indigenous cattle in the selected cluster ranged from 15 to 109 with an average of 53 animals per herd and it was larger than the values reported for the area by Daniel and Wolf, (1986). The slightly higher average size of our study herds is due to the way these locations were selected and hence may not be an appropriate estimate of herd size for the area.

Calving showed a strong seasonal pattern, with a majority of calvings occurring in the months of October to December. This period is marked by the heavy North-East monsoon rains which usually result in 800 mm to 900 mm of rainfall. A similar seasonal calving pattern was reported for cattle (Ozawa *et.al.*, 1978) and for buffaloes (de Silva *et.al.*, 1985) in Sri Lanka. This seasonal pattern of calving, is presumably due to entrainment of postpartum ovarian activity by the nutrient abundance during the North-East monsoon season (September to January) as suggested by Lundström *et.al.*, (1982).

The calving interval was 338 days with a range of 298 to 515 days. These animals are subjected to suckling by the young and the lactation lasts about 3 to 4 months with 1 to 2 litres of milk per day. Cumulative relative frequency showed that 81.1% of total calving intervals were within the range of 298 to 365 days. This is in agreement with Mahadevan (1952) who reported 355 days of calving interval but is less

than the values reported by Ozawa *et.al.*, (1978) and Daniel and Wolf, (1986). These short calving intervals of indigenous zebu cattle may be due to early onset of postpartum ovarian activity of cows which calve down early in the North-East monsoon season. It appears that the nutrient requirement for their maintenance and low production could be met very early in the postpartum period through the natural grass and fodder which are in abundance following the rains. The other category of animals which had shown a long calving interval ranging from 366 to 515 days may probably be the cows which had calved down during the latter part of the calving season, with their postpartum periods extending into drier spells.

The birth weights of calves ranged from 10.1 to 22.6 kg with an average of 15.7 kg for both locations. There was no significant regional variation. This value was in agreement with those reported earlier by Mahadevan, (1952) who reported that the mean birth weights were 14.4 and 14.9 kg for female and male calves, respectively. The birth weight of the indigenous zebu appears to be lower as compared to birth weights of the exotic zebu in Sri Lanka, which was between 15 kg to 25 kg (Navaratnam, 1979). These smaller birth weights may be due to continuous inbreeding of the animals as closed herds over centuries without selection for production performances where the natural selection was for survivability. Further, it may also be due to poor nutrition of the mother, during gestation, where most gestations have extended over the drier months of the year.

The growth rate which averaged 87.2 grams per day, was extremely low compared to other types of cattle. In one study, exotic zebu in Sri Lanka recorded a growth rate of 303 grams per day while *Bos taurus* recorded a growth rate of 133 grams per day (Tilakaratne, 1974). The growth rate of the animals in this study was further reduced during the months of August through November which was marked by the severe drought. The environmental stresses such as hot temperature and humidity along with the poor quality of herbage during the dry season, which extends over a longer period of the year, may have affected the growth of the animals. Another factor may be the low genetic potential for growth in these animals.

The age at which puberty occurred in the animals of this study ranges from 673 to 1094 days. These values were much higher compared to the values reported for exotic *Bos indicus* and *Bos taurus* (Hawk

*et.al.*, 1954; Reynolds *et.al.*, 1963). As shown in study, the delay in reaching puberty may be due to small body weight at birth and slow growth rate during the prepuberal period.

The first oestrous cycles of many heifers were preceded by a short elevation of progesterone. This may be due to a short cycle which may have occurred prior to normal oestrus or probably due to luteinization of pre-ovulatory follicles prior to the onset of regular oestrous cycles. The majority of animals became pregnant at the first oestrous cycle. The age at first calving of indigenous zebu animals in this study is in close agreement with Mahadevan, (1952) who reported 1272 days of age at first calving for indigenous zebu animals. The gestation length of indigenous zebu cattle is similar to that of their counterparts in the Indian subcontinent (Littlewood, 1937).

The postpartum ovarian activity as measured by plasma progesterone concentration commenced within a range of 42 to 94 days postpartum in a majority of cows. In some animals, the first oestrus was followed by a short term elevation of progesterone which suggests a source of progesterone in the ovary prior to the first oestrus. The cows at Anamaduwa and Kandalama resumed oestrus activity early in the postpartum period compared to those at Bandagiriya. The cows at Bandagiriya were subjected to ad-libitum suckling during the day time unlike those at Anamaduwa and Kandalama. Thus, it is conceivable that suckling stimulus and the cow - calf interaction in indigenous zebu cattle delay the resumption of postpartum ovarian activity and hence could prolong the calving to conception interval. The early return to oestrus by the majority of animals, despite the suckling stimulus, allows the cows to become pregnant within 90 days postpartum. This early return to oestrus and early conception ensure that the animals calve down once a year. Further, many animals conceived at the first oestrus. The present findings are also in agreement with reports from other countries which reported higher fertility rate for tropical zebu cattle (Wilson, 1985; Voh and Otchere, 1989).

Zebu cattle in general have been considered as animals with calving intervals ranging from 12 to 24 months in many tropical countries. This wide variation undoubtedly suggests that the reproductive function of the tropical zebu cattle could be affected to a large extent by management and environmental factors. This indeed has been demonstrated by numerous studies and the major determinants were suckling, management

and season of calving (Ozawa *et.al.*, 1978; Eduvie and Dawuda, 1986; Voh and Otchere, 1989; Perera *et.al.*, 1984; de Silva *et.al.*, 1985). These reports suggested the possibility of genetic composition and also genotype and environment interaction as major determinants of the efficiency of the process of reproduction. The results of this study suggest that indigenous zebu cattle, managed under the traditional rural dry zone system with minimum inputs in terms of feed and labour and health care are able to reproduce with a high degree of efficiency. Our study also suggested that if variations exist in the management systems, particularly in suckling management, this could affect reproductive functions to a great extent during the postpartum period.

### CONCLUSIONS

The study showed that the indigenous zebu cattle managed under traditional dry zone management systems show strong seasonality in reproduction. They have very small body size at birth and grow very slowly during the prepuberal period and, as a result, the age at maturity or puberty appears to be as long as 3 years with first calving occurring at 4 years of age. After the commencement of reproductive activity, they appear to be very fertile with the majority calving every year. Their postpartum reproductive functions appear to be influenced by management factors, particularly by the variations in suckling practices.

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