Unique Reproductive Traits of Brahman and Brahman Based Cows

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GENERAL REPRODUCTIVE TRAITS

The Brahman is a Bos indicus breed which was developed in the Gulf Coast states of the United States by upgrading native United States cattle with various breeds of Bos indicus cattle from India (Phillips, 1963; Yturria, 1973). Breeders did not control proportions of the particular breeds of Indian cattle used in the development of the American Brahman. Even with the diverse genetic composition, or perhaps because of it, the adaptation of this Bos indicus breed to the Gulf Coastal region has led to its widespread incorporation into crossbreeding programs and to the development of other Brahman influenced breeds. The adaptive traits which specifically suit the Brahman and Brahman based cow for production in temperate, subtropical or tropical areas include: tolerance of internal and external parasites; tolerance of high solar energy, high ambient temperature and humidity; and the ability to utilize high fiber forages (Koger, 1963). The positive influence of the Brahman and Brahman based breeds on beef production is well documented (Rhoad, 1955; Cartwright and Fitzhugh, 1972; Koger, 1973). The single trait generally reported as a negative in Brahman or Brahman-based cows is lower reproductive rates compared with European breeds (Kincaid, 1957; Warnick, 1963; Reynolds, 1967; Temple, 1967; Plasse, 1973). Many aspects of the reproductive traits of Brahman and Brahman-based cattle have been studied.

AGE AT PUBERTY

Emphasis by the beef industry upon heifers calving at 2 yr of age has made early maturity an important economic trait. Brahman and Brahman-based heifers reach sexual maturity (puberty) at a greater age than do European heifers (Table 1). Brahman, Brahman-based and all other Bos indicus breeds have been found to be later maturing than the European breeds (Warnick et al., 1956; Luktuke and Subramanian, 1961; Temple et al., 1961; Reynolds et al., 1963; Reynolds, 1967; Plasse et al., 1968a). Both the Brahman and Brahman-based heifers reach puberty at too great an age to routinely calve at 2 yr of age.

GESTATION LENGTH

Cows of different breeds have differences in gestation length. Cows of breeds with longer gestation lengths are at a disadvantage when they are expected to have calving intervals of 365 d or less. Cows of European breeding (Bos taurus) have been reported to have an average gestation length of 282 d (Lush, 1945). Brahman, Brahman-based and other Bos indicus breeds have longer gestation lengths (Table 2). The small African Zebu is the only Bos indicus breed with gestation lengths similar to European breeds. Brahman-based breeds are intermediate in gestation lengths.

POSTCALVING FERTILITY

The primary reason that more Brahman and Brahman-based cows are open at the end of the breeding season than European breeds of cows, is that they do not come into estrus (heat) during the breeding season (Reynolds, 1967). Reynolds (1967) found that the average interval from calving to estrus was the shortest in Angus, intermediate in Brangus and longest in Brahman cows (Table 3).

Fertility of Brahman or Brahman-based cows is similar to European breeds of cows, if they show estrus. The interval from calving to conception in well managed Brahman herds indicates that fertility of Brahman or Brahman-based cows can be very high (Table 4). With an average gestation length of 290 d, a cow must conceive within 75 d after calving to be able to have a calving interval of 365 d or less. All herds of Brahman cows reported by Plasse et al., (1968c) achieved average intervals from calving to conception of less than 75 d.

SEASONALITY

The Brahman and Brahman based cow is a long day breeder. Various researchers have found that Bos indicus cattle have decreased reproductive function as day length decreases (Anderson, 1944; Tomar, 1966; Jochle, 1972; Randel, 1984). Anestrus has been reported in Bos indicus cattle during unfavorable seasons (Dale et al., 1959; Tomar, 1966; Plasse et al., 1968a; Stahringer et al., 1990). The frequency of anovulatory estrus also increased (Luktuke and Subramanian, 1961; Plasse et al., 1970; Stahringer et al., 1990). Plasse et al. (1970) reported a high incidence of quiet ovulation in Brahman heifers, and Jochle (1972) stated that conception rates of Brahman cattle are higher during the summer months. Neuendorff et al. (1984) reported that Brahman cattle have higher ($P < .005$) first service conception rates in the summer (61.4%) compared with the late fall (36.2%).

Bastidas and Randel (1987) found that the number of transferable embryos recovered per donor cow was affected by season ($P < .06$). The greatest recovery of embryos per donor cow was found during the fall season (4.2) and the lowest number (2.9) in the winter season (Figure 1). Massey and Oden (1984) reported that season did not affect recovery of transferable embryos from European breeds and that Brahman based breeds tended to produce the greatest numbers of embryos in the spring season. The study of Bastidas and Randel (1987) also found that pregnancy rates per Brahman donor cow were lower ($P < .02$) in the winter months (Figure 2). Bastidas and Randel (1987) stated that the combination of decreased numbers of transferable embryos and decreased pregnancy rate per donor cow resulted in fewer pregnant recipient cows per Brahman donor cow during the winter months (Figure 3).

These studies show that seasonality is an important reproductive trait of Brahman and Brahman based cows. Breeding seasons other than during the winter months are advantageous in Brahman and Brahman-based cows.

LONGEVITY

Cows with greater longevity allow the breeder to be more selective when choosing replacement females. While this will result in increased generation intervals, the herd will contain a larger proportion of mature cows which usually have higher percentages of calf crop weaned and wean heavier calves. A long term (14 yr) study of the productive longevity of beef cows indicated that Brahman cows lived longer because they tended to be more structurally sound and had fewer mammary problems than other breeds; yet, the Brahman cows had lower reproductive rates (Rohrer et al., 1988). Brahman crossbred cows had the longest productive lives of the cattle studied (Table 5). It is clear that Brahman and Brahman-based cows have unique reproductive traits, which are controlled by endocrine events.

ENDOCRINE CONTROLLED REPRODUCTIVE TRAITS

Estrus. The duration of standing estrus has been shown to be shorter in Bos indicus (Indian) as compared with Bos taurus (European) cattle (Anderson, 1936; DeAlba et al., 1961; Plasse et al., 1970). Estrogen has been shown to induce estrus behavior in cattle (Short et al., 1973) and to be the primary stimulus for induction of the preovulatory luteinizing hormone (LH) surge in cattle (Henricks et al., 1971; Christensen et al., 1974).

Rhodes and Randel (1978) reported that ovariectomized Brahman cows are less responsive to exogenous estrogen than ovariectomized Brahman x Hereford or Hereford cows. Ovariectomized Brahman cows did not accept heterosexual mounting at any dose of estrogen (Table 6). A lower proportion of Brahman x Hereford ovariectomized cows accepted heterosexual mount at the 1 mg dose compared with ovariectomized Hereford cows. When homosexual behavior is used as the measurement for behavioral estrus, a lower response was found in the Brahman cows compared with the Brahman x Hereford or Hereford cows (Table 7). Duration of the estrogen-induced estrus, averaged over all estrogen doses, was shorter in the ovariectomized Brahman and Brahman x Hereford cows compared with the Hereford cows (Table 8). Time from estrogen stimulus to the onset of behavioral estrus may be more indicative of the differential response of Brahman and Brahman-based cows to estrogens. When the time from estrogen stimulus to the onset of behavioral estrus was averaged over all doses, the Brahman cows required the longest time to show estrus. The Brahman x Hereford cows required an intermediate time and the Hereford cows the shortest time (Table 9).

The highest serum estrogen concentrations before estrus occur the longest time before estrus in Brahman, an intermediate time before in Brahman x Hereford and the shortest time before in Hereford cows (Randel, 1980; Table 10). The elapsed times from the endogenous estrogen rise in intact cows to the onset of estrus are remarkably similar to the times from injection of estrogen to estrus in ovariectomized cows of the same breeds (Tables 9 and 10).

There are breed differences in response to estrogen. Brahman and Brahman crossbred cows have a shorter, less intense estrus which occurs later relative to the estrogen stimulus. It is possible that patterns of follicular growth and estrogen secretion or metabolism are somewhat different in Brahman and Brahman-based cows. Patterns of behavioral estrus and the timing of physiological events related to estrus are certainly different in Brahman and Brahman-based cows.

Ovulation. Luteinizing hormone (LH) is the hormone responsible for ovulation in cattle. The preovulatory LH surge occurs 20 to 22 h before ovulation (Schams and Karg, 1969) or 3 to 6 h after the onset of estrus (Henricks et al., 1970) in European cattle. Gonadotropin releasing hormone (GnRH) has been shown to be the hormone which controls pituitary release of LH in cattle (Convey, 1973).

Ovariectomized Brahman and Hereford cows have similar pulsatile patterns of serum LH (Griffin and Randel, 1978). The Brahman cows had lower ($P < .10$) serum LH concentrations compared with the Hereford cows (Table 11). The Brahman cows were slightly lower than the Hereford cows in all measurements of LH response.

Griffin and Randel (1978) also challenged the ovariectomized Brahman and Hereford cows with 500 µg GnRH, and all of the cows responded with increased serum LH concentrations within 15 min (Figure 4). The mean serum LH response was lower ($P < .005$) in the Brahman (34 ± 4 ng/ml) than in the Hereford (67 ± 20 ng/ml) cows. The average peak concentration of LH was lower ($P < .005$) in the Brahman (94 ± 7 ng/ml) compared to the Hereford (185 ± 68 ng/ml) cows. The pituitary gland of the Brahman cow releases a smaller amount of LH when stimulated with GnRH than the pituitary gland of the Hereford cow.

Comparative data on the preovulatory LH surge in Brahman, Brahman x Hereford and Hereford heifers have been reported (Randel, 1976; Randel and Moseley, 1977). Randel (1976) used heifers which were treated with hormones for estrous synchronization. Brahman heifers had a smaller ($P < .05$) preovulatory LH surge than did the other heifers (Figure 5). Randel and Moseley (1977) utilized the same breeds, but the heifers were sampled under normal estrous cycling conditions (Figure 6). When the heifers were studied under normal estrous cycling conditions, the Brahman heifers had the smallest preovulatory LH surge, with the Brahman x Hereford heifers intermediate. The Hereford heifers had the greatest preovulatory LH surge ($P < .005$). The time from the onset of estrus to the peak of the preovulatory LH surge was shorter in the Brahman heifers (Table 12).

Estrogen has been shown to be the primary stimulus for the preovulatory LH surge in intact cows (Henricks et al., 1971; Christensen et al., 1974) and to cause a similar LH surge in ovariectomized cows (Hobson and Hansel, 1972; Short et al., 1973). The effect of exogenous estrogen on ovariectomized cows is relevant to the understanding of breed differences in pituitary function. Rhodes et al. (1978) found that the elapsed time from an estrogen injection to the peak LH concentration was the longest in ovariectomized Brahman cows, intermediate in Brahman x Hereford and shortest in ovariectomized Hereford cows (Table 13; Figure 7).

Not only did the estrogen induced LH surge occur later in the Brahman cows, the peak concentration ($P < .005$) was also smaller in the Brahman (20.2 ng/ml), intermediate in the Brahman x Hereford (36.0 ng/ml) and highest in Hereford ovariectomized cows (113.2 ng/ml). Brahman ovariectomized cows had the smallest area under the LH curve, Brahman x Hereford were intermediate, and Hereford cows had the greatest amount of LH released (Figure 7; Table 14; $P < .05$).

Brahman and Brahman based cows have lower mean LH concentrations, a smaller preovulatory LH surge and a smaller GnRH or estrogen releasable pool of pituitary are slower to respond to an estrogen stimulus with a release of hypothalamic GnRH compared with European cattle.

Randel (1976) reported the timing of physiological events leading to ovulation in Brahman, Brahman x Hereford and Hereford heifers. Brahman heifers ovulated in a shorter time ($P < .05$) after the onset of estrus, than did the other heifers (Table 15). The interval from the preovulatory LH surge to ovulation did not differ between the breeds. The major differences occurred in the timing of the preovulatory LH surge and ovulation relative to the onset of estrus. Ovulation times, relative to the onset of estrus, have been reported for grade Brahman heifers in Florida (25.6 h; Plasse et al., 1970), for Brahman heifers in Venezuela (20.6 h; Troconiz, 1976) and for Bos taurus heifers in Montana (33.2 h; Randel et al., 1973). Data from our laboratory depicting the physiological events culminating in ovulation, show that a total of approximately 40 h will elapse from estrogen stimulus to ovulation in Brahman and in Hereford cows (Figure 8). The primary difference between the breeds is that it takes longer for the Brahman cow to show behavioral estrus. Then, she ovulates earlier after showing estrus compared to the Hereford cow.

Corpus luteum. Detection of corpora lutea by palpation per rectum is more difficult in Brahman compared with European cows (Plasse et al., 1968a). Corpora lutea (CL) from Brahman heifers have been shown to be smaller than CL from Brahman x Hereford or Hereford heifers (Irvin et al., 1978), and CL from Brahman cows are smaller ($P < .01$) than those from Angus cows (Segerson et al., 1984; Table 16). Progesterone content of CL from Brahman heifers, Brahman x

Hereford heifers and Brahman cows is lower than in CL from Hereford heifers or Angus cows (Table 17).

In the experiment comparing Brahman and Angus cows on d 17 after estrus, Brahman cows had greater ovarian and stromal weights than Angus cows (Segerson et al., 1984; Table 18). The Brahman cows also had greater numbers of small (< 5 mm) follicles and more follicular fluid but smaller numbers of large follicles (> 5 mm) compared to Angus cows (Table 19).

As CL from Brahman cows and heifers are smaller and contain less progesterone than CL from European cows and heifers, it is not surprising that Brahman and Brahman x Hereford heifers have lower (P < .01) serum progesterone concentrations compared to Hereford heifers from 2 through 11 d after estrus (Randel, 1977; Figure 9). Similar results from Brahman and Angus cows from d 7 through 17 after estrus show that Brahman cows have lower (P < .05) serum progesterone and estradiol concentrations compared with Angus cows (Segerson et al., 1984; Figure 10 and 11). It is interesting to note that in this experiment, Brahman cows also had lower (P < .05) total uterine luminal protein (Figure 12).

In another experiment which examined the effect of breed and season, Brahman heifers had smaller (P < .001) CL than did European heifers (Rhodes et al., 1982; Table 20). Note that both concentration and content of progesterone in CL were higher in CL which were developed in the winter compared to those from the summer. When luteal cells were incubated with LH in vitro, Brahman luteal cells produced less progesterone and were less responsive to LH than European luteal cells, and luteal cells collected in the winter were less responsive than cells collected in the summer (Figure 13).

A possible explanation of these seasonal effects has been offered by Harrison et al. (1982). Brahman cows were shown to have the lowest preovulatory LH surge in the winter compared with spring or summer periods (Figure 14). It is possible that a shift in the timing of the LH surge occurred, with the cows in the winter having the LH surge before estrus. If this was the case, the surge would not have been detected as no samples were collected prior to estrus.

It seems clear from these reports that CL function is lower in Brahman cows than in European cows and that season moderates both pituitary and luteal function in Brahman and Brahman-based cows.

LATE PREGNANCY AND PARTURITION

Brahman cows, Brahman first-calf heifers and Brahman x Hereford cows were sampled to develop serum profiles of progesterone and estrogen and plasma profiles of relaxin from 12 d before calving through calving (Randel et al., 1988). Brahman cows and heifers had higher (P < .05) concentrations of relaxin (Table 21). The first-calf Brahman heifers had higher (P < .05) plasma concentrations of relaxin from 6 d before calving through calving compared with the mature cows. Serum estradiol concentrations were similar between breeds and ages (Table 22). The Brahman x Hereford cows had higher (P < .05) serum progesterone concentrations with the Brahman first-calf heifers intermediate and Brahman cows the lowest from d 12 through 9 before calving. Serum progesterone concentrations were similar between breeds and ages on d 6 before calving (Table 23). The Brahman x Hereford cows had greater concentrations of progesterone prior to parturition, but relaxin concentrations were higher in the Brahman heifers. These endocrine differences may contribute to the ease of calving found in Brahman and Brahman based cows and heifers.

POSTPARTUM

Brahman cows have been compared with Angus cows on d 17 and 34 after calving to assess LH profiles and response to a low dose (10 ng/kg) of GnRH (Stahringer et al., 1989; Figure 15). Brahman cows had higher ($P < .03$) basal LH, a greater ($P < .03$) GnRH-induced pulse amplitude and a higher ($P < .03$) GnRH-induced pulse height compared with Angus cows (Figure 16). Brahman cows responded to the 10 ng/kg dose of GnRH with a greater area under the GnRH-induced LH curve (Figure 17). These data would appear to indicate that Brahman cows are very responsive to either endogenous or exogenous GnRH during the postpartum period. Pituitary function in Brahman cows during the postpartum period is equal to or greater than pituitary function in European cows.

SUMMARY

Brahman and Brahman based cows have unique reproductive traits when compared with European cows. Age at puberty is greater and results in an older age at first calving. Gestation length is the longest in the Brahman compared with all European breeds. Fertility of Brahman and Brahman-based cows after calving is normal but only if they have returned to estrus during the breeding season. Because of the longer gestation period, the Brahman and Brahman based cows must return to fertility rapidly to achieve a 365 d calving interval. Brahman and Brahman-based cows are long day breeders and exhibit greater seasonal fluctuations than European breeds. Brahman and Brahman-based cows have greater longevity due to structural soundness. Brahman x European first cross cows have the greatest longevity.

Brahman and Brahman-based cows do not show as much estrus behavior or as long a period of standing estrus as European cows. The estrogen surge which causes the cow to come into estrus occurs earlier before estrus and produces a smaller preovulatory LH surge in Brahman and Brahman-based cows. Brahman cows ovulate earlier after the onset of estrus than other breeds. Brahman cows have smaller corpora lutea, and Brahman and Brahman-based cows have lower amounts of progesterone in the circulation. In most cases, the Brahman and Brahman-based cows have lower circulating concentrations of reproductive hormones compared with European cows.

Reproductive endocrinology of Brahman and Brahman-based cows differs from European cows in many subtle ways. These differences in hypothalamic, pituitary and ovarian relationships are important when systems are being devised to control, alter or enhance reproductive efficiency in Brahman influenced females. Systems which have been designed for European cattle may require some modification prior to their most effective use in Brahman or Brahman-based cows.

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Table 1. Age at Puberty		
Breed	**No.**	**Age at puberty (d)**
British Breeds	57	436
Brahman	22	690
Brahman x European	68	438
Brahman based (Brangus)	114	528

Source: Reynolds, 1967.

Table 2. Gestation Length		
Breed	**Gestation length (d)**	**Source**
Brahman	292.8	Plasse et al., 1968b
Brahman-based (Brangus)	286.0	Reynolds, 1967
Nelore	291.4	Veiga et al., 1946
Nelore and Guzerat	292.9	Haines, 1961
Nelore, Gir and Guzerat	292.0	Briquet and DeAbreu, 1949
Africander	295.0	Joubert and Bonsma, 1959
Africander	295.0	Van Graan and Joubert, 1961
African Zebu	282.7	Hutchinson and Macfarlane, 1958
Ethiopian Zebu	283.0	Mukasa-Mugerwa and Tegegne, 1989

Table 3. Interval From Calving to Estrus

Breed	Interval (d)	Source
Hereford	59	Warnick, 1955
Angus	63	Warnick, 1955; Reynolds, 1967
Brangus	74	Reynolds, 1967
Brahman	79	Reynolds, 1967

Table 4. Interval From Calving to Conception in Brahman Cows

Ranch	No. of cows	Interval (d)
A	114	61
B	285	71
C	132	72
D	380	59
All	911	65

Source: Plasse et al., 1968c

Table 5. Longevity and Reasons For Removal

Breed	Mean life (yr)	Reason for culling (%)	
		Unsoundness	Reproduction
Angus	10.3	27.6	17.2
Hereford	9.8	36.4	20.0
Brahman	9.7	13.3	33.3
Angus x Brahman	14.6	28.1	9.4
Brahman x Hereford	13.2	17.9	20.5

Source: Rohrer et al., 1988.

Table 6. Proportions of Ovariectomized Cows Accepting Heterosexual Mount After Injection of Estradiol-17β

Breed	Estradiol-17β			
	1 mg	2 mg	4 mg	8 mg
Brahman	0/6**	0.6**	0/6**	0/6**
Brahman x Hereford	2/6†	6/6	6/6	6/6
Hereford	5/6	6/6	5/6	6/6

† $P < .10$.

** $P < .005$.

Source: Rhodes and Randel, 1978.

Table 7. Proportions of Ovariectomized Cows Accepting Homosexual Mount After Injection of Estradiol-17β				
	Estradiol-17β			
Breed	**1 mg**	**2 mg**	**4 mg**	**8 mg**
Brahman	4/6†	5/6†	4/6†	5/6†
Brahman x Hereford	5/6	6/6	6/6	6/6
Hereford	5/6	6/6	6/6	6/6

† $P < 0.5$.
Source: Rhodes and Randel, 1978.

Table 8. Duration of Estrus in Ovariectomized Cows Treated With Estrogen (1-8 mg)	
Breed	**Duration (h)**
Brahman	8.2
Brahman x Hereford	8.4
Hereford	12.3

Source: Rhodes and Randel, 1978.

Table 9. Elapsed Time From Estrogen Treatment (1 to 8 mg) To Estrus In Ovariectomized Cows	
Breed	**Elapsed time (h)**
Brahman	20.6
Brahman x Hereford	12.9
Hereford	9.9

Source: Rhodes and Randel, 1978.

Table 10. Time of the Highest Serum Estrogen Prior to the Onset of Estrus	
Breed	**Time (h)**
Brahman	24[a]
Brahman x Hereford	16[b]
Hereford	8[c]

[a,b,c] Different superscripts differ $P < .05$.
Source: Randel, 1980.

Table 11. Comparison of Serum LH Values for Ovariectomized Brahman and Hereford Cows		
Measurement	**Brahman**	**Hereford**
Mean serum LH (ng/ml)	5.60	8.60
Number of LH peaks/4 h	3.00	3.33
Mean magnitude of LH peaks (ng/ml)	7.85	10.45
Serum LH pulse height (ng/ml)	4.28	6.50

Source: Griffin and Randel, 1978.

Table 12. Relationships Between Breeds and Timing of the Preovulatory LH Surge		
	Time from Estrus to the LH Peak (mean h ± SE)	
Breed	**Randel (1976)**	**Randel and Moseley (1977)**
Brahman	0.4 ± 3.4	2.0 ± 1.3
Brahman x Hereford	6.8 ± 2.1	3.0 ± 1.0
Hereford	5.3 ± 1.3	6.5 ± 1.8

Table 13. Elapsed Time to Peak LH Following Estradiol-17β Administration in Ovariectomized Brahman, Brahman x Hereford and Hereford Cows	
Breed	**Elapsed time to peak LH (mean h ± SE)**
Brahman	27.8 ± 2.0[a]
Brahman x Hereford	23.8 ± 0.9[b]
Hereford	22.1 ± 1.0[c]

[a,b,c] Mean times followed by a different letter differ significantly (P < .05.).
Source: Rhodes et al., 1978.

Table 14. Area Under the Estrogen Induced LH Surge in Brahman, Brahman x Hereford and Hereford Ovariectomized Brahman	
Breed	**Area (mean ± SE)**
Brahman	6.0 ± 2.8[a]
Brahman x Hereford	11.1 ± 2.1[b]
Hereford	25.1 ± 7.4[c]

[a,b,c] Mean areas followed by a different letter differ significantly (P < .05).
Source: Rhodes et al., 1978.

Table 15. Timing of Physiological Events (mean h ± SE)			
Breed	**Estrus to LH surge**	**LH surge to ovulation**	**Estrus to ovulation**
Brahman	0.4 ± 3.4	18.5 ± 3.1	18.9 ± 2.2[a]
Brahman x Hereford	6.8 ± 2.1	22.2 ± 2.6	29.0 ± 1.3[b]
Hereford	5.3 ± 1.3	23.3 ± 2.1	28.6 ± 1.5[b]

[a,b,c] Mean times followed by a different letter differ significantly (P < .05).
Source: Randel, 1976.

Table 16. Corpus Luteum Weight (g)			
	Day of cycle		
Group	**8**	**13**	**17**
Brahman Heifers	2.5 ± .1[a]	2.7 ± .1[a]	--
Brahman x Hereford heifers	4.6 ± .4[b]	3.8 ± .3[b]	--
Hereford heifers	4.0 ± .4[b]	3.6 ± .3[b]	--
Brahman cows	--	--	2.4 ± .1[c]
Angus cows	--	--	4.1 ± .3[d]

[a,b] Values with different superscripts differ (P < .05).
[c,d] Values with different superscripts differ (P < 0.01).
Sources: Irvin et al., 1978 and Segerson et al., 1984.

Table 17. Progesterone Content of CL	
Group	**µg/CL**
Brahman heifers	216.9 ± 45.0
Brahman x Hereford heifers	217.7 ± 35.3
Hereford heifers	334.6 ± 87.8
Brahman cows	190.8 ± 28.9
Angus cows	266.3 ± 23.9

Sources: Irvin et al., 1978 and Segerson et al., 1984.

Table 18. Ovarian, Stromal and Corpora Luteal (CL) Weights for Active and Inactive Ovaries Measured on Day 17 in Angus and Brahman Cows[a,b]

		Ovarian wt. (g)		Stromal wt. (g)	
Breed	**No.**	**Active**	**Inactive**	**Active**	**Inactive**
Angus	20	9.2 ± .4	4.6 ± .3***	3.9 ± .3**	3.6 ± .3**
Brahman	19	11.0 ± 1.1	7.9 ± .9	6.8 ± .9	6.2 ± .7

[a] Active ovary designates the ovary containing the CL, while the inactive ovary is devoid of the CL.
[b] Values below represent mean ± SE.
** Different (P < .01) between breeds.
*** Different (P < .001) between breeds.
Source: Segerson et al., 1984.

Table 19. Ovarian Follicular Characteristics for Active and Inactive Ovaries Measured on Day 17 in Angus and Brahman Cows[a,b]								
Breed	**No. of follicles of specific diameters**				**Diameter (mm) of follicles > 5 mm**		**Follicular fluid wt. (g)**	
	< 5 mm		**> 5 mm**					
	Active	**Inactive**	**Active**	**In-active**	**Active**	**Inactive**	**Active**	**In-active**
Angus	22.3±3.4**	20.2±.3*	2.3±.5*	1.8±.5	7.8±.4	7.3±.6	1.3±.1	1±.1**
Brahman	40.8±5.6	37.1±5.3	1.2±.3	0.9±.2	7.7±.6	6.7±.4	1.8±.4	1.6±.2

[a] Active ovary designates the ovary containing the CL, while the inactive ovary is devoid of the CL.
[b] Values below represent mean ± SE.
* Different (P < .05) between breeds.
** Different (P < .01) between breeds.
Source: Segerson et al., 1984.

Table 20. Effect of Breed and Season on CL Weight, Progesterone Concentration and Progesterone Content				
Measurement	**Brahman**		**Hereford x Holstein**	
	Summer	**Winter**	**Summer**	**Winter**
Weight (g)	2.74 ± .10[a]	3.01 ± .29[a]	4.58 ± .44[b]	5.11 ± .49[b]
Progesterone Concentration (µg/g)	30.8 ± 2.8[d]	52.6 ± 7.8[e]	39.0 ± 7.1[f]	40.4 ± 1.9[f]
Progesterone Content (µg/CL)	104.0 ± 5.3[g]	153.2 ± 35.9[h]	174.1 ± 35.9[i]	201.9 ± 9.5[i]

[a,b] Means ± SE with different superscripts differ ($P < .001$).
[d,e,f] Means ± SE with different superscripts differ ($P < .10$).
[g,h,i,j] Means ± SE with different superscripts differ ($P < .01$).
Source: Rhodes et al., 1982.

Table 21. Peripheral Plasma Relaxin Immunoreactivity (pg/ml)			
	Brahman		Brahman x Hereford cows
Days from calving	First-calf heifers	Cows	
-20	500-650	500-600	500-650
-12	1816 ± 948	1596 ± 414	850 ± 150
-6	2758 ± 826	1018 ± 367	786 ± 316
-4.5	2962 ± 457	1555 ± 543	1143 ± 282
-1	2815 ± 464	984 ± 1227	1665 ± 479
0	2556 ± 653	1227 ± 229	1019 ± 192

Source: Randel et al., 1988.

Table 22. Peripheral Plasma Estradiol-17β (pg/ml)			
	Type of dam		
	Brahman		Brahman x Hereford
Days from calving	First-calf heifers	Cows	Cows
-12	240 ± 55	168 ± 28	290 ± 42
-9	284 ± 32	182 ± 24	290 ± 20
-6	361 ± 45	294 ± 39	348 ± 38
-4.5	375 ± 43	326 ± 32	317 ± 13
-1	405 ± 51	441 ± 54	339 ± 46
0	489 ± 103	436 ± 67	354 ± 40

Source: Randel et al., 1988.

Table 23. Peripheral Plasma Progesterone (ng/ml).			
	Type of dam		
	Brahman		Brahman x Hereford
Days from calving	**First-calf heifers**	**Cows**	**Cows**
-12	2.62 ± 0.39[a]	1.83 ± 0.40[b]	4.07 ± 0.45[c]
-9	2.03 ± 0.35[a]	1.65 ± 0.23[b]	2.43 ± 0.29[c]
-6	1.76 ± 0.51[a]	1.80 ± 0.44[a]	1.98 ± 0.42[a]
-4.5	1.42 ± 0.44[a]	0.97 ± 0.29[a]	2.90 ± 0.62[b]
-1	0.08 ± 0.06[a]	0.46 ± 0.26[b]	0.78 ± 0.34[b]
0	0.15 ± 0.13[a]	0.07 ± 0.04[a]	0.04 ± 0.03[a]

[a,b,c] Means within rows with different superscripts differ ($P < 0.05$).
Source: Randel et. al., 1988.