Florida Crossbreeding Research

D. G. Riley, G. R. Hansen, J. R. Crockett, T. A. Olson, C. C. Chase, Jr., and D. E. Franke

USDA-ARS, Grazinglands Research Laboratory, El Reno, OK and University of Arkansas, Fayetteville, AR

ABSTRACT: This review highlights the accomplishments of three University of Florida beef cattle research locations from the 1940s through the late 1980s. During that time, the Everglades Research and Education Center at Belle Glade, the Range Cattle Research and Education Center at Ona, and the Beef Research Unit at Gainesville conducted long-term crossbreeding research. These locations produced estimates of breed effects and heterosis for a variety of traits in Brahman and a number of other breeds. Most importantly, these facilities investigated the crossbred superiority (heterosis retained or expressed) in several crossbreeding systems, including terminal crosses, two- and three-breed rotations, and inbred matings (including F1 and ⅓ - ⅓ parents). In most of these studies, formal tests were not conducted, but results generally supported the dominant model of heterosis expression for most reproductive and calf growth traits. However, there was large loss of heterosis for weaning rate (almost 40% of that expressed by F1 cows with backcross calves) for ⅔ Brahman ⅓ Devon cows mated inter se at Belle Glade. There was almost a total loss of the heterosis expressed for 18-mo weight in ⅔ Brahman ⅓ Devon heifers at Belle Glade and for cow weight in F2, backcross, and three-breed cross (Brahman, Charolais, and Angus) cows at Ona. Early work in Florida also emphasized the complex interaction of reproductive performance with lactation status, age of cow, and nutritional plane in Brahman and Brahman-cross cows. There appears to be a negative autocorrelation between successive reproductive events that correspond with the age of the cow; it seems that reproductive performance in a given year could be effectively predicted with knowledge of the cow’s lactation status in the previous breeding season. This is especially important considering the high cost of heifer development, the late onset of puberty in Brahman heifers, and the longer gestation length of Brahman calves. This research has provided a framework for future investigations of Brahman crossbred superiority, especially for reproductive traits.

Key Words: Beef Cattle, Brahman, Crossbreeding, Florida, Reproductive Performance

Introduction

One of the most notable dilemmas in beef production in the southern United States is the conflict between cow adaptability and performance in other areas. The biological types of cattle that are adapted to the local forages, high temperatures, high pest loads, and humidity have some undesirable characteristics. Some of those include substandard disposition, inadequate beef quality, and especially, poor reproductive performance as purebreds. The beginnings of beef cattle research in Florida were based on crossbreeding. Much of the early work was directed at cow reproductive performance and calf survival.

One of the major contributions of Florida beef research is the knowledge of heterosis expressed in different crossbreeding systems. Much of the beef cattle breeding work in the 1950s through the mid-1980s was related to expression of heterosis, especially in reproductive traits, and its proportionality to breed heterozygosity (the "dominance model") as described in the classic papers by Dickerson (1969, 1973). As such, the work served in part as a practical assessment of crossbreeding theory, as well as to provide practical assessment of crossbreeding systems for cow-calf producers in the region. The objective of this paper is to summarize the beef research accomplishments of Florida researchers at state facilities at Belle Glade, Gainesville, and Ona. Most of the estimates of heterosis and breed effects from this work have been reported in other reviews (Long, 1980; Wyatt and Franke, 1986). The reviewed work occurred from the
early 1940s through the mid-1980s. It is appropriate to mention the team approach that was apparently encouraged by university leadership and the attitude of group discovery exhibited by investigators at all three locations that lasted for the duration of their scientific careers.

Research Locations

Belle Glade

The Agricultural Research and Education Center at Belle Glade was earlier known as the Everglades Experiment Station. Located in south Florida at 26°42' latitude and an elevation of 12.5 ft, it is an area with high annual rainfall (> 55 in) and subtropical temperatures (averages range from 61 to 83°F). The predominant forage that cattle grazed during these projects was Roselawn St. Augustinegrass (*Stenotaphrum secundatum* [Walt.] Kunzt).

A project initiated in the 1940s (Kidder et al., 1964; Crockett, 1973a) was begun to produce and evaluate ¾ Brahman × ¾ Devon cattle, but the final design compared straightbreds, backcrosses (¼ Devon × ¾ Brahman), a two-breed rotation of the two breeds (“crisscrossing”), and *inter se* matings of half bloods and also matings of F₁ bulls to ¾ Devon cows were included in this group. Almost a decade (1951 to 1959) of reproductive data (n = 1,188) and calf weaning weight (n = 933) and weights of replacement heifers (n = 415) was collected and analyzed.

From 1962 to 1971 at Belle Glade, three generations of three two-breed rotations (Brahman-Angus, Brahman-Hereford, and Hereford-Angus) and contemporary straightbreds of the three breeds were studied (Crockett, 1973b; Crockett et al., 1973, 1978a, b). The focus of this work was reproductive traits (n = 3,327), including pregnancy rate, calf survival, and weaning rate.

From 1978 to 1983, reproductive and maternal performance (n = 751 for reproductive traits and n = 611 for traits of their calves) of Brangus cows mated to Brangus bulls was compared to that of F₁ and F₂ Brahman-Angus cows bred to F₁ Brahman-Angus bulls (Hargrove et al., 1991a, b).

Ona

The Range Cattle Research and Education Center at Ona (formerly Agricultural Research Center) is located in south-central Florida (27°25’ N latitude, 81°55’W longitude) at an elevation of 85 ft. Average rainfall and temperatures are only slightly lower than those at Belle Glade. The predominant forages used were bahiagrass (*Paspalum notatum*), pangolagrass (*Digitaria decumbens* Schult.), coastal bermudagrass (*Cynodon dactylon*), and to a lesser extent native species *Aristida and Andropogon*, Dutch white clover (*Trifolium repens* L.), and hairy indigo (*Indigofera hirsuta*).

Breeding research began at Ona in 1942 with the purchase of Brahman cows and a Shorthorn bull. In 1952 a crossbreeding study with these two breeds was begun (Peacock et al., 1973b). Five breed groups of cows were produced and evaluated; these included straightbred Shorthorn and Brahman, F₁ cows, and backcross cows (¼ Brahman × ¼ Shorthorn and ¼ Shorthorn × ¼ Brahman). All five groups were bred to Brahman and Shorthorn bulls. All breed groups were evaluated on low, medium, and high levels of nutrition. The objectives of this study were to estimate breed effects and heterosis on a variety of traits. The study continued for 10 years and was one of the most comprehensive crossbreeding studies of the era (Koger et al., 1975; Peacock et al., 1971, 1973a).

Evaluation of the Charolais breed began at Ona in 1959 using grade Charolais cows (Peacock et al., 1973b). From 1962 to 1974, a breeding project with Charolais, Brahman, and Angus was conducted using a diallel mating design as a base. Six breed groups of cows (three straightbred groups and three F₁ groups [reciprocals combined]) were mated to purebreds of all three breeds. Heterosis and breed effects were estimated for reproductive traits (n = 1,305), calf preweaning traits (n = 1,029) and steer growth and carcass traits (n = 351) using data from the project (Peacock and Koger, 1980; Peacock et al., 1978, 1979, 1981). Calf traits (weaning age, body condition score, and weight) of calves produced by F₁ bulls of all combinations mated to purebreds and F₁ cows were compared to that of purebreds (Peacock et al., 1986). Cow reproductive and size traits of the second and third generations of two- and three-breed crosses (produced by rotational and *inter se* matings) of these breeds were subsequently compared for calf traits and cow reproduction and size (Olson et al., 1993).

Gainesville

The Beef Research Unit is located near Gainesville in north-central Florida (latitude 29°40’ N) where cattle grazed bahiagrass (*Paspalum notatum*) and Dutch white clover (*Trifolium repens* L.). Average rainfall is slightly lower than both Ona and Belle Glade; average temperatures are substantially lower with frequent frosts in winter.

From 1959 to 1970 the research herd at the Beef Research Unit (crossbred Brahman and criollo base) was bred to form five breed types: grade Hereford,
grade Angus, and three two-breed rotations, including Hereford-Angus, Brahman-Angus, and Hereford-Santa Gertrudis (Koger, 1973a, b). Cow and calf performance of these five breed groups were evaluated (Restle et al., 1986).

From 1978 to 1980, a crossbreeding study was conducted with the Brown Swiss and Angus breeds in which straightbreds and F1 cows were mated to Angus and F1 bulls (Olson et al., 1985). Calf and cow performance were analyzed (n = 510) with estimation of breed effects and heterosis as objectives. Marshall et al. (1987) produced estimates of breed effects and heterosis for feedlot and carcass traits of steers produced in the study.

**Heterosis Retained in Different Crossbreds**

The F1 Bos indicus cow is the most productive breedtype in Florida and other sub- or semi-tropical areas but is expensive to purchase or produce. A common investigatory theme across four decades of Florida beef cattle research was the assessment of heterosis expressed for reproductive traits by other (non F1) crossbred Brahman cows. Heterosis expression is generally expected to be proportional to heterozygosity (dominance effects), and substantial loss (half) of heterosis would be expected to occur from the F1 to the F2 generations. If dominance effects do not adequately account for heterosis expressed (Dickerson, 1969, 1973), then losses may be even greater for crossbreds other than F1s.

**Reproduction and Survival**

Reproductive traits that were evaluated in the reviewed studies included various measures of cow efficiency. These included separate analyses of pregnancy rate, calving rate, and weaning rate, evaluated where cows that were exposed to bulls were assigned a value of 1 if they were pregnant, calved, or weaned a calf; 0 if they failed in a given category. Calf survival rate was analyzed similarly, where calves that failed to survive to weaning were assigned 0; Crockett et al. (1978b) defined this trait as survival from pregnancy to weaning. In such analyses, least squares means represent proportions that “succeeded”; usually these were expressed as percentages. Annual production per cow was calculated as the product of pregnancy rate, calf survival rate, and calf weaning weight. Relative cow efficiency was evaluated as annual production per cow divided by cow weight.

Early work with the Brahman and Devon breeds demonstrated significant crossbred superiority for reproduction in all crossbred cow groups (Kidder et al., 1964; Crockett, 1973a), but the highest values for F1 cows (Table 1). If it is assumed that the crossbred advantages of 5.4% for F1 Brahman-Devon represents the direct (expressed by the calf) heterosis estimate for weaning rate, then it can be assumed that most of the crossbred advantage for the other mating systems in Table 1 is due to maternal heterosis. Using this reasoning, the ½ Brahman ½ Devon cows (a few were

<table>
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<tr>
<th>Breed</th>
<th>Weaning data</th>
<th>Postweaning data</th>
<th>Level of heterosis</th>
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<td></td>
<td>Weaning rate (%)</td>
<td>No. calves</td>
<td>206-Day wt. (lbs.)</td>
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<tr>
<td>A × A</td>
<td>78.4</td>
<td>143</td>
<td>323</td>
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<td>B × B</td>
<td>50.0</td>
<td>67</td>
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<td>D × D</td>
<td>57.9</td>
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<td>Purebred dams, F1 progeny</td>
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<td>A or D × B or A × A</td>
<td>70.7</td>
<td>34</td>
<td>360</td>
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<td>B or D × D or B × BD</td>
<td>56.9</td>
<td>82</td>
<td>398</td>
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<tr>
<td>F1 dams, backcross progeny</td>
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<tr>
<td>A or D × A B, A + B, + B</td>
<td>72.9</td>
<td>51</td>
<td>422</td>
</tr>
<tr>
<td>B or D × BD B, D + B, D</td>
<td>63.9</td>
<td>106</td>
<td>400</td>
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<td>3/4 Blood dams, backcrossed</td>
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<td></td>
<td></td>
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<tr>
<td>B, B × D, B × D + B × D</td>
<td>61.0</td>
<td>102</td>
<td>393</td>
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Table 1. Performance of Brahman-Devon and Brahman-Angus crosses, 1950-59 (reproduced from Crockett, 1973a).

- A, B, and D represent Angus, Brahman, and Devon, respectively.
- Reproductive performance was affected adversely by brucellosis and may have biased breed differences.
- Heterosis expressed as the advantage of crossbreds over mean of purebreds.
3/4 Devon 1/4 Brahman, see Table 1) and 3/4 (Brahman or Devon) - 1/4 cows expressed approximately the same heterosis for weaning rate, which is consistent with expectation from the dominance model. However, if the huge advantage (> 50%) of the F1 Brahman-Devon cows is considered, both groups (3/4 Brahman 1/4 Devon and 3/4 Brahman or Devon - 1/4 Brahman or Devon) appeared to deviate substantially below dominance expectation.

Crockett et al. (1978b) reported heterosis estimates for three generations in three separate two-breed rotations. Estimates for heterosis for pregnancy rate in Angus-Brahman first, second, and third generation cows (F1, 3/4 - 1/4, and 3/4 - 1/4 cows) were 10.3, 7.0, and 2.7%, respectively for pregnancy rate; 20.4, 12.4, and 8.9% for weaning rate (only those estimates for F1 and 3/4 - 1/4 cows were significant for pregnancy and weaning rate); and 9.1, 5.1, and 6.7% for calf survival rate (only F1 heterosis was significant). The first generation (F1) of the Brahman-Hereford rotation had significant heterosis for weaning rate (12.7%) and the third generation (3/4 - 1/4) expressed significant heterosis for pregnancy rate (11.1%). No generation of the Hereford-Angus rotation expressed significant heterosis for any reproductive trait. Overall heterosis expression for all three generations for pregnancy rate (6.0, 3.7, and 5.9%, for generations one through three, respectively; only the estimate for the first generation was significant) and weaning rate (14.0, 6.1, and 4.6%) did not appear to differ from dominance model expectation. The authors realized one difficulty of analyses of oddly heritable, binomially-distributed traits, that "...as a trait approaches an incidence of 100%, there is little opportunity for the expression of hybrid vigor in crossbreds..."

Brahman, Angus, and Charolais cows were compared with all combinations of backcross (3/4 - 1/4) cows, F1 and F2 cows, and all combinations of 1/2 - 1/2 - 1/2 cows (Olson et al., 1993). Pregnancy rate heterosis ranged from 0.05 to 0.08 for the different breed combinations. Heterosis expressed for pregnancy rate in different mating systems were 0.071, 0.030, 0.063, and 0.072 for F1, F2, backcross dams, and three-breed cross dams—this does not appear to differ from dominance model expectation, but it should be noted that none of the contrasts used to estimate heterosis for the F2, backcross, or three-breed cross cows were significant.

Brangus and F3 cows had similar pregnancy and calving rates, annual cow production (weight) and cow efficiency (calf weaning weight/cow weight), but both groups had significantly lower performance for all of these traits than F1 Brahman-Angus cows (Hargrove et al., 1991a). In this study, F3 cows had a high stillbirth rate (11.0%) which resulted in a lower weaning rate (67.1%) than the Brangus and F1 cows (80.8 and 90.7%, respectively). No cow breed group differences in calf mortality from birth to 4 d or from 4 d of age to weaning were detected, but the difference between the calf survival rate of F2 cows (82.0%) and those of F1 and Brangus cows (91.7 and 94.0%, respectively) approached significance (P < 0.08).

Peacock et al. (1981) reported productive efficiency rate as the product of cow efficiency (calf weight/cow weight) and weaning rate. The authors compared mating system means (combining all breed types) for this rate. In comparison to the purebred (Brahman, Angus, and Charolais) system mean of 0.34, the system mean purebred cows raising first cross calves of all combinations was 5.9% greater. The mean for F1 cows raising backcross calves was 17.6% greater, and the mean for F1 cows raising calves sired by the third breed was 26.5% greater than the purebred mean. Though not discussed by Peacock et al. (1981), results were presented for pairs of breeds in the study. Brahman-Angus F1 cows expressed the largest crossbred advantage of any of the crossbred cow groups for productive efficiency rate when raising backcross calves (37.9%) or Charolais-sired calves (33.3%). Brahman-Charolais F1 cows were intermediate with 19.4% crossbred superiority when raising either backcross or Angus-sired calves. Angus-Charolais F1 cows raising backcross calves had 4.5% higher productive efficiency rate as compared to purebreds; it should be noted that when raising Brahman-sired calves that advantage was 36.4%.

Subsequent data of the project detailed by Peacock et al. (1981) were analyzed and reported for different mating systems, across all breeds (Olson et al., 1993). Pregnancy rates were 0.858, 0.929, 0.888, 0.921, and 0.93 for purebreds, F1 cows, F2 cows, backcross cows, and three-breed cross cows, with corresponding estimates of heterosis expressed for the above crossbred systems of 0.071, 0.030, 0.063, and 0.072. Only the estimates for backcross and three-breed cross cows approached significance, but the lower estimate F2 cows appears to be consistent with dominance expectation.

Annual production per cow (Crockett et al., 1978a), was defined as the product of pregnancy rate, calf survival rate, and weaning weight. Cows were assigned values of either 0 or the weight of their calf. The authors then estimated heterosis for annual production divided by cow weight for the first three generations in three two-breed rotations (cows in the three generations were F1, 3/4 - 1/4, and 3/4 - 3/4, respectively) were 42, 23, and 24% in Brahman-Angus, and 32, 11 (not significant), and 14% in Brahman-Hereford. Estimates of heterosis for this trait in the three generations of Hereford-Angus data
were 10, 6, and 3% (none were significant). When all
breedtypes were combined, the decline from
generation one to three in heterosis expressed for
annual production per cow weight appeared to
conform to expectation. Authors believed this decline
to be (consistent with thoughts for survival and
weaning rate [Crockett et al., 1978b]) due to the
higher survival rates of purebred calves in the second
and third generations.

**Cow and Heifer Weights**

Heterosis for growth in heifers was significant for
all except *inter se* groups at 12 and 18 mo of age and
decreased up to 18 mo of age (Crockett, 1973a).
Heterosis estimates for 12- and 18-mo weights in
Brahman-Devon were 17.2 and 14.9% and in
Brahman-Angus were over 21% for both traits.
Estimates for backcross heifers were 11.1 and 7.4% in
Brahman-Devon and 15.3 and 11.0% in Brahman-
Angus. Estimates for these traits in ⅔ Brahman ⅓ Devon
and ⅓ Brahman ⅔ Devon (out of pure bulls and
⅔ dams) were 10.3 and 7.9%. Heifers from *inter
se* mated ⅔ Brahman ⅓ Devon expressed almost no
heterosis for 12- and 18-mo weight (0.9 and 0.7%,
respectively). This would be a substantial departure
from dominance expectation.

Heterosis effects were large for cow weight in
Brahman-Angus and Brahman-Charolais, but not for
Charolais-Angus (Olson et al., 1993). Essentially all
of the cow weight heterosis expressed by F₁ cows was
gone in F₂, backcross, and three-breed cross cows.

**Calf Preweaning and Weaning Traits**

Estimates of heterosis for 205-d weight were 10.3
and 17.1% for Brahman-Angus and Brahman-Devon
crosses, respectively (Table 1; Crockett, 1973a).
Backcross progeny/F₁ dams expressed 29.2 and 17.6%
heterosis for Brahman-Angus and Brahman-Devon
crosses. Heterosis levels were only slightly reduced for
⅔ - ⅔ Brahman-Devon (both ways) at 15.6% and
*inter se* mated ⅔ Brahman ⅔ Devon at 10.3%, which
appears to be consistent with the dominance model for
expression of heterosis.

Crockett et al. (1978a) reported these estimates
(total) of heterosis for the first three generations of
two-breed rotations: weaning weight, 19, 13, and
21% in Brahman-Angus rotation, and 15, 9, and 17%
in Brahman-Hereford rotation, and 7, 1 (not
significant), and 8% in Hereford-Angus rotation.
Crockett et al. (1978a) reported total heterosis
estimates for body condition score that ranged from 5
to 13% for the different generations in all three
rotations evaluated (Brahman-Angus, Brahman-
Hereford, and Hereford-Angus). This study also
reported high levels of heterosis (11 to 19%) for birth
weight in all three evaluated generations of Brahman-
Hereford and Brahman-Angus rotations, but none in
the Hereford-Angus rotation.

Heterosis estimates for weaning body condition
score, weaning weight, and 205-d weight in *inter se*
matings of F₁s (Brahman-Angus, Brahman-Charolais)
were highly significant, while those for weaning body
condition score and weaning weight were significant
for F₁ Angus-Charolais (Peacock et al., 1986).
Although these were estimates for the mating system
(expectation of ⅔ direct heterosis + maternal
heterosis), the direct heterosis expressed by F₂ calves
did not appear to be substantially different from that
predicted by the dominance model. Heterosis
estimates expressed in backcross progeny for these
traits (F₁ bulls mated to purebreds) were
significant only for weaning body condition score and
205-d weight in Brahman-Angus. Dominance model
heterosis expectation for this system would be ⅔ of
the direct heterosis; estimates appeared to be much
lower than this expectation.

Total heterosis for weaning weight expressed by
F₁, backcross, and three-breed cross cows (Brahman,
Charolais, and Angus) did not appear to differ greatly
(45 to 65 lb), but the estimate for F₂ dams was not
different from 0 lb (Olson et al., 1993), which
suggests dramatic loss of heterosis from the F₁ to the
F₂ generations. No significant heterosis estimates for
birth weight or survival rate were detected. Although
heterosis estimates for weaning body condition score
were highest for calves from F₁ cows, they were
somewhat lower for backcross and three-breed cross
cows, and the estimate for F₂ cows was slightly lower
than half that of F₁ cows.

Preweaning average daily gain and weaning
weight of calves from *inter se* mated Brangus cows
and F₂ Brahman-Angus cows did not differ (*P > 0.05),
but both were less than calves from F₁ Brahman-
Angus cows (Hargrove et al., 1991b). Birth weights
did not differ for calves from the F₁ and F₂ cows;
calves from both groups were heavier than Brangus
calves.

**Interdependence of Cow Age, Lactation Status, and
Reproductive Success**

Early research in Florida identified the difficulties
and nuances associated with analyses of reproductive
data. The influence of lactation on subsequent
reproductive performance is detrimental (Koger et al.,
1962; Crockett, 1973a). Lactation status and age of
cow are tremendous influences on reproductive
performance. Nonlactating cows had lower weaning
rates in the following year (63 vs. 84%) in a large
study (1944 to 1958; n = 3,994 matings and 2,954

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calvings) at Ona (Koger et al., 1962), and there was a significant interaction of lactation status with cow age, which is illustrated in Figure 1 (reproduced from Koger et al., 1962). The cyclical (with regards to cow age) weaning rate appeared to be due the lower weaning rates of lactating cows, especially at young ages. This appears to be supported by results from two other Florida locations (Crockett, 1973a). In this study (Koger et al., 1962), the authors reported only the results of analyses of weaning rate, as calving rate results were similar. It may be that the reproductive status of a cow in a given year may be best predicted by her lactation status in the previous year, i.e., a negative autocorrelation exists between successive reproductive events. Koger et al. (1962) also reported differential response to lactation stress in different pasture programs, as they observed lower reproductive performance (weaning rate) for cows on lower nutritional planes. However, the authors noted a reduced weaning rate for non-lactating cows on improved pasture, and a greater preweaning death loss (though not analyzed) in the highest nutritional plane.

Breed effects appear to interact with lactation status and cow age to influence reproductive rates. Nonlactating cows of all breed groups performed at nearly the same level, but breed differences occurred when cows were lactating (Koger et al., 1962). Several breeds and breed types of both cows and bulls were included in this study, making analyses and interpretation difficult, but most of the positive effects on weaning rate appeared to be associated with heterotic effects in crossbred cows. Figures 2 and 3 (Crockett, 1967) illustrate the erratic pregnancy rates associated with age in British, crossbred, and Brahman cattle, particularly for Brahman cows at 2 through 6 years of age. Results from a survey of reproduction traits (n = 15,204) from 14 cow-calving producers in southern states (Temple, 1967) indicated that Bos indicus breeds (Brahman, Brangus, Santa Gertrudis) had higher calving (3 to 8%) and weaning rates (4 to 5%) for nonlactating cows than lactating cows in the following year, but the opposite was the case for British breeds (Angus, Hereford, and Shorthorn), as lactating cows had approximately 2% higher calving rates than nonlactating cows. Two states with large Bos indicus influence in the cow herd (Florida and Louisiana) had higher calving and weaning rates for nonlactating cows. Nonlactating cows tended to have higher calf mortality in the next year, which was consistent with the results of Koger et al. (1962). There appeared to be an interaction with cow age, as 2-, 3-, and 4-yr old and older nonlactating cows had 8.4, 11.6, and 5.3% death loss from 36 h to weaning in the next year, while lactating cows in the same categories had 4.3, 4.2, and 3.1% death loss in their next calves (Temple, 1967). Olson et al. (1985) also described an interaction of breed with cow age and lactation in which 2- and 3-yr-old Brown Swiss cows had much lower pregnancy rates (approximately 20% lower) than the other breed types (Angus and Brown Swiss-Angus F1s). Brown Swiss cows weaned.
Figure 2. Age and breed interacting on reproductive rate (reproduced from Crockett, 1967).

Figure 3. Effect of age in reproductive rate (reproduced from Crockett, 1967)

calves (Angus-sired) that had 35 lb heavier 205-d weights than all other cows; this was likely responsible for the lower pregnancy rate (30% lower) for lactating Brown Swiss cows.

Historically in Florida, most cows (virtually all of the literature reviewed in this paper) were bred as 2-yr-olds to calve as 3-yr-olds. It has been generally accepted that due to lower replacement costs (BIF, 1996) and greater lifetime productivity (Chapman et
al., 1978) heifers should be bred to calve first as 2-yr-olds in the United States, and this standard has been promoted even among the later-maturing Brahman and Brahman cross heifers. Our own experience with Brahman cattle is that at best about 10% of heifers will calve as 2-yr-olds. Among those (including crossbreds) that do calve at two years of age, it again has been our experience (though not statistically demonstrated) that even the "best" cows eventually fail to get pregnant somewhere from four to six years of age. There is an absence of experimental support for either the lifetime superiority (either from an economic or purely productive standpoint) of the system of breeding cows in the subtropical United States to first calve at two rather than three years of age. Brahman cows mature later than other breeds; Plasse et al. (1967b) reported age at first corpus luteum (detected by palpation) for Brahman heifers to range from 18.9 to 21.3 mo, as compared to 15 to 20 mo in crossbred Brahman heifers. This is likely a consequence of indicus adaptation to tropical and subtropical areas by acquisition of "built-in mechanisms to protect themselves from poor feed supplies," which include late puberty, suppression of estrus during lactation, and a tendency to even display this when well fed (Warwick, 1967). Gestation length in Brahman cows was 292.8 d (Plasse et al., 1967e), and average calving interval was 409.9 d and if skipped years were excluded, 374.7 d (Plasse et al., 1967a); this interval tended to shorten with increasing cow age. Although Plasse et al. (1967a) concluded that shortening the breeding season would increase selection pressure and therefore increase overall reproductive efficiency, enforcement of defined breeding seasons may result in eventual reproductive failure (as soon as ages four to six) for Brahman cows (and probably crossbreds).

Peacock et al. (1971) reported evidence of genotype x environment interaction influence on expression of heterosis in Brahman and Shorthorn crosses. Pregnancy rates of purebred and F1 cows were 11 and 19% higher for cows on highly improved pastures as compared to the same breed groups on native range. Weaning rates for the two groups were 10 and 15.7% higher on the improved pastures. The heterosis expressed for percent weaning rate increased linearly with improved conditions: 11.6% for cows on native range; 15.8% for cows on a combination pasture program; and 18.2% on highly improved pastures.

Implications

Crossbreeding research in Florida has produced results that generally support the dominance model of heterosis expression. There were two notable exceptions. Over 70% of the weaning rate heterosis expressed by F1 Brahman-Devon with backcross calves appeared to be lost in ¾ Brahman ¾ Devon (¾ - ¾ calves) and ¾ Brahman ¾ Devon cows with calves from inter se matings (Crockett, 1973a). There appeared to be almost total loss of heterosis for yearling weight and 18-mo weight in ¾ Brahman ¾ Devon heifers (Crockett, 1973a) and for cow weight in all non-F1 (F2, backcross, and three-breed cross) cows (Olson et al., 1993).

Early work in Florida also highlighted the complex interaction of reproductive performance with lactation status, age of cow, and nutritional plane. It is a very worthy challenge to appropriately model these interactions when studying and describing cow reproductive performance.

There is large continual emphasis in the United States on genetic improvement of calf growth performance; economies of scale in the feeder and packer segments of the beef industry are partly responsible for this emphasis. Efforts have been made to apply the selection programs that have been so successful in improvement of calf growth and dairy milk yield to cow reproductive traits; however, these programs are likely to be slower and less effective than crossbreeding. There is a renewed interest in crossbreeding, even among dairy researchers, as a means of improvement of fertility. The reviewed work here in each case included 10 or more years of reproductive data, which are especially large studies relative to most, but not all, of the studies of similar traits today. Even with these large data sets it was difficult to estimate significant contrasts. Support for long-term research into cow reproductive performance is rare today; there are at least two major similar studies today in Texas. This seems inadequate, as the problems are not resolved. Such studies could be conducted while providing the population as a source for DNA mapping or other popularly-funded work.

Much of what is understood about cow performance has come from this early Florida work. The cooperation and interaction between the cattle research entities in Florida during these reviewed studies enhanced the impact of this group and should serve as a model and example for researchers today.

Literature Cited


