Breeding Season Length Versus Calving Percentage in Beef Cattle Herds

R.E. Larsen[1], S.C. Denham[2], and J. Boucher[3]

Department of Large Animal Clinical Sciences[1], Department of Animal Science[2], and Department of Statistcs[3]
University of Florida, Gainesville

Long breeding seasons result in long calving seasons. This results in calvings distributed through a range of environmental and nutritional conditions and a disparity in calf maturity at any planned weaning time. It also results in cows entering their period of maximal nutritional requirements over the same range of environmental conditions. Attempts to increase cow and calf productivity often include focusing the calving season on a "best" time of year by shortening the associated breeding season.

In general, any beef production system which allows the periodic collection of all animals in the herd for examination, vaccination, and culling will utilize a limited breeding season in one form or another. The advantages of a limited breeding season, be it 1 or 6 mo, go far beyond the focusing of the calving season on the optimum environment. Limited breeding seasons allow, 1) defined annual check points for productivity and profitability, 2) annual herd health procedures at specific points in the growth and reproductive processes; 3) rational culling procedures based on reproductive success; and 4) assessment of replacement needs for herd improvement and maintenance of herd size.

Short breeding seasons of only 40 to 45 d have been used successfully on a number of farms. However, many producers recognize, based on their experience, that herd calving rate may be unacceptably low when such a curtailed breeding season is used in their environment and with the resources at their disposal. This discussion will address the relationship between breeding season length and calving rate based on three of the most influential reproductive parameters, conception rate per estrus exposed, gestation length, and duration of postpartum anestrus.

Field Studies

Beginning in 1965 a 4 yr experiment was performed in central Florida comparing 3 mo breeding seasons to year-round breeding seasons in Brahman and Santa Gertrudis cattle (McNutt, 1970). Calving percentage was 67% in cattle subject to a 3-mo breeding season and 85% in those bred year-round. The differences between the two breeds were not significant. This study did not pursue the tendency for calving rate to increase when the breeding season is lengthened after a period of shorter seasons.

A more recent 5 yr study in Nebraska (Deutscher et al., 1990) compared the calving rates of crossbred (Simmental, Angus, Hereford, Gelbvieh) cows managed with 45 and 75 d breeding seasons. These were further divided into groups with early breeding seasons (beginning May 20) and late breeding seasons (June 20). In the early breeding group the pregnancy percentage was 94.6% in the 70 d breeding season group vs 86.8% for the 45 d group. The difference narrowed in the late breeding group but was still higher for the 70 d breeding season group, 93.4% vs 91.6%.

In a study conducted in Central Florida from 1980 to 1987 (Denham et al., 1989) straightbred Angus, Hereford, and Brahman herds were assessed for pregnancy percentage with breeding seasons in the early years of 45 d for the Angus and Hereford breeds and 65 d for the Brahmans (table 1). Pregnancy percentage was 79.1 and 80.5 for the Angus and Hereford herds and 68.2% for the Brahman herds under those breeding season lengths. In an attempt to explain this disparity a computer model was developed which utilized only the variables conception rate per estrus exposed, gestation length, duration of postpartum anestrus, and breeding season length.

Modeling Beef Herd Reproductive Performance

Conception rate at each estrus during the breeding season is not constant. It is also under very limited control by the producer. Conception rate at first, second and subsequent breedings may decline due to the fact that most reproductively normal cows conceive with few breedings leaving a population of cows with a higher proportion of individuals who are not reproductively normal. Certain breeds are presented as having inherently higher or lower conception rates but this may be related to bull performance in certain studies rather than inherent cow fertility. In one study comparing Angus and Brahman cows for first service conception rate, the Brahman cows had the higher rate at 80% (Wiltbank et al., 1961). In another study comparing Angus and Brahman bulls for first service conception rate when bred to Angus and Brahman cows, the Angus sires exceeded Brahman sires by 15.7% for pregnancy rate at first service. (Reynolds et al., 1979). Under most conditions we expect conception rate per estrus exposed to be between 50 and 80%.

In the model of beef herd reproduction to be discussed the conception rate will be assumed to be the same for all animals in the modeled herd, regardless of age, and to be constant for each estrus.

Gestation length is rarely thought to be influenced by management, but it is influenced by breed or genotype. Selection for heavier calves has a tendency to also select for longer gestation. The differences between breeds is most apparent when comparing the Angus and Bos indicus breeds. While Angus have relatively short gestations of 278 d, Brahman cows have a mean gestation length of 293 d (Plasse et. al., 1968). While gestation length may be variable in any breed, the variation around the mean in Brahman cattle appears to be large, with many cows carrying calves in excess of 300 d. Different Brahman bulls produced sire differences for gestation length means ranging from 285.8 to 297.7 d (Plasse et al., 1968). Gestation length becomes important in modeling beef cattle reproduction when the period between conception and the first postpartum estrus becomes 1 yr or longer. A longer gestation length pushes the first postpartum estrus further into the breeding season, decreasing the number of estrus periods with exposure to the bull.

In the model of beef cattle reproduction a single value for gestation length is set for all cows in the modeled herd.

Duration of postpartum anestrus is the period from calving to the first estrus. This anestrus period is recognized as being a major factor in controlling the proportion of cows conceiving each breeding season (Wiltbank et al., 1961). Beef cattle producers have, through experience, accommodated the length of their breeding season to the length of postpartum anestrus. In general, areas with tropical and subtropical conditions and lower levels of nutrient resources tend to use long or year-round breeding seasons.

In the model of beef cattle reproduction a single mean value is used for the duration of postpartum anestrus in the modeled herd. While, in reality, the variability between cows for this value is even greater than for gestation length, the use of a mean value allows us to see the effect of shortening and lengthening the time from calving to first estrus.

Gestation Length Plus Postpartum Anestrus (GL + PRE)

Gestation length plus the duration of postpartum anestrus (Postpartum Return to Estrus, PRE) will be referred to as GL + PRE in this discussion. Many breeding experiments attempt to enhance the quality of "fertility" by creating a new crossbreed or genotype. "Fertility" has a number of components but is generally measured by the calving percentage achieved under the experimental conditions. For the purposes of this discussion "fertility" will have no meaning other than the effect of the number of days equal to GL + PRE. There is little evidence to suggest that a cow of one genotype, returning to estrus before the onset of the breeding season, with a normal involuted uterus, bred by a fertile bull on a subsequent estrus, will have a higher probability of conceiving than a cow of a different genotype, given the same conditions. So, we will reject conception rate as a factor in determining breeding season length. It plays a role, but one which is difficult to predict since it depends on disease factors and bull fertility.

GL + PRE becomes the determining factor in setting breeding season length whenever this value approaches or exceeds 365 d. In the beef cattle reproductive performance model certain assumptions are made:

1) Conception rate, gestation length, and postpartum anestrus are constant.
2) Herd size remains the same year to year.
3) All nonpregnant animals are replaced by reproductively active animals for the subsequent breeding season.

Under these conditions, whenever conception rate is less than 100%, calving dates will be distributed throughout the calving season and late calving cows will come into heat only once or not at all during the breeding season. table 2 shows the percentage of cows which experience only one estrus during breeding seasons of various lengths when GL + PRE is varied from 325 to 365 d. At a breeding season of 60 d (conception rate at 65%) a herd with GL + PRE of 345 d has 11.7% of its cows experiencing estrus only once, while a herd with GL + PRE of 365 d has 29.5% experiencing only one estrus during the breeding season. When GL + PRE exceeds 365 d some cows will fail to experience estrus during any limited breeding season. Table 3 lists the percentage of cows failing to return to estrus during varying breeding season lengths when GL + PRE is set at 370, 380, and 390 d (conception rate set at 65%). A herd with GL + PRE of 380 d using a 75 d breeding season would have 15.1% of its cows failing to return to estrus within the breeding season. This is not outside the realm of experience of some investigators. In a study in Louisiana, a straightbred Brahman herd contained 11.9% cows failing to experience estrus during a 75 d breeding season while a straightbred Angus herd contained only 0.2% cows not showing estrus (Reynolds et al., 1979). Pregnancy rates were 84.5% and 66.0% over 75 d for the Angus and Brahman herds.

Within this model, and presumably in the field, it makes no difference whether a change in GL + PRE is due to a shift in gestation length or a shift in the number of days to postpartum return to estrus (PRE). The effect on calving percentage is the same. Figure 1 demonstrates the nature of this relationship. At a breeding season length of 60 d (conception rate set at 60%) the calving percentage is identical for a herd with gestation length of 280 d and anestrus of 80 d (GL + PRE = 360) and for a herd with gestation length of 290 d and anestrus of 70 d (GL + PRE = 360). This confers an advantage on those genotypes with shorter gestation lengths. This advantage is quite small under conditions which promote short anestrus durations (eg PRE of 55 to 65 d). When anestrus durations are 70 d or more the effect of gestation length becomes a significant factor in calving percentage when herds are managed with short breeding seasons. With a 60 d breeding season, under conditions which result in a conception rate of 60% and postpartum anestrus of 80 d, herds with a gestation length of 278 d have a 14% advantage in calving percentage over herds with a 293 d gestation length.

Regional differences in nutrient resources produce different expectations for the duration of postpartum anestrus. But, differences in the genotypes of cattle used in subtropical vs temperate regions tend to magnify the differences seen in reproductive performance. Tropical and subtropical regions utilize cattle adapted to the environment. That adaptation includes resistance to heat, parasites, and the ability to survive periods of low nutrient availability. Many of these genotypes have longer gestation lengths as a biological characteristic. As a result, the cattle population in much of the tropics and subtropics has an extended postpartum anestrus, as might be expected, as well as an extended gestation length when compared to herds in temperate regions. The resulting prolonged GL + PRE value dictates the use of longer breeding seasons for calving percentage goals to be met.

Calving Percentage and Profitability

Decreasing the length of the breeding season does not inherently increase calving percentage and profitability. In fact, when all other biological and management considerations are held constant, reducing the breeding season reduces calving percentage. This does not suggest that year-round breeding is preferable to a limited breeding season. Any limited breeding season, even one of 10 or 11 mo, makes possible the kind of management and resource utilization which can increase calf crop and profitability. Reduction in breeding season length requires changes in management if calving percentage is to be maintained above a certain target.

Improvement in productivity and profitability of a herd involves culling strategy as much as the introduction of new genetic material. A rational culling strategy can be devised to maximize profitability or minimize losses under most systems (Pfeiffer et al., 1989). However, a culling strategy for improvement in performance depends on exceeding a threshold value for calving percentage. If culling strategy and operation profitability depend on a calving percentage of 80% or more for best results, a herd with GL + PRE of 345 d requires a much different breeding season length than a herd with a GL + PRE of 375 d. Figure 2 shows the projections of calving percentage when conception rate is 60% and GL + PRE is set at various levels over a range of breeding season lengths from 40 to 180 d. If we require an 80% calving percentage, the herd with GL + PRE equal to 345 d may well be successful with a breeding season of 40 to 50 d. A herd with GL + PRE of 375 d will require a 110 d breeding season to meet this goal of an 80% calf crop.

There are a variety of ways to influence the reproductive characteristics of a herd so that shorter breeding seasons can be productively used. Most of them involve more intensive management and attention to detail. Diseases must be rigorously controlled. Conception rate may be raised by introduction of bulls with satisfactory semen and good libido, serving capacity, and mating ability. Gestation length and postpartum anestrus can be reduced by selection of genotypes and individual animals. Postpartum anestrus can be reduced by a variety of nutritional, hormonal, and management regimens. Profitability resulting from this increase in investment of management effort and physical resources will depend, as always, on the price of beef and the cost of resources.

Literature Cited

Denham, S.C., R.E. Larsen, and J. Boucher. 1989. A deterministic model of reproductive performance in beef cattle. J. Anim. Sci. 67(Suppl. 1):437.

Deutscher, G., D. Colburn, M. Knott, M. Nielsen, J. Stotts and D. Clanton. 1990. Breeding and calving season effects on cow productivity. 1990 Beef Cattle Report. pp 9-13. Institute of Agriculture and Natural Resources. University of Nebraska, Lincoln.

McNutt, R.H. 1970. Three-month vs year-round breeding season with Brahman and Santa Gertrudis cattle. M.S. Thesis. University of Florida, Gainesville.

Pfeiffer, G., D. Fiske, S. Azzam, and M. Nielsen. 1989. Impact of cow culling decisions and reproductive performance. 1990 Beef Cattle Report. pp 22-24. Institute of Agriculture and Natural Resources. University of Nebraska, Lincoln.
Plasse, D., A.C. Warnick, R.E. Reese and M. Koger 1968. Reproductive behavior of Bos indicus females in a subtropical environment. II. Gestation length in Brahman cattle. J. Anim. Sci. 27:101.
Reynolds, W.L., T.M. DeRouen, S. Moin, and K.L. Koonce. 1961. Factors affecting pregnancy rate of Angus, Zebu, and Zebu-cross cattle. J. Anim. Sci. 48:1312.
Wiltbank, J.N., E.J. Warwick, E.H. Vernon and B.M. Priode. 1961. Factors affecting net calf crop in beef cattle. J. Anim. Sci. 20:409.

Table 1. Observed Calving Percentage in Single Sire Brahman, Angus, and Hereford Herds (Mean No. Cows/Herd=24) on a Central Florida Beef Cattle Station.

Breed	Years observed (no.)	Herds observed (no.)	Observed calving %	Breeding season (d)
Brahman	3	20	68.2	65
	1	5	74.1	71
	1	5	65.3	72
	1	5	63.2	75
	1	5	78.9	90
	1	6	81.9	122
Angus	6	37	79.1	45
	1	7	77.5	60
	1	6	88.3	60
Hereford	6	29	80.5	45
	1	5	86.7	60
	1	6	83.4	60

Table 3. Percentage of Cows Not Returning to Estrus During the Breeding Season at a Gestation Length of 290 Days, Conception Rate of 65%, and With Postpartum Return to Estrus and Breeding Season Length Varied with Increases in Breeding Season Length After an Initial Period of Stable Breeding Season Lengths.

Breeding season length (d)	Postpartum return to estrus (d)		
	80	90	100
45	8.8	22.2	29.3
60	6.7	18.0	25.8
75	5.6	15.1	22.6
90	4.8	13.1	19.3
105	4.2	11.6	17.9
120	3.8	10.2	15.2
135	3.4	9.6	14.5
150	3.1	8.6	13.4

Table 2. Percentage of Cows Showing Heat Only Once During the Breeding Season at a Gestation Length of 285 Days and a Conception Rate of 65% with Postpartum Return to Estrus and Breeding Season Length Varied.

Breeding season length (d)	Postpartum return to estrus (d)				
	40	50	60	70	80
45	20.7	20.7	21.1	25.7	37.3
60	10.2	10.7	11.7	16.6	29.5
75	5.2	5.6	6.8	11.5	24.3
90	2.5	2.9	3.9	8.5	20.7
105	1.2	1.5	2.3	6.6	18.0
120	0.7	0.8	1.5	5.3	15.9
135	0.3	0.5	0.9	4.3	14.3
150	0.2	0.2	0.6	3.5	13.0

Figure 1. Projected calving percentage when postpartum return to estrus (PRE), conception rate (60%) and breeding season (60 d) remain constant and gestation length is varied. Projections using PRE values of 55, 60, 65, 70, 75, and 80 d are presented.

Figure 2. Projected calving percentage at four values of gestation length + postpartum return to estrus (GL + PRE) when conception rate (60%) remains constant and breeding season length is varied. Projections using GL + PRE of 345, 355, 365, and 375 d are given.