Reproductive Efficiency of Cows of Different Sizes

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INTRODUCTION

The effect of cow size on reproduction has become of greater concern in recent years as a result of marked increases in cow size in both purebred and commercial herds and the extremely large effect of fertility on the profitability of commercial cowherds. This increase in mature size has come about as a result of the use of large imported European breeds in crossbreeding programs and as a result of selection within the existing British and *Bos indicus* breeds for mature size. Some of the increase in mature size has likely been the result of a correlated response to selection for yearling weight, but unfortunately there has been considerable direct selection for mature height and weight as evidenced by the advertising of the mature weights and heights in breed journals. Also, it is an unfortunate fact that for many years there has been a tendency for judges to use height as a major criterion for placement in the showring. While it is perhaps now generally assumed that increased cow size will lead to reduced reproductive efficiency, relatively few studies have examined the magnitude of differences in cow size that exist in many breeds of cattle in the United States today. The effect of cow size has been confounded with breed composition in most of the studies which have been conducted to date. The purpose of this paper is to report on results of the effect of cow size on reproduction in the Brahman breed at the Sub-tropical Agricultural Research Station (STARS) near Brooksville, Florida, and to review other studies that have investigated the effect of cow size within the same breed or breed cross on reproductive traits.

Effect of Cow Size on Reproductive Efficiency in Brahman Cattle in Florida

The Brahman herd at STARS has been mated according to frame size (hip height) since 1983, with the shorter cows being mated to shorter bulls and the taller cows being mated to taller bulls. From 1983 until 1990, moderate-sized cows were also mated to moderate-sized bulls. The mean hip heights for the small, medium and large frame-size cows at maturity were 52, 54 and 55.5 in, respectively. The hip heights of the small, medium and large frame-size bulls used were 53, 55 and 57.5 in, respectively, at 2 yr of age. The bulls were selected from within the STARS herd or were loaned from private herds. All were of gray Brahman breeding. The cows were maintained on bahiagrass pastures, with hay and protein supplement being fed during the winter months. Heifers were bred for the first time at 2 yr of age. A breeding season of 90 d was used from 1983 through 1986 but was lengthened to 120 d in 1987.

The weights, heights, reproductive rates and body condition scores of females born since 1984 are shown in Table 1. The difference between the hip heights of the small vs the large frame-size groups of females ranged from 2.4 to 3.5 in depending on age. This difference would be slightly less than two frame-size scores based on the American system, with the small frame size group being about 5 on this system and the large cows being about 7. Age at puberty data from heifers born during the early years of the study have been analyzed by Senseman (1989). Heifers from the small frame-size group reached puberty somewhat earlier -- 588 d -- and at lighter weights -- 666 lb -- than did the large-frame heifers that reached puberty at an average weight of 754 lb at 635 d of age. The heifers were not exposed to bulls until they were more than 2 yr of age, however, when the majority of the heifers of all frame sizes had reached puberty. As a result, differences in pregnancy percentages at 2 yr of age were not great -- 93.7, 89.7 and 86.9% for heifers of small, medium and large frame size, respectively. Even as non-lactating 2-yr-olds, however, there was a difference in the condition scores of the heifers, with those of the small frame-size group having a condition score nearly one unit higher (8.2 vs 7.3, using a scale from 1 to 17) than that of the large frame-size heifers. The mean condition score of the medium-size heifers was intermediate, at 7.7.

Major differences were observed in the pregnancy rates of lactating 3-yr-old (first lactation) cows, with the small, medium and large frame-size groups having rebreeding rates of 74.9, 51.8 and 34.5%, respectively. The small frame-size females, which were 3.5 in shorter than the large ones had a mean condition score of 5.4, compared to 4.5 for the large females. Again, the condition score of the medium-frame cows was intermediate. As has been observed in other studies using commercial cattle in Florida, the condition scores corresponded directly to their pregnancy rates. The higher pregnancy rate of the small frame-size females, in addition to being the result of higher mean condition score of this group, also was likely influenced by their earlier average calving date. The average calf age at weaning for the calves from the small frame-size females was 228 d, indicating that they had calved 16 d earlier than the intermediate-size females and 13 d earlier than the large-frame females. While the calves weaned by the large frame-size females were 48 lb heavier than those of the small cows (498 vs 450 lb), the production of weaned calf per cow exposed to breeding -- a measure of cow efficiency determined by multiplying the calf weaning weight times the pregnancy rate -- was nearly twice as high for the small than the large females.

In adult cows, the differences in condition scores and pregnancy rates between small and large cows were small. Also, the difference between the heights of the small and large groups, was not as great as it was for the younger cows. It does appear, however, that the major problem with the use of larger frame-size cattle, from the standpoint of reproduction, will be with later age at puberty and poor rebreeding success while lactating for the first time. To some extent, it may be possible to minimize these problems through increased nutrition, especially that of the lactating female whose condition score can be an indicator of whether or not she is receiving adequate nutrition to allow rebreeding success. It may not be economically feasible, however, to supply the level of nutrition necessary for the excessively large females to rebreed while lactating.

Effect of Cow Size on Reproductive Efficiency in Angus Cattle at STARS

A comparable effect of hip height on reproductive traits has been observed in Angus cattle at this same location. While the differences in mature size are not as large due to different selection goals and both size groups are small relative to popular Angus herds today, the results are similar to those of the Brahman. The goal was to select one line (line A) for greater mature weight and the other line for an earlier maturing pattern (line K). The two lines were initiated from the same foundation Angus herd. Cows were assigned to either the A or the K herds based on predictions of their mature sizes and maturing rates.

Approximately 10 yr of selection based on these parameters resulted in some difference in hip heights (Table 2), perhaps a difference of about one frame score. Heifers or cows from the A line (large mature size) were consistently heavier and taller than those of the K line (early maturity) from weaning through maturity. The line A females, however, were also thinner (had lower condition scores) at all ages prior to maturity. The line K cows had stopped growing (increasing in weight) by 4.5 yr of age, but the line A cows continued growing for another year (Beltrán and Olson, 1990). Senseman (1989) reported that the line A heifers reached puberty at a mean age of 518 d and a mean weight of 591 lb whereas the line K heifers were 31 d younger and 40 lb lighter at puberty. The reason for the relatively late age at puberty in both these lines is that these heifers received low levels of nutrition through their first winter (not much more than maintenance).

Since these heifers were not exposed until 2 yr of age, the earlier puberty of the line K heifers was not expressed in a higher first-exposure pregnancy rate, and in fact they showed a slightly lower pregnancy rate than the line A heifers as 2-yr-olds. While lactating with their first calves, however, the rebreeding rate was much lower for the line A heifers, 64.9% as opposed to 79.2% for the line K heifers. The mean condition score (1 to 17 scale) of the line A heifers was correspondingly lower, 7.6 as opposed to 8.4 for the line K heifers. As 4-yr-olds, however, the differences between the lines in terms of pregnancy rate and condition scores had largely disappeared. Just as was found with Brahman, the disadvantages of the larger type cattle in terms of lowered fertility diminished with increasing age and, therefore, maturity.

Beltrán (unpublished data) also discussed the relationships among growth and reproductive patterns in this same herd of Angus cattle before the selection for increased mature size or maturing rate began. He observed that those cows with larger mature sizes tended to have lower conception rates while lactating with their first calves than smaller, faster-maturing cows. The heifers in this herd were found to have reached puberty when they had achieved about 60% of their mature weight. Heifers that bred as 2-yr-olds but failed to rebreed as lactating 3-yr-olds were found to have reached only 50% of their mature weight as yearlings. In contrast, those heifers that bred back while nursing their first calves had reached a higher proportion of their mature weight (57%) by 1 yr of age. Thus, these data indicate that early-maturing heifers will show greater fertility as young cows.

Also, degree of maturity (percent of mature weight) as long yearlings (550 d) was found to be highly negatively correlated (r_g = -.92; r_p = -.62) with mature weight. This is another strong indication that selection for larger cows at maturity will result in later-maturing heifers that will be less fertile as young, lactating cows. These correlations indicate that increasing mature weight will result in heifers having reached a smaller proportion of their mature size as yearlings and thus have a lower chance of conceiving as a yearling during a fixed breeding season. This is because they have a lower likelihood of having reached puberty since they will not have reached the 60 to 65% of mature weight required to reach puberty in time to breed as yearlings. It appears from these data as well that larger mature size is going to be associated with lowered reproductive performance in young lactating females when they are maintained under less-than-optimal nutritional conditions.

RESULTS FROM STUDIES IN OTHER STATES

The question of the effect of size on reproductive traits under two different managements was investigated in Iowa using composite breed populations of small, medium and large mature sizes (Buttram and Willham, 1989). Each of the composite populations contained about 40% Angus breeding. Samples of each line were maintained at two farms in Iowa, one which utilized spring calving and weaning at traditional ages and another at which cows were calved in the fall and their calves were weaned at 45 d of age. All heifers were bred as yearlings to calve as 2-yr-olds. All cows or heifers that did not calve were culled regardless of the reason.

Weights, heights, and cycling and conception rates of the three size groups are shown in Table 3. As yearlings, the three size groups differed by about 2 in and 66 lb. The height and weight differences between the lines increased slightly at older ages. These heights correspond to frame scores of about 3.2, 4.2 and 5.1 for the small, medium and large groups, respectively. The sizes (across farms) were different ($P < .05$) for both calving rate and cycling rate. The differences, however, were due to the extremely poor performance of the large-frame heifers in the poorer, fall-calving environment. Under the more favorable environment, both the cycling and calving percentages were essentially equal for all three size groups. Under the fall-calving environment, however, the large frame-size group exhibited cycling and calving rates about 20% lower than those of the small-size group. The authors suggested that smaller cattle that mature earlier and at lighter weights are likely to be more desirable if heifers are to be raised under less-than-optimal conditions, and it is desired to breed them at 14 to 15 mo of age. Larger, later-maturing heifers would have to be given more feed in order to reach puberty at the same age.

The differences among the size groups as lactating 2-yr-olds were comparable to those of the yearling heifers, as the cycling and calving rates of the small cows surpassed ($P < .05$) those of the large cows (Table 3). The advantage of the small over the large cows for calving rate ($P < .05$) continued in their subsequent (third) parity. However, the differences were not significant between the size groups for cycling rate. In considering these results, it also should be remembered that many of the dams of bulls being sold for use in commercial herds today are much larger than the frame score 5 cows considered as the large-type cows in this study. The effects upon reproduction of cattle of frame scores 6 and greater may be much greater than that observed in this study.

Another study was recently published (Lopez de Torre et al., 1992) in which the reproductive efficiency of

Retinta (*Bos taurus*) cows in Spain was related to their mature size. Their analysis indicated that as mature cow size increased, the number of calves they weaned in a 5-yr period decreased. For an increase of 220 lb in mature weight, the total number of calves weaned was reduced by .5. A slightly greater reduction in calf numbers (.7) was reported by Stewart and Martin (1981) for a 220-lb increase in cow weight in Angus, Milking Shorthorn and their crosses. Marshall et al. (1984) reported a similar reduction in Red Poll cattle.

Also, the weaned calf weight per cow exposed to breeding decreased by 17 lb for each 100-lb increase in cow weight. A similar reduction was observed by Stewart and Marshall. Those cows that were earlier in reaching mature weight and that tended to be smaller at maturity weaned more calves and had higher weaned calf weight per cow exposed.

The subject of milking ability has not been discussed in this paper. It is clear, however, that it also has an important effect on reproductive efficiency. Excessive milk production greatly increases the nutritional requirements of the cow and, under limited nutrition, will likely result in cows losing body condition to the extent that they do not rebreed on schedule. If large frame-size young cows are also heavy milk producers, this would exacerbate the problem that such females have with rebreeding promptly.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

To summarize, the effects of increasing mature size through selection for hip height (frame score) include increased age at puberty and a decline in maturing rate. In addition, rebreeding rates as young lactating females will likely decline. It may be possible, however, to minimize this reduced fertility by providing additional nutrition to the larger females. For example, heifers with larger frame scores (taller) will have to be fed to gain more weight by the start of the breeding season as yearlings (in order to achieve 65% of mature weight) than those with smaller expected mature weights. Also, lactating first-calf heifers (whether 2 or 3 yr of age) with larger frame scores will have to be fed more than similar small frame-size heifers in order to achieve comparable levels of fertility. If a cattleman elects to attempt to feed satisfactory reproduction into large frame-size females, the question then would be, "How much feed is going to be necessary?" The answer to this question clearly depends on the forage quality and quantity available, the type of supplemental feed provided, and also on the size, age, degree of maturity, and level of milk production of the heifers involved. However, it would be appropriate to provide nutrition for lactating first-calf heifers at a level that would allow most heifers to maintain a condition score of about 6 on the 1-to-9 system.

In Florida the additional cost of providing the nutrition required to maintain adequate nutrition in larger first-lactation heifers, especially in heifers that are under 3 yr of age, is likely to be prohibitive. One final question that this raises then is, "How big should my cows be to be efficient under my conditions?" My recommendation, relative to cow size, is to maintain the minimum cow size necessary to produce an adequate growth rate and carcass size in their male progeny. This can be accomplished in cows with frame scores of 4 and 5, possibly 6, using the U.S. system. Adequate nutrition will need to be provided to allow cows of this size with moderate milk-producing ability to maintain sufficient body condition to rebreed. By avoiding excessive cow size, the amount of often expensive supplemental nutrition required to maintain satisfactory levels of reproduction will be reduced.

To produce reproductively efficient, moderate-size cattle, it is necessary that bulls of moderate size be used. Bulls used should be approximately frame score 5, possibly high 4's or low 6's. Bulls of this frame size are moderate-sized and should have good thickness and body depth, and tend to be earlier maturing. Selection based on scrotal circumference (>32 cm at 12 to 16 mo of age would also be helpful.

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TABLE 1. Growth and fertility traits of small, medium and large Brahman cows by age of cow.

	Size Groups by Age of Cow								
	Size (2 yr)[a]			Size (3 yr)[a]			Size (5 yr and older)[b]		
Trait	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
Weight, lb	944	1027	1043	776	908	972	1027	1107	1138
Hip height, in	51.3	53.7	55.2	51.6	53.9	55.1	52.6	54.3	55.5
Condition score[a]	8.2	7.7	7.3	5.4	5.0	4.5	6.2	6.2	6.0
Pregnancy rate, %	93.7	89.7	86.9	74.9	51.8	34.5	75.1	83.3	74.6
Calf age at weaning, d				228	212	215	203	197	193

[a]These data were collected on only those females born from selected matings for frame size. Condition scores are on a 1-to-17 scale.
[b]These data were collected on all lactating females of more than 5 yr of age that had also weaned a calf the previous year.

TABLE 2. Growth and fertility traits of Angus cattle of two maturing patterns at STARS.

	Trait							
	Weight, lb		Hip Height, in		Condition Score[c]		Pregnancy Rate, %	
Age	A[a]	K[b]	A	K	A	K	A	K
Weanling	428	417	37.6	35.7	8.4	9.0		
Long yearling	813	787	46.3	45.2	8.1	8.6		
2.5 yr	899	873	46.9	45.5	9.0	9.5	80.9	77.9
3.5 yr	899	871	47.4	46.1	7.6	8.4	64.9	79.2
4.5 yr	972	884	47.4	46.3	8.0	7.9	80.6	84.7

[a] Line A cattle were selected for a heavier predicted mature size.
[b] Line K cattle were selected for a faster predicted rate of maturing.
[c] Based on a 1-to-17 system.

TABLE 3. Growth and fertility traits of small, medium and large composite crossbred cows by parity number.

	Size Groups by Parity Number								
	Size[a] (Parity 1)			Size (Parity 2)			Size (Parity 3)		
Trait	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
Weight, lb	569	633	701	836	930	1056	884	985	1138
Hip height, in	43.3	45.3	47.2	46.9	49.2	51.6	47.6	50.0	52.4
Calving rate, %	79.0	76.0	67.3	85.0	78.1	70.7	80.8	66.1	68.7
Cycling rate, %	91.2	89.9	80.5	96.4	95.2	90.5	91.6	87.5	86.4

[a] These sizes represent cows of frame sizes of 3.2, 4.2 and 5.1 for the small, medium and large cows, respectively.