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Introduction

Resources used by cow herds for beef production vary greatly. To optimize reproduction and other production characteristics in the cow herd, breeding and management should be matched with the feed resources available for production. One management decision is whether to develop replacement females to calve first as 2-year-olds or as 3-year-olds. When feed resources are limited or expensive relative to other costs and value of output, it may be economical to delay the first calving until 3 years of age. When feed resources are adequate to support rapid growth and development of heifers and thus to reduce age at puberty to 14 months of age or less, then calving at 2 years of age may be optimum. Another management decision is whether or not cows should be culled the first time they are open, or held over for another opportunity to breed (in lieu of keeping an additional replacement heifer). This study was conducted to evaluate effects of 2-year-old *vs* 3-year-old first calf management on longevity and lifetime production of cows and on current economics of beef production.

Procedure

Data on average annual production, cow survival, and cumulative production through 12 years of age were studied on 328 cows produced at the Fort Robinson Beef Cattle Research Station, Crawford, Nebraska, from 1960 through 1963. The cows were F_1 reciprocal crosses and straightbreds among the Hereford, Angus, and Shorthorn breeds. The cows were transferred from Fort Robinson to MARC in 1972, where the experiment was completed in 1975.

The heifers produced in 1960 and 1961 were grown under a management program appropriate for producing their first calves as 3-year-olds. Those produced in 1962 and 1963 were grown under a management program appropriate for producing their calves as 2-year-olds. Heifers from the first two calf crops received 1.0 lb of 40 percent protein supplement per head/day on native range during their first winter, whereas the heifers from the last two calf crops received about 4.5 lb of concentrate feed per head/day in addition to a liberal feeding of hay and access to limited winter range. These management programs were designed to produce gains of about 0.5 lb and 1.0 lb per day, respectively, for the two groups during the 196-day wintering period. Except for level of feeding in their first wintering period and age at which they were first assigned to breeding pastures, all females were managed as one group after they entered the breeding herd.

The cows were run on native range at Fort Robinson or on improved cool-season brome pastures at MARC. During winter months, hay was fed *ad libitum.* Protein requirements were met by either feeding alfalfa hay or a 40 percent protein supplement. The cows were exposed to natural service breeding for about 75 days, commencing in late May or early June each year. Cows were diagnosed for pregnancy in the fall each year.

Results

Average annual production. Results in Figure 1 show that calf crop percentage weaned was low for heifers raising their first calves as 2-year-olds, but, at ages 3 through 12 years, their calf crop percentage was comparable to that of females managed to calve first as 3-year-olds. Results in Table 1 show that, over all ages, pregnancy rates and calf crop percentage at birth, at 72 h, and at weaning, were about the same for females bred first at 1 year of age to calve as 2-year-olds (M1) as for females bred first at 2 years of age to calve as 3-year-olds (M2).

Average 200-day weaning weight per calf and per cow exposed (cow gets credit for weaning wt of a live calf weaned or a credit of zero if no calf weaned) are shown in Figure 2. As expected, weaning weights increased as cows advanced from 2 or 3 years of age to mature ages (5 to 9 yr) and then decreased as cows became older. On the average, 200-day weaning weight per calf and per cow exposed were higher for M2 cows than for M1 cows (Table 1). This difference was due in part to the low weight of calves out of 2-year-old first calf females. If only the 10 calvings from 3 through 12 years of age are considered in both management regimes, production by M1 cows, compared to M2 cows, was lower for weaning weight per calf (434 lb *vs* 449 lb) but was nearly the same for weaning weight per cow exposed (345 lb *vs* 349 lb).

Cow survival. Survival of cows under 2-year-old (M1) and 3-year-old (M2) first calving management programs is shown in Figure 3 under the actual (A) and imposed (I) culling policies. A different trend for survival of M1 and M2 females was observed depending on culling procedure. The interaction favored AM1 over IM1 much more than AM2 over IM2 and suggests that the actual practice (AM1), culling open females as yearlings but allowing them to stay in the herd if open their second breeding season while raising their first calf, increased their probability of surviving in the herd greatly relative to that for the imposed practice of culling females that failed to rebreed while raising their first calves as 2-year-olds (IM1). Also, AM1 females tended to have higher survival rates than AM2 females after 3 years of age, suggesting that culling of females for infertility at a year of age may be more effective at improving fertility at older ages than culling for infertility the first time as 2-year-olds.

The data in Figure 3 show that, under the imposed culling policy, differences in number of breeding seasons, or opportunities to cull for failure to conceive, account for most of the differences between IM1 and IM2 at any given age. For example, after seven breeding seasons in both systems, survival is more nearly the same for IM1 (about 48.5 pct at 7 yr) and IM2 (about 50.5 pct at 8 yr) than at the same age. Differences between IM1 and IM2 are even smaller after 2, 3, 4, 5, 6, 8, or 9 breeding seasons, emphasizing the importance of infertility or conception failures on cow survival under the imposed culling policy.

Cumulative lifetime production. If breeding heifers at 1 year of age to calve first as 2-year-olds (M1) has no adverse consequences on subsequent reproduction and maternal performance, then the M1 system must yield greater lifetime performance than breeding heifers as 2-year-olds, because it will potentially produce an extra calf. Cumulative production of calf weight weaned through 12 years of age is shown in Figure 4 for females first mated as yearlings (M1) or as 2-year-olds (M2) under the A and I culling policies. Reproductive components of cumulative lifetime production are shown in Table 2. Under the actual culling policy to 12 years of age, AM1 experienced 1.2 more breeding seasons, 1.2 more pregnancies, gave birth to 1.1 more calves, weaned .9 more calves, and produced a total of 304 lb more 200-day calf weight than AM2 cows. Under the imposed culling policy, the differences were

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not nearly as favorable for the IM1 over IM2 because of the reduced survival (Figure 3) and longevity of IM1 cows compared to IM2 cows (longevity, 6.9 *vs* 7.8 yr, respectively). Under the imposed system, although females were exposed to breeding a year earlier, by 12 years they experienced only .4 more breeding opportunities, resulting in .3 more pregnancies, .3 more calves born, and .2 more calves weaned. Since these additional calves were raised at relatively young ages (see Fig. 2), cumulative lifetime production of cows up to 12 years of age was slightly less (53 lb, or 2.5 pct) for the IM1 cows than for IM2 cows. This result casts doubt on the advisability of culling females the first time they are open after calving at 2 years of age or older (IM1), provided their fertility was established by pregnancy as a yearling (AM1).

Economics. Income for alternative age at first calving management and culling policies are compared in Table 3, assuming that all cows are sold after weaning their last calves at 12 years of age. Gross income of M2 cows was $997 higher than that for M1 cows under the A culling policy. Under the I culling policy, gross income of M2 cows was $1,461 above that for M1 cows. However, replacements of M2 cows have to be maintained an extra year. When costs of growing replacements is considered (see footnote e, Table 3), adjusted income of M1 cows was $2,161 and $2,018 greater than for M2 cows under the A and I culling policies, respectively. Adjusted income under A and I culling policies was similar. Extra costs of growing more replacements under the I culling policy was compensated for by higher income from salvage value of cows. Current U.S. tax laws favor the I culling policy, since income from sale of cows is considered as a capital gain and taxed at a lower rate than income from sale of calves. These results indicate that managing heifers to calve first as 2-year-olds is more profitable than managing heifers to calve first as 3-year-olds under either culling policy, assuming current differences in feed costs and other resources required to develop heifers to breed first at 1 *vs* 2 years of age.

Table 1.—Average annual lifetime production of cows managed to calve first as 2-year-olds and as 3-year-olds

Item	2-year-old first calving management	3-year-old first calving management
Pregnancy rates, pct[a]	88.1	85.1
Calf crop born, pct[a]	84.1	82.1
Calf survival to 72 h, pct[a]	81.0	80.2
Calf crop weaned, pct[a]	77.7	77.3
Birth weight per calf born, lb	77.2	76.7
200-day wt per calf weaned, lb	429	449
200-day wt per cow exposed, lb	336	349.5

[a]Per cow exposed to breeding.

Table 2.—Cumulative lifetime production up to 12 years of age per female initially assigned to breeding pastures to calve first as 2-year-olds and as 3-year-olds under two culling policies[a]

Item	Actual culling		Imposed culling	
	2-yr-old first calving (AM1)	3-yr-old first calving (AM2)	2-yr-old first calving (IM1)	3-yr-old first calving (IM2)
Number of breeding seasons	8.5	7.3	6.3	5.9
Number of pregnancies	7.4	6.2	5.5	5.2
Number of calves born	6.8	5.7	5.2	4.9
Number of live calves at 72 h	6.6	5.6	5.0	4.8
Number of calves weaned	6.3	5.4	4.8	4.6
Total 200-day weight weaned, lb	2,736.2	2,431.4	2,057.0	2,110.4

[a]*Actual culling policy.* Heifers and cows 10 years old or older diagnosed as not pregnant were culled the first time they were open. After the first breeding season throught 9 years of age, cows failing to conceive in two successive breeding seasons were culled. Cows were also culled for severe unsoundness.

Imposed culling policy. Females were culled the first time they were open regardless of age and for severe unsoundness.

Table 3.—Estimated annual output in herds of 100 cows managed to calve first as 2-year-olds or 3-year-olds under actual and imposed culling policies

Item	Actual culling		Imposed culling	
	2-yr-old first calving (AM1)	3-yr-old first calving (AM2)	2-yr-old first calving (IM1)	3-yr-old first calving (IM2)
No. of replacement heifers[a]	12.36	14.38	16.53	17.47
Gross weaning weight output, lb	33,664	34,932	33,946	36,854
Net weaning weight output[b], lb	29,503	29,909	28,334	30,416
Income from calves[c], $	15,636	15,868	15,016	16,120
Salvage value of cows[d], $	4,111	4,876	5,785	6,142
Gross income, $	19,747	20,744	20,801	22,262
Cost of growing replacement heifers[e], $	3,067	6,225	4,101	7,580
Adjusted income[f], $	16,680	14,519	16,700	14,682

[a]The age distribution of cows was assumed to be at equilibrium with all cows removed at 12 years of age.
[b]Gross output minus weight of proportion of replacement heifers required.
[c]Net output of weight at weaning times value (53 cents per lb, averaged 1972 to 1982, USDA Agricultural Statistics, 1983).
[d]Assuming mean cow weight found in study of 1,124 lb times value (33.69 cents per lb, averaged 1972 to 1982, USDA Agricultural Statistics, 1983).
[e]From budgets estimated by Nebraska Cooperative Extension Service, 1984; a cost from weaning to 14 months of $248.10 per heifer for 2-year-old first calving management and a cost from weaning to 26 months of $433.90 per heifer for 3-year-old first calving management.
[f]Value of output free of differences in replacement costs.

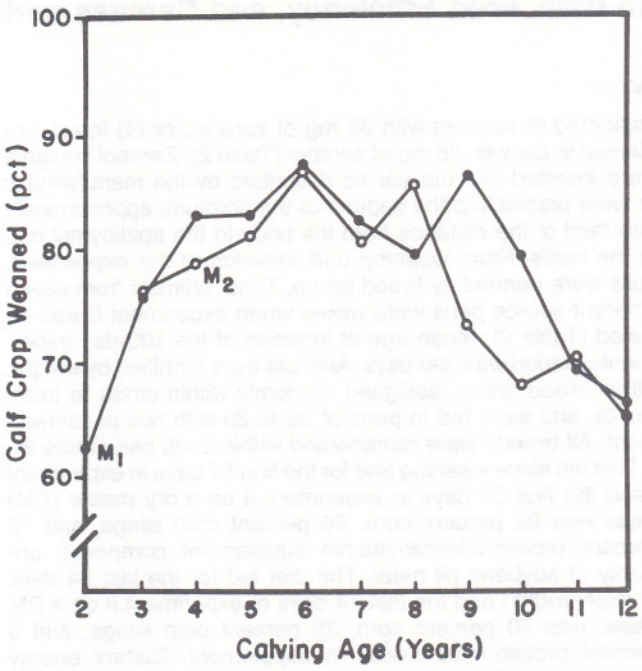

Figure 1—Calf crop weaned per cow exposed to breeding by age for cows first mated as yearlings (M1) or 2-year-olds (M2) under the actual culling policy.

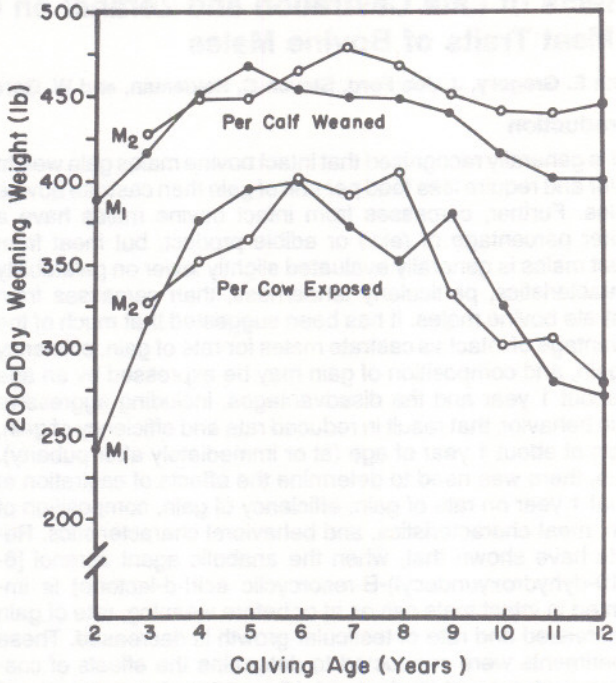

Figure 2—Weaning weight per calf weaned and weaning weight per cow exposed to breeding by age for cows first mated as yearlings (M1) or 2-year-olds (M2) under the actual culling policy.

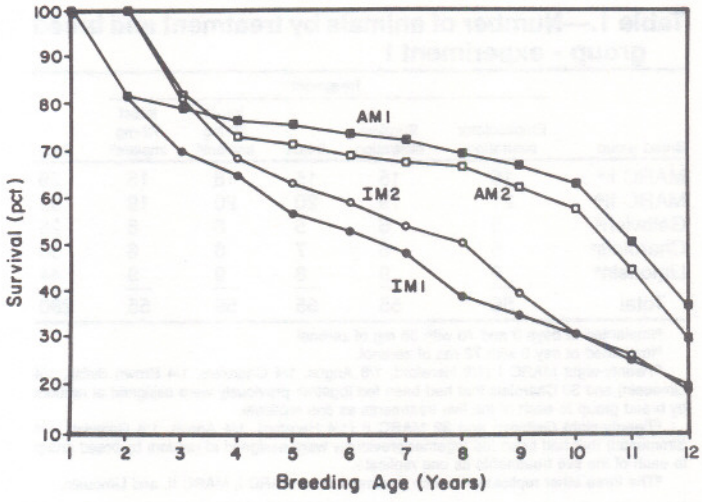

Figure 3—Cumulative survival of cows first mated as yearlings (M1) or as 2-year-olds (M2) under the actual (A) and imposed (I) culling policies.

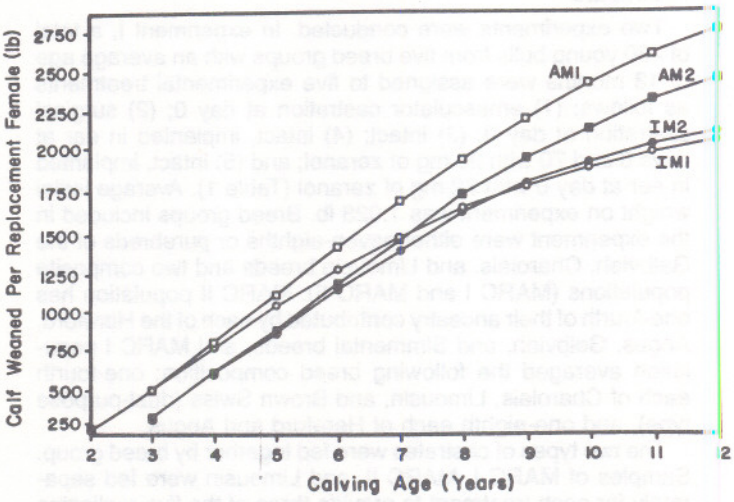

Figure 4—Cumulative productivity of all cows first exposed to breeding either as yearlings (M1) or as 2-year-olds (M2) under the actual (A) and imposed (I) culling policies.