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Summary

A three-year study (2001-2003) was conducted to determine the effect of development system on reproductive performance of first-calf heifers. March-born heifers (n=261) were developed to reach either 55% of mature body weight (MBW) before a 45-day breeding season or 50% of MBW before a 60-day breeding season. Extending the breeding season 15 days for heifers developed to 50% of MBW prior to the first breeding season resulted in equal pregnancy, calving and weaning rates to heifers developed to 55% of MBW. Furthermore, the reduction in development costs in the 50% of MBW system more than offset the reduced income from lower weaning weights caused by later calving dates, resulting in decreased cost to produce one pregnant yearling heifer or 2-year old cow.

Introduction

Pregnancy rates in heifers are dependent upon the number exhibiting estrus early in the breeding season. The study of sexual maturity in a number of species provides evidence for the importance of diet during development or growth and suggests factors other than chronological age can control physiological changes necessary for puberty. Numerous studies indicate post-weaning growth rate is inversely correlated with age at puberty; however, previous work at the Gudmundsen Sandhills Laboratory (*2002 Nebraska Beef Report*, pp. 4-7) reported first- and second-calf conception rates were similar in heifers developed to reach either 55% or 60% of mature weight prior to breeding as yearlings.

Initial selection and management decisions are made at weaning under conditions of risk and uncertainty. Common practice is to select the oldest and heaviest heifers and feed at relatively high planes of nutrition. Although this practice increases the likelihood of heifers reaching puberty before or early in the breeding season, it results in higher feeding and development costs. Feeding lower levels of nutrition should result in lower development costs, but may decrease subsequent reproductive performance. The objectives of this study were: 1) to determine the effects of developing heifers to a pre-breeding target weight of 50% or 55% of MBW, and 2) to determine if extending the breeding season in heifers developed to a lower pre-breeding weight can offset possible reductions in reproductive performance expected in these heifers.

Procedure

Biological Data

Two hundred sixty-one MARC II (1/4 each of Angus, Hereford, Simmental, and Gelbvieh)-Husker Red (3/4 Red Angus, 1/4 Gelbvieh) crossbred heifers (505 lb; n = 88, 90 and 83 head in 2001, 2002 and 2003, respectively) were assigned randomly to one of two heifer development systems: 55% of mature body weight (MBW) before a 45-day breeding season (Intensive, INT; n=119) or 50% of MBW before a 60-day breeding season (Relaxed, RLX; n=142). The INT pre-breeding weight was established from previous research (*2002 Nebraska Beef Report*, pp. 4-7). To assure an adequate number of heifers would remain in the cow herd as 2-year olds, more heifers were developed in the RLX system each year because it was expected there would be a higher cull rate in that system due to a lower first calf conception rate.

At the initiation of the trial each year, heifers were weighed on two consecutive days and stratified to treatments by first day weight and birthdate. Treatments were initiated January 1, 2001, and December 1, 2002 and 2003. Heifers were placed in hay-feeding grounds, by treatment, for the winter feeding period and fed a diet consisting of meadow hay and protein supplement (INT also received whole corn in 2002 and 2003; Table 1). Heifers were weighed monthly and feed amounts adjusted to obtain desired gains.

At the end of the winter feeding period (May 15), all heifers were weighed and body condition score (BCS) was determined. A blood sample was collected from all heifers 10 days apart prior to start of the breeding season to determine cycling status before breeding. To eliminate the possibility of bull effects, all heifers were combined for breeding. Heifers were maintained on native Sandhills upland range for breeding, beginning May 20 of each year. INT heifers were removed from the breeding pasture

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after a 45-day exposure, while RLX heifers remained with the bulls for an additional 15 days. Sixty days after the end of the RLX breeding season (approximately September 10), all heifers were examined for pregnancy via rectal palpation and the number of days pregnant was estimated. All pregnant heifers were combined and maintained on sub-irrigated meadow regrowth during the fall grazing period (September-October). Non-pregnant heifers were sorted at time of palpation and sold.

During the second winter period, all pregnant heifers received 1.5 lb/head/day of supplement and were allowed ad libitum access to meadow hay. Heifer weights and BCS were recorded approximately February 15 of each year, prior to the start of calving. Heifers began calving approximately March 1. Calving date and calf birth weight were recorded within 24 hours of parturition. After calving, heifers were maintained on meadow hay and supplement until May 10, then placed on sub-irrigated meadow. Heifers remained on meadow until June 5 when they were placed on native Sandhills upland range. Two-year-old cows were exposed to bulls for 60 days beginning on June 5 for rebreeding. Calves from the 2-year-old cows were weaned in early September, and cows were examined for pregnancy (second calf) at that time. Calf weaning weights and cow body weights and BCS were also recorded at this time. Calf weaning rates, based on the number of heifers exposed to bulls during breeding and the number of heifers determined pregnant, and cows remaining in the herd as pregnant 2-year olds were then calculated.

Data were analyzed using the mixed model procedures of SAS. Year was treated as a random variable and differences between treatments were determined using Least Significant Differences (LSD), with a protected F-test. All pregnancy and cyclicity data were transformed to the logit scale and analyzed using the mixed model procedure. Initial analysis used overall means for each system; therefore, differences between systems are based on a 45- and 60-day breeding season for INT and RLX, respectively. Estimated breeding date was calculated from the number of days pregnant at pregnancy diagnosis to determine heifers that were pregnant within 30 and 45 days (only RLX means adjusted in the 45-day analysis) from the initiation of the breeding season. Data were then re-analyzed using only heifers pregnant within 30 or 45 days of the initiation of the breeding season to determine the effects of extending the breeding season in the RLX system.

Table 1. Winter feed rations for heifers developed in an intensive (INT; 55% MBW + 45-day breeding season) and relaxed (RLX; 50% MBW + 60-day breeding season) system.

	Feedstuff (lb/head/day)		
Item	Meadow Hay	Protein Suppl.[a]	Corn
RLX			
Year 1	10.8	3.5	—
Year 2	9.0	2.4	1.1
Year 3	9.5	2.9	2.0
INT			
Year 1	13.0	1.3	—
Year 2	11.9	0.7	—
Year 3	11.7	1.3	—

[a]Protein supplement consisted of 51.9% wheat middlings, 20.6% dried distillers grain, 10.0% soybean hulls, 12.8% cull beans and 2.5% cane molasses in year 1; 44.9% wheat middlings, 40% gluten feed, 10% soybean hulls and 2.5% cane molasses in years 2 and 3.

Economic Analysis

Each heifer development system was analyzed for economic feasibility to determine which strategy may be optimal for production of replacement heifers. For the analyses, 10-year average prices for feed and 5-year average prices for cattle were used. Pasture costs were determined from year 2003 values. Supplement costs were an average of the actual costs paid over the three-year period. A labor charge of $10 per ton of feed delivered was charged. Interest (10%) was charged on the entire animal costs and half the feed costs. Cost to produce a pregnant yearling and 2-year old cow were determined using overall, 30- and 45-day means for each system.

Results

Biological Data

Performance results from treatment initiation through second-calf pregnancy diagnosis are reported in Table 2. There was no difference in beginning weight between the two systems and averaged 505 lb for both systems. At pre-breeding, heifers in the INT system were 69 lb heavier ($P < 0.001$) and had a 0.5 unit greater ($P < 0.001$) BCS, due to the difference (0.46 lb/day; $P < 0.001$) in winter ADG. Target pre-breeding weight for both systems was based on an expected MBW of 1200 lb. Therefore, targeted pre-breeding weight was 600 and 660 lb for RLX and INT heifers, respectively. Both systems exceeded their targeted pre-breeding weight, which resulted in RLX heifers averaging 50.9% and INT averaging 56.5% of MBW prior to the initial breeding season.

The percentage of heifers determined to be pubertal before the breeding season (as indicated by serum progesterone level greater than 1ng/ml on at least one of two sample dates) did not differ between the two systems. Fifty-two percent of INT heifers were pubertal prior to initiation of the breeding season, while 33% of RLX heifers

Table 2. Biological and production results from treatment initiation through re-breeding of 2-year-old cows reared in an intensive (INT; 55% MBW) or relaxed (RLX; 50% MBW) heifer development system (overall means).

Item	RLX	INT	SEM	*P*-value
Cow data through 1st calving (3 years)				
No. of heifers	142	119		
Beginning wt.	505	505	6.6	0.99
Winter ADG, lb	0.71	1.17	0.04	<0.001
Pre-breeding wt	610	679	11.0	<0.001
Pre-breeding BCS	5.2	5.7	0.07	<0.001
Percent MBW	50.9	56.5	0.92	<0.001
Pubertal, %[a]	33.4	52.0	10.7	0.35
Pregnancy check wt.	829	864	10.1	<0.001
Pregnancy check BCS	5.6	5.9	0.07	<0.001
Pregnant, %	87.2	89.8	4.1	0.51
No. days pregnant	88	96	1.4	<0.001
Pre-calving wt.	980	1010	18.7	0.02
Pre-calving BCS	5.3	5.3	0.05	0.78
Cow data from 1st calving through 2nd calf pregnancy diagnosis (2 years)				
Pregnancy check wt.	903	926	9.3	0.11
Pregnancy check BCS	5.0	5.0	0.08	0.81
Pregnancy, %	90.5	92.2	3.2	0.70
Bred 2-year-old cows in herd, %	74.8	72.5	6.4	0.82
Calf performance				
3 years data				
Calf birth date	Mar 15	Mar 9	2.4	<0.001
Calf birth weight	75	75	0.9	0.61
Calving difficulty, %	32.0	26.9	4.9	0.46
Calving rate, per HE[b]	85.3	87.4	3.3	0.68
Calving rate, per PH[c]	95.6	98.6	1.1	0.15
2 years data				
Calf weaning wt.	190	197	2.7	0.04
Weight/day of age at weaning	2.40	2.38	0.07	0.38
Weaning rate, per HE[b]	80.8	77.6	6.7	0.67
Weaning rate, per PH[c]	90.7	87.7	6.4	0.47

[a]Percentage of heifers determined to have reached puberty (determined by a circulating serum progesterone level > 1ng/ml^{-1}) prior to the beginning of the initial breeding season.
[b]Percentage based on number of heifers exposed to bulls for breeding.
[c]Percentage based on number of heifers determined pregnant via rectal palpation 60 days following breeding.

were determined to have commenced estrous cycles by this same point. Weight at the time of pregnancy determination was greater ($P < 0.001$) for INT heifers; however, the difference was less than half of that seen at the initiation of the breeding season (69 vs. 35 lb difference between systems at the beginning of breeding and at pregnancy determination, respectively). This indicates that the heifers in the RLX system were able to partially compensate for weight differences created by the development system. A similar pattern was observed in BCS, with RLX heifers gaining more condition throughout the summer than INT heifers but the compensation was not sufficient to overcome existing differences. Therefore, RLX still maintained a lower average BCS ($P < 0.001$) than INT heifers at time of pregnancy diagnosis. Pregnancy rate following the initial breeding season was not different between the two systems and averaged 88.5% for both.

Weight change during the second wintering period (October-February) did not differ between systems, with heifers from both gaining an average of 152 lb. Therefore, weight differences created by the previous winter development protocol still existed before calving. The body weight difference at pre-calving (29 lb) was similar to that at the time of pregnancy determination. Body condition score change during the second winter did differ ($P = 0.002$) between systems, with INT heifers losing 0.5 units while the RLX lost only 0.2 units of condition score. This resulted in BCS at pre-calving to be similar ($P = 0.78$) between systems.

Average calving date did differ ($P < 0.001$) between systems, with INT calving approximately six days earlier than RLX heifers. This resulted primarily from the 15-day extended breeding season used in the RLX system. Calf birth weights were not different between systems. In conjunction, incidence of dystocia also did not differ between systems, with 32.0% and 26.9% of RLX and INT heifers requiring assistance at calving, respectively. The percentage of heifers that calved did not differ between systems when based on the number of heifers exposed to bulls during the initial breeding season; however, it did tend to differ ($P = 0.15$) when based on the number of heifers determined to be pregnant after the initial breeding season.

Calf weaning weights were different ($P = 0.04$) between systems with INT being heavier at weaning; however, when expressed as weight per day of age, no difference between systems exist. Weaning rates were also not different when expressed either on a per heifer exposed or per pregnant heifer basis. Cow body weights still tended ($P = 0.11$) to differ at calf weaning and second-calf pregnancy determination, with a 23 lb difference still evident at that time. Cow BCS, however, was similar between systems at weaning and pregnancy determination. Second-calf pregnancy rates were not different between systems and averaged 90.5% and 92.2% for RLX and INT systems, respectively. Additionally, the percentage of cows remaining in the herd as 3-year olds (bred 2-year olds) was similar, between systems averaging 74.8% and 72.5% for the RLX and INT systems, respectively.

Analysis of pregnancy and calving data using only heifers bred within 30 or 45 days of the start of the breeding season reveals the

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impact of extending the breeding season in the RLX system. First-calf pregnancy rate after 30 days from the initiation of the breeding season tend to differ ($P = 0.06$) between systems, with INT heifers having a 15.7% increase over RLX heifers at that point. By 45 days, the difference is reduced to 9.3%, which is no longer statistically significant. During the extended 15-day breeding period (from 45 to 60 days) for the RLX heifers, an additional 6.7% of heifers became pregnant. This caused the overall pregnancy rates between the two systems not to differ, with the RLX and INT systems averaging 87.2% and 89.8%, respectively. Second-calf conception rates did not differ at 30 or 45 days, nor did the overall means differ.

Average calving date remained different in the 30- ($P < 0.001$) and 45-day ($P < 0.001$) analyses, although the difference in the 30-day (4 days) and 45-day (3 days) analyses are numerically less than the difference in the overall means (6 days). Calf birth weight means and differences do not change across analyses. Weaning weight differences did vary across analyses, however. Weaning weights are not different in the 30-day analysis ($P = 0.42$) but tend to differ in the 45-day analysis ($P = 0.18$), while differences between the overall means is significant ($P = 0.04$). Calving rates, when expressed on a per heifer exposed basis, tend to differ (14.2% difference between systems; $P = 0.19$) in the 30-day analysis, a result of the lower first-calf pregnancy rate between the two systems at 30 days. By 45 days, the trend diminishes and calving rate at 45 days and overall are not different. Calving rate, expressed on a per pregnant heifer basis, tends to be different at 30 ($P = 0.15$) and 45 days ($P = 0.17$). Weaning rate does not differ between systems across all analyses, and is not affected by calculation method. Lastly, percent of heifers remaining in the herd as pregnant two-year old cows does not differ in any of the analyses; however, the RLX system does improve from a 8.3% deficit in the 30-day analysis to a 2.3% increase over the INT system in the overall analysis.

Table 3. Total and net costs within each of the first two production years for cows developed in an intensive (INT; 55% MBW) or relaxed (RLX; 50% MBW) heifer development system that were bred in either 30, 45 or 60 (RLX only) days of the initial breeding season.

	RLX			INT	
Item	30 day	45 day	60 day	30 day	45 day
1st year cost					
Total development cost	$ 659	$ 659	$ 659	$ 683	$ 683
Net cost per bred yearling heifer	$ 709	$ 703	$ 695	$ 727	$ 720
2nd year cost					
Total 2-year cost	$1039	$1031	$1022	$1062	$1055
Net cost per bred 2-year old cow	$ 700	$ 693	$ 693	$ 725	$ 714

Economic Analysis

Results from the economic analysis using 30-day, 45-day, and overall means for each system are summarized in Table 3. Net cost to produce one bred yearling heifer decreased $6.00 in the RLX by extending the breeding season from 30 to 45 days, with an additional $8.00 savings by extending the season to 60 days. These savings are still evident after the second breeding season, with a reduction in $7.00 for the first 15-day extension; however, due to differences in weaning weights between the 45- and 60-day analysis in the RLX system, the cost to produce one bred 2-year-old remained the same when extending the breeding season from 45 to 60 days. Similar trends occurred in the INT system, with a $7.00 per bred yearling heifer and an $11.00 per bred 2-year-old cow savings by extending breeding from 30 to 45 days.

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