2009

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Proceedings, Western Section, American Society of Animal Science

Vol. 60, 2008

IMPLICATIONS OF GOING AGAINST THE DOGMA OF FEED THEM TO BREED THEM[1]

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ABSTRACT: Effects of providing differing levels of harvested feed during postweaning development and subsequent winters on reproduction, BW, BCS, and calf BW were evaluated in heifers produced over a 7-yr period from dams fed levels of harvested feed from Dec to March that were expected to be marginal (MARG) or adequate (ADEQ), based on average quality and availability of winter forage. Heifers were either fed to appetite (CON) or restricted fed at 80 % of that consumed by CON on common BW basis (REST) for 140-d period from about 2 mo after weaning to 1 mo before breeding. Heifers were managed together through breeding until Dec when they were separated so CON could be fed adequate harvested feed and REST could be fed marginal levels of harvested feed until 2 to 3 wk before start of calving in March. Cows remained in their treatment through subsequent winters until removed for failure to reproduce or wean a calf. Percent of heifers becoming pregnant and remaining at start of 2nd breeding season was not influenced by dam or heifer treatments ($P > 0.23$; total df = 631). Retention to start of 3rd breeding was less ($P = 0.01$) in REST (58 %) than CON (69 %). Interaction of dam and cow treatments ($P < 0.07$) influenced retention to 4th and 5th breeding. Retention to 4th breeding was less ($P < 0.1$) for REST cows from ADEQ dams (46 %) than the other dam by cow treatment groups (57 to 62 %). Retention to 5th breeding was less for REST cows from ADEQ dams (39 %; $P < 0.01$) than REST cows from MARG dams (66 %); with CON cows from MARG (50%) or ADEQ dams (51 %) being intermediate. Weight and BCS at start of each breeding was 10 kg and 0.10 BCS less ($P < 0.01$) for REST than CON cows. At start of 3rd, 4th and 5th breeding, cows from MARG dams were 15 to 24 kg heavier ($P < 0.01$) than cows from ADEQ dams. Calves from REST cows and MARG granddams were lighter ($P < 0.01$) at birth and weaning by 1.0 and 6.9 kg, respectively, than calves from the other groups (interaction $P < 0.06$). Productivity of cows managed on 2 levels of harvested feed inputs was influenced by the level of harvested feed provided to their dams; greatest feed input did not maximize long term retention.

Key Words: Heifer development, Pregnancy, Retention

Introduction

Feed resources consumed by the cowherd are a major cost associated with beef cattle production. This is especially true for rangeland-based production settings were harvested feed is provided to supplement developing heifers and pregnant cows through periods when quality and quantity of rangeland forage may be limiting. An abundance of research concerning the influences of nutrition on heifer development and cow reproductive performance has resulted in guidelines on body conditions that reflect a nutrient status that will optimize reproductive performance (R. D Randel 1990; Dunn and Moss, 1992; Wettemann et al., 2003). However, a major limitation of the research is a focus on short term effects (single production year) without consideration of long-term implications. There is little doubt that providing cows with sufficient feed can maximize the probability of successful reproduction. However, this may not result in maximum biological and economical efficiency. Providing adequate feed to maximize reproductive rate does not result in differential retention between females with high and low feed requirements that remain in the cow-herd. For example, cows with high feed requirement would more likely be culled for reproductive failure when managed under reduced feed inputs. Likewise, increasing the proportion of cows with reduced feed requirements may provide producers a margin of safety at times when feed resources are scarce or costly. In addition to reducing cost of development, rearing animals under caloric restriction may prolong lifespan, as has been shown in other species (reviewed in Speakman and Hambly, 2007), and as has been suggested for cattle (Hughes et al., 1978).

The present research is a portion of a long-term project to evaluate the influence of 2 levels of nutritional input during heifer development and winter supplementation on lifetime productivity. Objectives of this research were to evaluate the impact of the 2 levels of nutritional input on reproductive performance, BW, BCS, and BW of calves at birth and weaning in females produced over the first 7-yr of the study.

Materials and Methods

All research protocols used in this study were approved by our institutional Animal Care and Use Committee. Cows used in this study were a stable composite population (**CGC**; ½ Red Angus, ¼ Charolais, ¼ Tarentaise). Females studied represent a randomly selected population produced over a 7-yr period (2002 through 2008) by mating CGC dams and sires (n = 62) with consideration given to minimize inbreeding, but without emphasis on production traits. Beginning in the fall of 2001, all cows in this herd were randomly assigned to be fed levels of harvested feed from Dec to March of each year that were expected to be marginal (MARG) or adequate (ADEQ),

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based on average quality and availability of winter forage. Each group of cows was managed on separate pastures during the winter to allow differential feeding. For the majority of the winters in this study, pasture forage was readily available for grazing and the only additional harvested feed provided was alfalfa cake or hay, depending on year, as a supplemental source of protein. This supplement was fed either daily or every other day to achieve an average of about 1.8 kg/d for each ADEQ cow and an average of about 1 kg/d for each MARG cow. During days when access to pasture forage was limited due to snow covering, cows were fed at a rate equivalent to 10.9 or 9.1 kg alfalfa hay/d for each cow in the ADEQ or MARG treatments, respectively.

Each year at weaning, heifer calves were stratified into groups based on weaning weight and were randomly assigned to 1 of 4 (Yr 1) or 1 of 22 to 24 pens (subsequent years). In Yr 1, heifers were group fed with 26 or 27 heifers/pen. Heifers in Yr 2 through 7 were individually fed in pens that contained 6 individual feed bunks equipped with electronic Calan gates (American Calan, Northwood, NH). Heifers were allowed a minimum of 1 mo for adaptation to experimental pens (all years) and to become trained to the head gates (Yr 2 to 7). During this time, heifers were allowed ad libitum access to the test diet fed (described below) once daily. In Yr 1, pens were randomly assigned to receive either control (n=2) or restricted (n=2) level of feeding. In Yr 2 to 7, heifers were randomly assigned within pens to either a control or restricted level of feeding for a 140-d trial. Feed restriction was initiated when heifers were approximately 8 mo of age and 227 $\pm$ 21 kg BW. Control heifers (CON) were fed to appetite and restricted heifers (REST) were fed at 80 % of that consumed by controls adjusted to a common BW basis, as determined at 4-wk intervals using the following formula: [0.80 x (mean BW of restricted/mean BW control) x mean daily feed intake (as fed basis) of controls over the 28-d period]. Total numbers of heifers in each treatment by dam treatment classification for Yr 1 through 6 are shown in Table 1. For calves born in Yr 7, (2008), data are currently limited to BW at birth and weaning.

Composition of the diet fed during the postweaning period is shown in Table 2. Weight of feed offered was recorded daily. Orts were removed from the feed bunk and weight recorded as necessary to ensure that fresh feed was provided for each heifer on a daily basis.

At the end of the 140-d trial, heifers were combined and managed together through breeding and subsequent grazing season. At approximately 14 mo of age (30 to 40 d after end of restriction), heifers from Yr 1 to 4 were weighed and subjected to an estrous synchronization protocol to facilitate breeding by AI followed by natural mating for the remaining duration of a 48- to 53-d breeding season . In Yr 5 and 6, heifers were subjected to a 62-d breeding season with natural mating only. In late Nov to early Dec of each year, pregnant heifers were separated back into their treatment groups to allow for provision of harvested feed at the same levels as described above for the cows; where CON heifers were fed what was expected to be adequate level harvested feed and REST heifers were fed a marginal level of harvested feed. These winter feeding treatments continued until 2 to 3 wk before start of calving in March, when heifers were recombined and managed together. Females remained in their treatment through subsequent winters until removed for failure to reproduce or wean a calf. Percent of heifers becoming pregnant and remaining in the herd at start of each breeding season was recorded. Birth weight and weaning weight were measured on calves produced by females on the different treatments.

Data were analyzed with the GLM procedure of SAS (SAS Inst. Inc., Cary, NC). Influence of treatment and dam treatment on reproduction, BW, BCS, and BW of calf at birth and weaning were analyzed using a model that included year of birth, treatment, dam treatment and the interaction of these fixed effects. Least square means and SE are presented, unless specified otherwise.

Results and Discussion

Feed intake and growth characteristics of heifers developed on the two levels of feeding have been reported previously for Yr 2, 3 and 4 (Roberts et al., 2007). As was reported for these 3 years, restricted fed heifers consumed 27% less feed over the 140-d trial resulting in a 26 kg lighter ($P <$ 0.001) BW at the end of the trial. Differences in BW of restricted and control fed heifers persisted ($P < 0.01$) throughout the pre-breeding period (316 vs. 338 $\pm$ 2 kg at approximately 13.5 mo of age) and subsequent grazing season (404 vs. 414 $\pm$ 2 kg at about 19.5 mo of age). Although ADG was reduced during feed restriction, ADG from end of the 140-d trial to 19.5 mo of age was greater ($P < 0.01$) in restricted heifers than control heifers (0.49 vs. 0.42 $\pm$ 0.005 kg/d), indicative of a compensatory response. Weight (Figure 1) and BCS at start of breeding at 2 to 5 yr of age, was 10 kg and 0.10 BCS less ($P <$ 0.01) for REST than CON cows. Thus, the REST protocol used in this study resulted in lighter BW of cows throughout 5 yr of age. This appears to be due, at least in part, to lower BCS. At 3, 4 and 5 yr of age, cows from MARG dams were 15 to 24 kg heavier ($P < 0.01$) than cows from ADEQ dams (Figure 1). These data indicate that BW of a cow may be influenced by level of winter supplemental feed provided to its dam.

Retention of females out to the 5th year of breeding is depicted in Figure 2. Percent of heifers becoming pregnant in their first breeding season (Yr 1 Figure 2) and proportion remaining in the herd at start of 2nd breeding season (Yr 2 in Figure 2) was not influenced by dam or heifer treatments (P of model > 0.23). Retention to start of 3rd breeding was less ($P =$ 0.01) in REST (58 %) than CON (69 %) cows. Interaction of dam and cow treatments ($P < 0.07$) influenced retention to 4th and 5th breeding. Retention to 4th breeding was less ($P < 0.1$) for REST cows from ADEQ dams (46 %) than the other dam by cow treatment groups (57 to 62 %). Retention to 5th breeding was less for REST cows from ADEQ dams (39 %; $P < 0.01$) than REST cows from MARG dams (66 %); with CON cows from MARG (50%) or ADEQ dams (51 %) being intermediate. While not statistically different until Yr 3, the numeric trend for Yr 1 and 2 is for the REST cows to have fewer retained, which is most obvious in cows from ADEQ dams (solid black vs. solid gray bars in Figure 2). It is expected that these experimental treatments would be most similar to experimental conditions evaluated in previous research, where level of nutrition of dam has not generally been considered, but most likely was managed

for optimal production. In this respect, the comparison of CON cows from ADEQ dams to REST cows from ADEQ dams fits the results expected based on previous research concerning nutritional effects on reproduction. Furthermore, results indicate that the negative effects appear to be cumulative over the 5 breeding seasons. However, a novel observation of the present research is the apparent influence of the dam's level of nutrition on its offspring's response to nutritional treatment. While number of cows that are old enough to have observations for retention out to 4 and 5 breeding seasons may be somewhat limited, the data indicate that managing cows on what was expected to be marginal levels of nutrition, improved the ability of their offspring to sustain reproductive performance when they were managed with marginal levels of harvested feed inputs.

Calves from REST cows and MARG granddams were lighter ($P < 0.01$) at birth and weaning by 1.0 and 6.9 kg, respectively, than calves from the other groups (interaction $P < 0.06$; Table 3). As with retention, these results provide evidence that a cow's response to different levels of nutrition may be altered by the nutritional treatments imposed on it's dam. The basis for the small decrease in BW at birth and weaning for calves from REST cows and MARG granddams remains to be determined. However, it is interesting to speculate that this small decrease in output may be contributing to the increased rates of retention out at 5th breeding. While additional data concerning long term retention are needed, current trends indicate that the small decrease in calf output may be more than compensated by increased longevity.

Implications

Productivity of cows managed on 2 levels of harvested feed inputs was influenced by the level of harvested feed provided to their dams; greatest feed input did not maximize long term retention. Thus, feeding to maximize short term reproductive performance or any other trait may not equate to the greatest production efficiency in the long term. In this respect, greater efficiency is probably achieved by matching the genetics to the environment rather than altering the management (increase feed inputs) to support changes resulting from genetic selection. This research also provides evidence that nutritional influences on replacement heifers may begin in utero, or earlier, and continue throughout life. Maintaining cows under a marginal nutritional environment through the winter and developing their heifers on lower levels of nutrient input may improve efficiency and enhance longevity.

Literature Cited

Dunn, T. G. and G. E. Moss. 1992. Effects of nutrient deficiencies and excesses on reproductive efficiency of livestock. J. Anim. Sci. 70: 1580-1593.

Hughes, J.H., D.F. Stephens, K.S. Lusby, L.S. Pope, J.V. Whiteman, L.J. Smithson, and R. Totusek. 1978. Long-term effects of winter supplement on the productivity of range cows. J. Anim. Sci. 47:816-827.

Randel, R. D. 1990. Nutrition and postpartum rebreeding in cattle. J. Anim. Sci. 68:853-862.

Roberts, A. J., S. I. Paisley, T. W. Geary, E. E. Grings, R. C. Waterman, and M. D. MacNeil. 2007. Effects of restricted feeding of beef heifers during the postweaning period on growth, efficiency and ultrasound carcass characteristics. J. Anim Sci 85: 2740-2745.

Speakman, J. R. and C. Hambly. 2007. Starving for life: What animal studies can and cannot tell us about the use of caloric restriction to prolong human lifespan. J. Nutr. 137:1078-1086.

Wettemann, R. P., C. A. Lents, N. H. Ciccioli, F. J. White, and I. Rubio. 2003. Nutritional- and suckling-mediated anovulation in beef cows. J. Anim. Sci. 81(E. Suppl. 2):E48-E59.

Table 1. Year of birth (YOB) and number of control and restricted fed heifers from dams that were provided adequate (ADEQ) or marginal (MARG) levels of harvested feed throughout the winter

		Control		Restricted	
Yr	YOB	ADEQ	MARG	ADEQ	MARG
1	2002	21	31	30	23
2	2003	31	32	34	28
3	2004	43	43	44	38
4	2005	39	30	35	31
5	2006	36	37	38	33
6	2007	36	31	34	34
All		206	204	215	187

Table 2. Composition (%, DM basis) of diets fed during the 140-d feeding period for Yr 1 and range of composition for Yr 2 to 7

	Yr 1	Yr 2 to Yr 7
Corn silage	52	67 to 68
Alfalfa	38	17 to 18
Supplement[1]	10	15
DM	47.5	36 to 37
CP	13.3	15 to 18

[1]Containing protein and mineral.

Table 3. Influence of level of nutrition provided to granddam and dam on BW of calves at birth and weaning[1]

Granddam treatment	Dam treatment	BW at birth, kg	BW at wean, kg
ADEQ	CON	35.0	203.6
ADEQ	REST	35.0	202.3
MARG	CON	35.0	201.4
MARG	REST	33.6[2]	196.4[2]

[1]See figure legends for description of nutritional treatments.
[2] Differs ($P < 0.01$) from other groups.

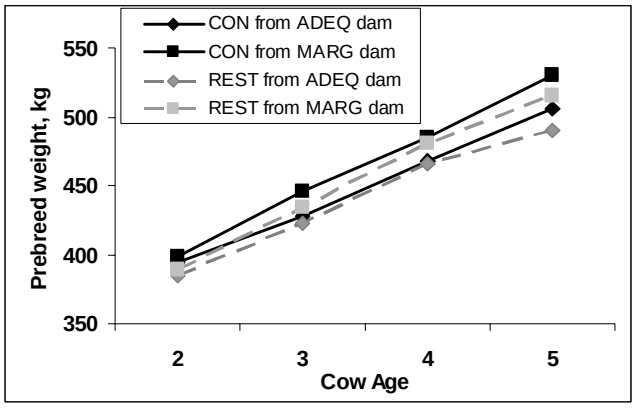

Figure 1. Effect of level of feed inputs provided during postweaning development and annual winter supplementation and by level of winter feed inputs provided to dams on BW of cows prior to breeding at 2 to 5 yr of age classified by. Cows developed with ad lib access to feed and provided adequate winter harvested feed inputs (CON, black lines) were heavier ($P = 0.01$) than cows developed with restricted feed intake and provided marginal levels of harvested feed in the winter (REST; grey lines). At 3, 4 and 5 yr of age, cows from dams provided marginal levels of harvested feed in the winter (MARG, square symbols) were heavier ($P < 0.01$) than cows from dams provided adequate levels of harvested feed during the winter (ADEQ, diamond symbols).

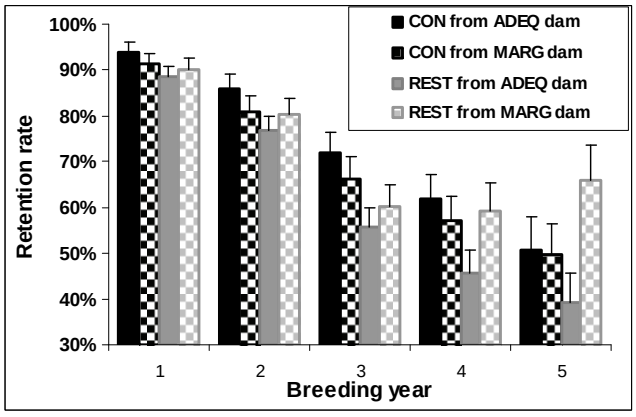

Figure 2. Retention of cows classified by level of feed inputs provided during postweaning development and annual winter harvested feed inputs and by level of winter feed inputs provided to their dams. Heifer calves born to dams that had been fed levels of harvested feed from Dec to March of each year that were expected to be marginal (MARG, depicted by square symbols in bars) or adequate (ADEQ, depicted by solid bars) were randomly assigned to be fed ad libitum (CON, black bars) or restricted (REST; gray bars) access to feed during a 140-d trial after weaning, and then were subsequently fed adequate or marginal of harvested feed from Dec to March of each year. Number of animals represented for each breeding year is dependant on number years elapsed since year of birth, and thus numbers evaluated decline each year (n = 776, 632, 505, 385 and 226 for Yr 1 though 5, respectively) accounting for the disconnect between breeding years. Values shown for Yr 1 are heifer pregnancy rates. Values for Yr 2 through 5 are proportion remaining at beginning of 2nd through 5th breeding season. Retention did not differ among groups in Yr 1 or 2, but was greater in CON (black) than REST (gray) cows at Yr 3 ($P = 0.01$). Treatment by dam treatment interactions were evident for Yr 4 and 5 ($P = 0.07$ and 0.04, respectively). In Yr 4, retention was less for REST cows from ADEQ dams than other groups ($P < 0.1$). In Yr 5, retention of REST cows from ADEQ dams ($P = 0.005$) and CON cows from MARG dams ($P = 0.09$) was less than for REST cows from MARG dams.