EFFECTS OF DAM AGE, PREPARTUM NUTRITION AND DURATION OF LABOR ON PRODUCTIVITY AND POSTPARTUM REPRODUCTION IN BEEF FEMALES

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Summary

Sixty-two, 2-yr-old heifers and 65 cows, 4 to 7 yr old, were assigned randomly at 60 d before the median predicted calving date to a factorially designed study. Main effects were: age of dam (heifer or cow), moderate (M) or high (H) precalving feed level (110 or 135% of National Research Council recommendation) and short (S) or prolonged (P) duration of Stage II of parturition. After calving, all dams were placed in the same range pastures and received supplemental hay and a grain-salt mix until adequate range forage was available to produce weight gains in the lactating dams. Dams were bred in a 45-d artificial insemination period. Calving difficulty scores and duration of labor (Stage II) were greater (both P<.01) in heifers than in cows; calf birth weight (P<.01), calf vigor at birth (P<.05) and calf gains birth to weaning (P<.01) were higher in cows. Effect of gestation feed level on precalving, calving and postpartum data were nonsignificant. Eighty-two percent of the S females were given obstetrical assistance and 15% of the P females required assistance at parturition (P<.01). More S dams exhibited estrus by the beginning of the breeding season than P dams (91.4 vs 81.7%, P<.10), and October pregnancy of S dams was higher than P dams (89.5 vs 75.6%, P<.05). Interaction effects of dam x duration of Stage II were not significant, but short duration of labor had beneficial effects on postpartum reproduction in both dam age groups. Results of this study indicate prolonged labor may result in depressed subsequent reproduction in beef dams.

(Key Words: Dam Age, Gestation Diet, Labor Duration, Dystocia, Postpartum Reproduction, Beef Cattle.)

Introduction

Calf losses at or shortly after birth result in a major depression in the net calf crop of beef cattle (Bellows et al., 1979a). Up to 70% of these losses result from dystocia and over 50% of these losses could be prevented by giving timely obstetrical assistance to affected dams (Patterson, 1979). Depressed postpartum reproductive performance in dams that experienced dystocia has been reported (Brinks et al., 1973; Laster et al., 1973). However, little information is available as to how dystocia depresses subsequent reproduction or how these effects might be affected or altered by obstetrical intervention and manual assistance during parturition.

This study was conducted to determine the effects of duration of Stage II of labor on postpartum reproduction in heifers and cows that received moderate or high feed levels before parturition.

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Materials and Methods

The study involved 127 crossbred (varying percentages of Hereford, Angus and Charolais breeding) beef females. Sixty-two were 2-yr-old, first-calf heifers and 65 were cows ranging in age from 4 to 7 yr. All females had been assigned randomly for breeding to one of three sires by artificial insemination (AI) in a 45-d breeding season.

Sixty days before the median predicted calving date, pregnant dams were assigned randomly within age, breeding and calf-sire group to a 2 x 2 factorially designed study. Main effects studied were: moderate (M) or high (H) precalving feed level, short (S) or prolonged (P) duration of Stage II of parturition and age-of-dam grouping (2-yr-old heifers or cows).

All dams received 3 million IU of injectable vitamin A at the 60-d precalving assignment and were separated by age group and held in feedlots throughout the precalving and calving periods. Animals were group fed, and the M and H precalving diets supplied a calculated 110 and 135% of the NRC (1976) total digestible nutrients (TDN) requirements. The diet consisted of 80% mixed grass-alfalfa haylage (IFN 3-00-266) and 20% corn silage (IFN 3-02-820). Average values of proximate analyses of periodic feed samples obtained throughout the study were: dry matter, 34.6%; ash, 9.1%; ether extract, 4.6%; crude protein, 14.2%; crude fiber, 28.6%; nitrogen-free extract, 43.3%.

Females on the H diet were fed to gain .8 kg daily, which was estimated to result in a gain approximately equivalent to the weight of the term conceptus. Females on the M diet received 80% of that amount. Feed levels were adjusted at 2- to 3-wk intervals throughout the precalving period to produce the desired weight changes.

A mineral mix containing 49% iodized salt, 49% dicalcium phosphate (IFN 6-01-080), 2% trace minerals and sufficient wheat bran (IFN 4-08-008) to prevent hardening of the mixture was fed free choice throughout the entire study.

Body weights and condition scores of all females were determined periodically throughout the study. Initial data were obtained on January 22 and precalving data on February 26. Preacting pelvic measurements were determined as described by Bellows et al. (1971a). Condition scores were determined by the method described by Bellows et al. (1982). Dams that had not calved by March 31 were weighed, scored and measured to obtain data closer to the actual calving date. The postcalving weights and condition scores of the dam were obtained within 12 h after calving, at the beginning and end of the breeding season (June 15 and July 30, respectively) and at weaning (October 6) when the study was terminated.

All females in the S and P groups were observed at intervals ranging from 15 to 30 min, 24 h daily throughout the calving season, and parturition stage (I, II or III as described by Roberts, 1971) was determined for each dam. Dams determined to be in Stage I were watched more closely to determine the start of Stage II, defined as start of the abdominal press (labor). Dams assigned to the P group were allowed to remain in labor until the calf was born or until it appeared to an experienced herdsman that a live calf could not be born without obstetrical assistance. The length of Stage II (from the first observed abdominal press until the calf was born) was determined and recorded in minutes as the duration of labor for dams assigned to the P group.

Dams assigned to the S group were allowed to progress normally through Stage I and into the early phase of Stage II to assure complete cervical dilation. For assisted S dams, full cervical dilation was assumed when fetal membranes and(or) feet were observed protruding from the vulva of the dam. The dam was then taken to an obstetrical stall and the calf was delivered with obstetrical assistance regardless of real or potential dystocia. The objective was to create a difference in duration of labor between dams in the P and S groups. Deliveries were assisted with hand pull and obstetrical chains or with the aid of a mechanical calf puller when necessary. Obstetrical procedures were routine and were performed by trained, experienced herdsmen.

Deliveries for dams in both P and S groups were scored from 1 to 4, depending on the amount of traction required to extract the fetus (Bellows et al., 1971b). Abnormal presentations (three calvings) were scored 5 and were eliminated from the study.

Calves were identified with ear tags and the navel treated with 7% iodine solution immediately after birth. Each calf was given a vigor score within 1 h after delivery as follows: 1—normal, 2—weak, and 3—dead or died within 1 h after birth. Calf birth weights were obtained within 12 h after birth. All calves were dehorned with caustic paste and male calves were castrated.
with elastrator bands at this time. If both the
dam and calf exhibited normal postpartum
vigor and health, they were moved to a crested
wheatgrass (Agropyron cristatum) pasture
within 24 h after parturition.

All dam-calf pairs were pastured together
during the postpartum, breeding and post-
breeding periods. Good quality alfalfa hay (IFN
1-08-059) and a grain-salt mix were fed free
choice during the early postpartum period. The
grain-salt mix consisted of 20.0% wheat bran
(1F1N 4-08-008), 2.0% dicalcium phosphate
(IFN 6-01-080) and .5% trace minerals. The
remainder consisted of ground barley (IFN
4-08-343) and iodized salt. Barley percentage
ranged from 57.5 to 65.5% and salt percentage
ranged from 12.0 to 20.0%. Salt content was
varied to regulate consumption and daily
consumption averaged .96 kg/head. Supple-
mental feeding of hay and grain was terminated
on May 1 when sufficient forage was available
to produce weight gains in the lactating dams.

The postpartum interval was defined as the
time in days from parturition to first estrus.
Postpartum estrus was detected daily by use of
sterile bulls with marking harnesses and by
visual observation. The sterile bulls were with
the females from calving until the beginning of
the breeding season. Any dam that had not
previously been recorded as exhibiting estrus
during the postpartum-prebreeding period was
palpated rectally to determine ovarian activity.
If a corpus luteum was palpated, an estimated
estrous date was assigned based on palpable
consistency of the luteal tissue. Estrous dates
were assigned in this manner to five heifers
(three from the S and two from the P groups),
and the data were used in the statistical analy-
ses of postpartum reproductive measures.

The breeding season started on June 15 and
continued for 45 d. Dams were assigned ran-
domly within experimental subgroup to breeding
by AI to one of three Angus sires. Estrus was
detected visually during the daylight hours
throughout the breeding season. Females in
estrus between 2200 and 1000 h were bred that
evening at 1800 h. Females in estrus between
1000 and 2200 h were bred at 0600 h the
following morning. These breeding times
resulted in females being bred approximately 8
to 20 h after being detected in estrus. Females
received 3-s manual clitoral massage after
completion of insemination (Short et al.,
1979).

Body weight of dams and calves and con-
dition scores of the dams were obtained at the
end of the breeding season and again at weaning
on October 6 when the study was terminated.
Pregnancy status of all dams was determined by
rectal palpation on October 6.

Data were analyzed using least-squares
analysis of variance for unequal subclass num-
bers (Harvey, 1960). A preliminary analysis was
conducted to determine effects of sire of calf
and assistance or no assistance within the S or
P groups. These effects and interactions were
nonsignificant and data were pooled over these
variables for all subsequent analyses and pre-
sentation of data. The independent variables in
the final analyses included age of dam, labor-
duration group, precalving feed level, sex of calf
and the two-factor interactions. All two-way
interactions were calculated and tested for
significance. Higher order interactions were
considered random error and were included in
the error term. The dependent variables were
postpartum interval, percentage in estrus by
June 15, services/conception and percentage
pregnant in October from the 45-d breeding
season. Reproduction data were also analyzed
using date calved as a covariate to adjust for
differences in calving date.

Results

Means for all precalving data are shown in
table 1. Cows were heavier (P<.01) than heifers
at the beginning of the study and before calving
and also had larger pelvic dimensions (P<.01).
The precalving pelvic area of the cows averaged
80.6 cm² greater than heifers (P<.01). Initial
body condition scores for heifers were higher
(P<.01) than for cows. All other differences in
precalving data were nonsignificant with
the exception of gestation weight gains of dams
on the H diet exceeding gains of dams on the M
diet (P<.05).

Means for data obtained at calving are shown
in table 2. Calving difficulty scores and duration
of labor (measured in P dams only) were greater
(both P<.01) in heifers than in cows. Birth
weights of calves from cows were higher (P<.01)
than from heifers, calves from cows were more
vigorous at birth (P<.01) than calves from
heifers, and male calves tended (P<.10) to be
heavier at birth than females. Effects of gestation
feed level on the calving data were nonsignifi-
cant.

Calving difficulty scores were higher (P<.01)
in the S dams than in P dams. This difference
would be expected because 82% of the dams
### TABLE 1. LEAST-SQUARES MEANS OF DAM PRECALVING DATA

<table>
<thead>
<tr>
<th>Item</th>
<th>Number</th>
<th>Body weight, kg</th>
<th>Condition score&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Body weight, kg</th>
<th>Condition score&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Pelvic Height, cm</th>
<th>Pelvic Width, cm</th>
<th>Pelvic Area, cm&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Gestation daily gain, kg/d</th>
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<td>17.2</td>
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<td>450.2</td>
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<td>453.2</td>
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<td>16.4</td>
<td>305.9</td>
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<td>df/ms</td>
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<td>1,621.9</td>
<td>1.4</td>
<td>1,643.1</td>
<td>1.6</td>
<td>1.4</td>
<td>1.0</td>
<td>926.5</td>
<td>.2</td>
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</tbody>
</table>

<sup>a</sup>Score: 1 = thinnest; 10 = fattest.

*P<.05.

**P<.01.
DURATION OF LABOR IN BEEF FEMALES

TABLE 2. LEAST-SQUARES MEANS OF CALVING DATA

<table>
<thead>
<tr>
<th>Item</th>
<th>Number</th>
<th>Calving difficulty scorea</th>
<th>Duration laborb, min</th>
<th>Calf birth wt, kg</th>
<th>Calf vigor scorec</th>
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<td>1.41</td>
<td>54.1***</td>
<td>32.4</td>
<td>1.17</td>
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<td>1.74</td>
<td>41.0</td>
<td>33.6</td>
<td>1.06</td>
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<td>Moderate</td>
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<td>35.6</td>
<td>33.7</td>
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<td>1.28</td>
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<td>2.13**</td>
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<td>1.78</td>
<td>42.4</td>
<td>34.3†</td>
<td>1.10</td>
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<td>34.2</td>
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<td>116</td>
<td>.4</td>
<td>666.1</td>
<td>14.8</td>
<td>.1</td>
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</table>

*a* 1 = no assistance to 4 = major traction requiring mechanical calf puller.  
*b* Stage II labor; prolonged-labor dams only (no. = 29 and 31, heifers and cows, respectively).  
*c* Score: 1 = live, vigorous calf; 2 = live, slow or weak calf; 3 = dead calf.  
†P<.10.  
*P<.05.  
**P<.01.

assigned to the S group had scores greater than 1 compared with 15% in the P group (P<.01). All other differences between S and P groups were nonsignificant. It is interesting to note 18% of the S dams calved rapidly and no assistance was given. In addition, early assistance had no significant effect on calf vigor at birth (table 2). Thus, assisting delivery early in Stage II, when completed correctly, did not result in a detrimental effect on the vigor of the calf.

Duration of labor (Stage II) in this study averaged 38.3 min (table 2). However, actual duration could be determined in dams in the P group only, and numbers in the age categories were 29 heifers and 31 cows. Duration of labor in these females averaged 54.1 min in heifers vs 22.5 min in cows (P<.01), and duration of labor for dams giving birth to male calves averaged 8.2 min (P>-.10) longer than for delivery of female calves. These labor durations are shorter than those reported by Roberts (1971) and those found in later studies at this laboratory (R. A. Bellows, unpublished data). The longer durations are probably due to more accurate determination of the actual start of Stage II, which is difficult to establish without continuous observation.

Postcalving body weights, condition scores and weight changes of the dams are summarized in table 3. Cows were heavier than heifers and had higher condition scores at all data-collection periods (all P<.05 to P<.01). Cows gained more rapidly before breeding (P<.05) and lost weight more rapidly (P<.01) from the end of the breeding season until weaning. Most effects due to gestation feed level were nonsignificant, but significant differences were consistent with expected carryover effects of feed level and compensatory gains reported in other studies from this laboratory (Bellows and Short, 1978).

Effects of duration of labor on dam and calf weights and weight changes were small and not significant. Prebreeding condition scores of S dams were higher (P<.05) than those for P dams. The reason for this is not clear. Condition scores for S dams were .2 score higher (P>.10) immediately before calving, thus, explaining some of the prebreeding difference but including initial condition score as a covariate did not affect this difference. Thus, the possibility that shortened labor might have a beneficial effect on body condition during the immediate postpartum period cannot be completely ignored. However, the effects of duration of
labor on weight gains of the dam during this period were not significant, indicating this change in condition score was not associated with effects on weight gain of the dam.

Dams nursing female calves had higher condition scores ($P<.01$) at all postcalving periods studied than dams nursing male calves. This difference may have been related to milk production stimulated by the male calf (Reynolds et al., 1978) because male calves gained more rapidly than female calves ($P<.05$ to $P<.01$) during the entire time period from birth to weaning (table 4). But, these changes in body condition were not reflected in significant changes in weights or gains of the dam. These changes may indicate that physiological changes may occur in beef females that are not necessarily detected by weighing the animal, and these subtle changes may then be related to the favorable relationships between body condition scores and postpartum reproduction reported by Whitman (1975) and Bellows et al., (1979b; 1982).

Calf weights and gains are summarized in table 4. Calves from cows weighed more and gained more rapidly throughout the study than calves from heifer dams ($P<.10$ to $P<.01$). Because both groups were of similar genetic background and calves were sired by the same bulls, these differences were possibly due to greater milk production from the older dams. Greater growth in calves suckling cows than heifers is in agreement with previous research (Urick et al., 1981; Bellows et al., 1982).

There did not appear to be any significant carryover effect of gestation feed level or labor duration on calf weights or gains. The lack of a detrimental effect of short labor-early assistance on calf growth performance is in agreement with the lack of effect on calf vigor (table 2). These results show that early obstetrical assistance, if given correctly, did not depress calf performance at birth or from birth to weaning. Male calves were heavier and gained more rapidly than heifer calves throughout the study ($P<.10$ to $P<.01$). These findings are in agreement with results of numerous other studies.

Main and interaction effects of the variables studied on postpartum reproduction are summarized in tables 5 and 6, respectively. Marked differences between heifers and cows were found in postpartum interval ($P<.01$) and percentage showing estrus by the beginning of the breeding season ($P<.01$). Cows tended to require more services/conception and had a
### TABLE 4. LEAST-SQUARES MEANS FOR Calf Weights AND Gains

<table>
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<tr>
<th>Main effects</th>
<th>No. head</th>
<th>Birth wt, kg</th>
<th>Age-adjusted calf weights (kg) at:</th>
<th>Gains (kg/d)</th>
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<td>Prebreeding</td>
<td>End breeding</td>
<td>Weaning</td>
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<tr>
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<td>62</td>
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<td>88.4</td>
<td>132.2</td>
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<td>.83</td>
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<td>.94**</td>
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<td>83.7</td>
<td>128.4</td>
<td>168.7</td>
<td>.82</td>
<td>.86</td>
<td>.60</td>
<td>.75</td>
</tr>
<tr>
<td>df/ms</td>
<td>116</td>
<td>14.8</td>
<td>329.5</td>
<td>452.0</td>
<td>466.0</td>
<td>.03</td>
<td>.02</td>
<td>.02</td>
<td>.01</td>
</tr>
</tbody>
</table>

*P < .10.

**P < .05.

***P < .01.
TABLE 5. POSTPARTUM REPRODUCTIVE PERFORMANCE, MAIN EFFECTS

<table>
<thead>
<tr>
<th>Item</th>
<th>Number</th>
<th>Postpartum interval, d</th>
<th>% in estrus by begin breeding season</th>
<th>Services/conception</th>
<th>October pregnancy, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of dam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heifer</td>
<td>62</td>
<td>62.4**</td>
<td>78.4</td>
<td>1.23</td>
<td>78.2</td>
</tr>
<tr>
<td>Cow</td>
<td>65</td>
<td>44.3</td>
<td>94.8**</td>
<td>1.14</td>
<td>86.9</td>
</tr>
<tr>
<td>Gestation feed level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>63</td>
<td>54.5</td>
<td>83.7</td>
<td>1.16</td>
<td>87.8</td>
</tr>
<tr>
<td>High</td>
<td>64</td>
<td>52.2</td>
<td>89.4</td>
<td>1.22</td>
<td>77.2</td>
</tr>
<tr>
<td>Duration of labor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short</td>
<td>67</td>
<td>52.4</td>
<td>91.4†</td>
<td>1.15</td>
<td>89.5*</td>
</tr>
<tr>
<td>Prolonged</td>
<td>60</td>
<td>54.4</td>
<td>81.7</td>
<td>1.23</td>
<td>75.6</td>
</tr>
<tr>
<td>Calf sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>61</td>
<td>53.8</td>
<td>93.8*</td>
<td>1.22</td>
<td>80.0</td>
</tr>
<tr>
<td>Female</td>
<td>66</td>
<td>52.9</td>
<td>79.4</td>
<td>1.15</td>
<td>85.0</td>
</tr>
<tr>
<td>df/ms</td>
<td>116</td>
<td>354.9</td>
<td>.10</td>
<td>.20*</td>
<td>.14</td>
</tr>
</tbody>
</table>

*Degrees of freedom = 93.
†P<.10.
*P<.05.
**P<.01.

higher pregnancy rate in October; these differences were not statistically significant but are in agreement with values previously reported in the literature (Doornbos, 1978). All effects of gestation feed level were nonsignificant.

Perhaps the most interesting findings noted were the effects of short or prolonged labor on postpartum reproduction of the dam. More S dams exhibited estrus (P<.10) by the beginning of the breeding season (table 5), and covariate analyses indicated this was not a result of a difference in calving date between the S and P groups. In addition, the October pregnancy rate was 13.9 percentage points higher (P<.05) in the S dams. More dams (P<.05) that gave birth to male calves were in estrus by the beginning of the breeding season. The reason for this was not identified in this study but appeared to be due in part to a trend for more male calves to be born early in the calving season.

TABLE 6. LEAST-SQUARES MEANS FOR POSTPARTUM REPRODUCTION AND DAM AGE X OBSTETRICAL ASSISTANCE INTERACTIONS

<table>
<thead>
<tr>
<th>Interactiona means</th>
<th>Duration of labor</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>Short</td>
<td>Prolonged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dam age and item</td>
<td>animals</td>
<td>Number</td>
<td>Number</td>
<td></td>
</tr>
<tr>
<td>Heifer</td>
<td></td>
<td>33</td>
<td>61.1</td>
<td>29</td>
</tr>
<tr>
<td>Postpartum interval, d</td>
<td>33</td>
<td>86.7</td>
<td>29</td>
<td>70.0</td>
</tr>
<tr>
<td>Estrus begin breeding season, %</td>
<td>29</td>
<td>1.16</td>
<td>19</td>
<td>1.30</td>
</tr>
<tr>
<td>Services/conception</td>
<td>33</td>
<td>87.8</td>
<td>29</td>
<td>68.6</td>
</tr>
<tr>
<td>Cow</td>
<td></td>
<td>34</td>
<td>43.6</td>
<td>31</td>
</tr>
<tr>
<td>Postpartum interval, d</td>
<td>34</td>
<td>96.2</td>
<td>31</td>
<td>93.5</td>
</tr>
<tr>
<td>Estrus begin breeding season, %</td>
<td>30</td>
<td>1.13</td>
<td>26</td>
<td>1.16</td>
</tr>
<tr>
<td>Services/conception</td>
<td>34</td>
<td>91.1</td>
<td>31</td>
<td>82.5</td>
</tr>
</tbody>
</table>

aAll P>.10.
Interaction effects of age of dam x obstetrical assistance are shown in table 6. These interaction effects were not significant, but effects of short labor were all in the desirable direction for both dam-age groups. The greatest difference was noted in October pregnancy rate, with S heifers having a 19.2-percentage point higher pregnancy rate and S cows having an 8.6-percentage point higher pregnancy rate than the P contemporaries.

The relationship between duration of labor was examined by calculating correlation coefficients (r) in dams in the P group. Significant r values within cows were found between duration of labor and prebreeding calf weight (.43), calf weight at the end of the breeding season (.40), and calf weaning weight (.36). Significant r values within heifers were found between duration of labor and pelvic height (−.52) and pelvic area (−.47). Correlations between duration of labor in heifers and cows and postpartum interval were .13 and .31, respectively, and −.21 and −.23 for October pregnancy, respectively; however, these correlations were nonsignificant.

**Discussion**

Results of this study indicate that obstetrical assistance, per se, is not the cause of depressed postpartum reproduction associated with dystocia reported by Brinks et al. (1973) and Laster et al. (1973). Although complete information is not available from this study, the results tend to suggest that short labor resulting from rapid spontaneous parturition or created by early obstetrical assistance given when the reproductive tract is fully dilated may even tend to circumvent the postpartum reproduction problems associated with prolonged labor and dystocia.

The October pregnancy rate averaged 13.9 percentage points higher in dams in the S group. The actual cause of this higher pregnancy rate is not clear from the results of this study. More dams from the S group had shown estrus (+9.7%; P<.10) by the beginning of the breeding season than dams in the P group. Covariate analyses indicated this difference remained significant after adjusting for initial body condition score. One might speculate that prolonged labor resulted in degrees of physical exhaustion of the dam, which had a prolonged physiological effect on the dam; and this was reflected in changes in body condition. This hypothesis remains to be tested. We conclude that the increase in October pregnancy rate resulted from cumulative desirable effects on these variables, recognizing that other effects could also be involved.

**Literature Cited**


