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Impact of Method of Heifer Development and Post-AI Management on Reproductive Efficiency

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Introduction

An important part of any production system is the reproductive performance and costs associated with developing replacement heifers. The cost of developing replacement heifers has a tremendous impact on the profitability and sustainability of cow-calf operations, and reproductive failure costs the U.S. beef and dairy industries approximately $1 billion annually (Bellows et al., 2002). Heifers need to calve by 24 months of age to achieve maximum life-time productivity (Patterson et al., 1992), and heifers that lose a pregnancy or conceive late in the breeding season are likely to not have enough time to rebreed during a defined breeding season. In addition, heifers that calve earlier with their first calf are more likely to bred back as two year olds and remain calving at the beginning of the calving season. This is important to overall profitability since age of calf at weaning is the single largest factor that affects weaning weight. Analysis of 3700 calves at the USDA- Meat Animal Research Center indicated that for each day of age after the beginning of the breeding season that a calf is born 2.4 pounds of weaning weight is lost (personnel communication R. Cushman). Therefore, to improve the efficiency of production, it is important to develop heifers that will bred early and calving at the beginning of the calving season.

Heifer Development

The goal of all heifer development methods is to have a heifer that has reached puberty and has good fertility at the start of the breeding season. However, one also needs to consider how the method of development can influence management after AI, and how this management can impact pregnancy success. There are many methods that can be used to develop replacement heifers. However in several locations, heifer development usually involves placing heifers into a feedlot or a confined feeding situation from weaning until breeding. This allows for intensive management of nutrient intake and growth to insure proper development for successful breeding. However, utilizing this method of heifer development usually results in a diet transition, from the development diet to grazing forage, at the start of the breeding season. This change in nutritional management has the potential to influence the reproductive efficiency and performance of the heifer for her entire life, since heifers need to calve by 24 months of age to achieve maximum life-time productivity (Patterson et al., 1992). Nutritional status can also have a tremendous influence on embryonic survival through many mechanisms. Heifers fed 85% maintenance requirements of energy and protein had reduced embryo development on day 3 and day 8 compared to heifers fed 100% maintenance (Hill et al., 1970) indicating decreased embryonic growth. Therefore, changes in nutrition can have a tremendous impact on embryo survival and the ability of heifers to conceive during a defined breeding season.

Impact of Development Method on Heifer Performance

Previous research has indicated that young ruminants learn grazing skills from mothers and other adults (Flores et al., 1989a, b, c), and these behaviors are learned early in life (Provenza et al., 1988). Heifers that grazed forage from weaning to breeding rather than being placed in drylots appeared to retain better grazing skills and had increased average daily gains into the subsequent summer (Olson et al., 1992: Salverson et al., 2009: Figure 1). Weaning is the period of time during which animals increased their consumption of forage (Lyford, 1988) to transition from maternal care to independence (Galef, 1981; Martin, 1984). This learning resulted in the development of preferences or aversions to plants and in the development of the motor skills necessary to harvest and ingest forages efficiently (Provenza et al., 1987). Furthermore, during the 1st year of life willingness to try novel food declined (Lobato et al., 1980). Thus young livestock ingest small amounts of novel food and gradually increase the amount ingested if no adverse effects occur (Burritt et al., 1987; Chapple et al., 1986). Therefore, when introduced to novel food livestock may spend significantly more time and energy foraging (Osuji, 1974), but ingest less (Arnold et al., 1977; Curll et al., 1983; Hodgson et al., 1981). Livestock with experience foraging have better skills and therefore, ingest more food per unit of time (Flores et al., 1989a; Hodgson, 1971). A decrease in feed intake from 120% of maintenance to 40% of maintenance resulted in a loss of 56.3 lbs over 2 weeks (4.03 lbs/day; Mackey et al., 1999); similar to the losses reported by Salverson et al. (2009; Figure 1) when heifers were moved from a feedlot to grass.

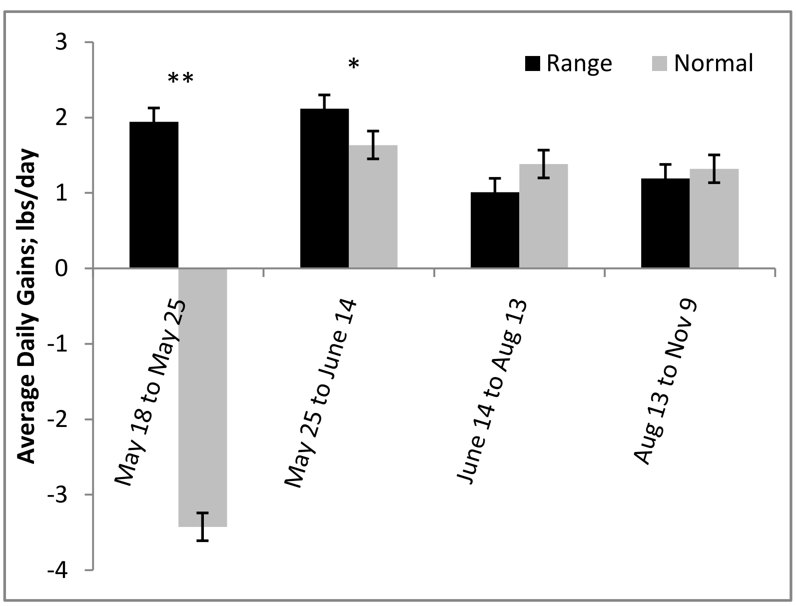

Figure 1. Average daily gain (lbs/day) of heifers weaned and developed on range (Range) compared to heifers weaned and developed in a drylot (Normal). All heifers were moved to the same pasture on May 18th (**P* = 0.06; ***P* < 0.05)

Impact of Development Method on Reproductive Performance

Recent studies using transrectal ultrasonography to monitor embryo development report the incidence of pregnancy loss from day 25 to day 90 after insemination to range from 6% to 40% (Ayalon, 1978; Bellows et al., 2002; Maurer et al., 1983; Peters, 1996; Silke et al., 2002). Post-insemination nutrition may influence embryonic survival through many mechanisms. Nutritionally mediated changes to the uterine environment can occur by changing components of uterine secretions or by influencing the circulating concentrations of progesterone that regulate the uterine environment (see review by Foxcroft, 1997). More specifically, protein intake can directly influence the uterine environment. Excess intake of protein (25% excess of UIP or DIP) had no effect on uterine environment on the day of estrus but altered the environment of the uterus on day 7 (Elrod et al., 1993). This is around the same time as embryonic blastocyst formation (Flechon et al., 1978; Peters, 1996; Shea, 1981). In addition, heifers fed only 85% maintenance requirements of energy and protein had reduced embryo development on day 3 and day 8 compared to heifers fed 100% maintenance (Hill et al., 1970) indicating decreased embryonic growth. Therefore, excess or under nutrition can have a tremendous impact on embryo survival and the ability of heifers to conceive or maintain pregnancy during a defined breeding season. Following insemination, heifers are usually turned to grass and are often not supplemented. Spring grass can vary tremendously in nutrient content. It is possible that energy and protein requirements may be undersupplied or oversupplied and thus increased embryonic mortality.

A decrease from 120% of maintenance to 40% of maintenance resulted in decreased follicular growth and 60% of heifers becoming anovular within 13 to 15 days of diet change, but this did not affect fertility in animals that ovulated (Mackey et al., 1999). In a recent study we developed beef heifers from weaning to breeding either in a feedlot (n = 52; LOT) or on grass (n=53; GRASS). Immediately following fixed-time AI all heifers were moved to the same pasture. Blood samples were collected from all heifers on the day of AI (d 0), and 11 days after AI. Pregnancy success was determined 42 d following AI. There tended ($P = 0.10$) to be more LOT heifers cycling prior to the breeding season (94% vs 84%), but GRASS-developed heifers tended ($P = 0.20$) to have greater conception rates to the fixed-time AI compared to LOT heifers (57% vs. 44%; Table 1). In addition, pregnant heifers had greater glucose than open heifers on d 11 ($P = 0.04$; 77.4 ± 1.24 and 73.8 ± 1.24 mg/dL) but not on d 0 ($P = 0.88$).

Table 1. Impact of heifer development method on cycling status and pregnancy success.

	LOT[a]	GRASS[b]	*P* =
Cycling Prior to Breeding Season	94%	84%	0.10
Pregnancy Success	44%	57%	0.20

[a]Developed from weaning to breeding in a feedlot.
[b]Developed from weaning to breeding on pasture.

In another recent study, beef heifers at two locations (n = 144 and 164 at location 1 and 2, respectively) were developed in a feedlot from weaning to breeding. At time of insemination heifers were randomly allotted to one of two treatments: 1) heifers were moved from feedlot to graze spring forage, or 2) heifers were moved to graze spring forage and supplemented with DDGS (5 lbs/hd/day) for 42 days. Pregnancy success was determined 42 days after AI. At location 1, there was no difference between treatments in weight change from AI to pregnancy determination (17 ± 3.9 and 15 ± 3.7 lbs for heifers not supplemented and supplemented; respectively). However, at location 2, heifers that were grazing spring forage alone lost 37 ± 4 lbs, but heifers that were grazing spring forage and were supplemented gained 45 ± 3 lbs from AI to pregnancy determination ($P < 0.01$). Furthermore, AI pregnancy rates did not differ between treatment ($P = 0.54$) at location 1 [34 % (24/70) and 39 % (29/74) for heifers not supplemented and supplemented; respectively]. However, at location 2, pregnancy success was different between treatments ($P = 0.05$). Heifers that were not supplemented after AI had decreased pregnancy success (26%) compared to heifers that were supplemented (40%). Therefore, when heifers were developed in a feedlot, pregnancy success tended to be influenced by weight gain after moving heifers to grass.

Table 2. Influence of supplementing feedlot developed heifers when moved to grass on pregnancy success.

	Pasture	Pasture & Supplement	P-Value
Location 1	34 % (24/70)	39 % (29/74)	0.54
Location 2	26 % (19/74)	40 % (36/90)	0.05

In a third study, beef heifers at one location (n= 333) were developed on a forage diet from weaning to breeding. All heifers were brought into a feedlot and synchronized with a 7 day CIDR protocol. At time of insemination heifers were randomly allotted to one of three treatments: 1) heifers were moved to graze spring forage, 2) heifers were moved to graze spring forage plus supplemented with DDGS (5 lbs/hd/day) for 42 days, or 3) heifers were returned to the feed lot for 42 days. Pregnancy success was determined 42 days after AI. Body condition increased ($P < 0.01$) from the day synchronization began (day -7; 5.4 ± 0.05) to day 42 in both the heifers that were supplemented on pasture and the heifers that were kept in the feed lot (5.9 ± 0.04 and 5.8 ± 0.04, respectively; Table 3). Body condition did not change from day -7 to day 42 among the heifers that were on grass alone (5.4 ± 0.05 and 5.4 ± 0.04 for day -7 and day 45, respectively; Table 3). Pregnancy success did not differ between treatments [59% (65/111), 57% (63/111), and 56% (62/111) for heifers on grass alone, heifers on grass plus supplemented, and heifers in the feed lot, respectively). Therefore, when heifers are developed on grass, there was no effect on pregnancy success weather they were returned to grass and supplemented or not or even kept in the feed lot.

Table 3. Influence of supplementing pasture developed heifers following artificial insemination on Body Condition Score.			
	Feedlot	Pasture	Pasture & Supplement
Day -7	5.4 ± 0.05	5.4 ± 0.05	5.4 ± 0.05
Day 42	5.8 ± 0.04*	5.4 ± 0.04	5.9 ± 0.04*
*P < 0.01			

Management Decisions to Improve Performance and Efficiency

As described by Salverson et al. (2009) when feedlot developed heifers were moved to grass average daily gains were decreased compared to range developed heifers for the first 30 days (Figure 1). However, after 30 days of being on spring forage average daily gains were similar between treatments. Therefore, we conducted a preliminary study to determine the influence of moving feedlot developed heifers to grass before time of AI on pregnancy success. In this preliminary study, 50 heifers were equally divided into 2 treatments 1) moved to grass 30 days prior to breeding and 2) left in the feedlot until breeding. From breeding to pregnancy determination (day 35) heifers moved to grass early gained 17 lbs but heifers left in the feedlot only gained 0.6 lbs ($P = 0.07$). Pregnancy success following detection in standing estrus did not differ ($P = 0.81$) and were 62% (13/21) and 58% (14/24) respectively for heifers moved to grass and left in the lot. However, 13% (3/24) of the lot heifers that conceived to AI lost their pregnancy, but only 5% (1/21) of the grass heifers lost their pregnancy. Therefore, final AI pregnancy success was 57% for grass heifers and 46% for lot heifers.

Heifer Development to Improve Reproductive Efficiency

Development of heifers in a feedlot or on pasture requires constant monitoring. When heifers were developed to gain less than a pound a day, from weaning until approximately 360 days of age when all heifers were turned to spring forage, pregnancy success was decreased compared to heifers developed to gain a pound or more a day (Short and Bellows, 1971). In addition, heifers developed to gain less than a pound a day maintained fewer pregnancies from their first pregnancy diagnosis in August to their final pregnancy diagnosis in October compared to heifers developed to gain more than a pound a day (Short and Bellows, 1971). However, development of heifer to excess body condition negatively impacted reproductive efficiency (Patterson et al., 1992), and increased the amount of assistance needed at time of parturition (Arnett, et al., 1971). Furthermore, heifers that had been developed to a body condition of 7 or 5 and nutrient restricted until they became anestrous did not resume estrous cycles until they reached a body condition score of 6.0 and 5.2, respectively (Cassady et al., 2009). Therefore, heifers in greater body condition when diet change occurs at breeding experience a greater change in nutrient intake and lose condition will require increased weight gains to resume cyclic activity.

During the cycle before heifers became anovular plasma concentrations of IGF-1, insulin, and glucose were only 12.2, 42, and 78% that of heifers fed maintenance, respectively (Bossis et al., 1999). Plasma concentrations of GH and NEFA were 320% and 252% of heifers fed maintenance, respectively (Bossis et al., 1999). Re-alimentation of nutritionally induced anestrous resulted in a gradual increase in dominant follicular growth rate, IGF-I, pulsatile LH and estradiol concentrations to the point when ovulation was reinitiated, but concentrations of glucose and insulin returned to normal levels prior to the point of ovulation, and concentrations of nonesterified fatty acids rapidly decreased following re-alimentation of nutrition (Bossis et al., 2000). Therefore, heifers should be carefully managed from weaning to breeding to make sure heifers are properly developed and not under or over conditioned at time of insemination. A practical method to manage body condition in heifers is by body condition scoring periodically throughout the development period. Heifers should be in a body condition score 5 to 6 at breeding, similar to post-partum cows.

Implications

A supply of properly developed heifers is important to the sustainability of any cattle operation. However, the method by which heifers are developed and how they are managed following insemination can have a tremendous impact of the reproductive performance and the lifetime productivity of replacement heifers. Heifers that are developed in a feedlot experience decreased average daily gains compared to forage developed heifers when they are moved from the feedlot to grazing spring forage. This decrease in average daily gains coincides with decreased pregnancy success in feedlot developed heifers when moved to spring forage immediately following insemination. Therefore it is necessary to realizing that a sudden change in diet can have a tremendous impact in pregnancy success if this diet change occurs immediately following insemination.

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