HEIFER DEVELOPMENT: SAME CHALLENGES – MORE OPTIONS

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Introduction

Producing the next generation of females for the beef herd is one of the most important and costly enterprises for cow/calf operations. The physiological events that need to occur for heifers to be ready for breeding at 14-15 months of age were covered in this symposium by Dr. Smith. Factors affecting puberty onset and reproductive maturity include nutrition, genetics, photoperiod and growth (Wiltbank et al., 1966; Schillo et al., 1992; Martin et al., 1992; Hall, 2013). Even the prenatal environment can have dramatic impacts on heifer fertility (See Dr. Funston's proceedings paper).

Heifers that become pregnant early in their first breeding season have long been known to remain in the herd longer and produce more pounds of calf (Lesmeister et al., 1973). Recently, this concept was reinforced using heifers of current genetics. Heifers conceiving in the first 21 days of the breeding season remained in the herd longer and produced more total pounds of weaning weight through six calvings (Cushman et al., 2013; Figure 1). Similarly, heifers conceiving to a synchronized AI have greater lifetime productivity than heifers that conceive to cleanup bulls (French et al., 2013). Producers indicate that longevity is an important trait particularly in commercial beef operations. Indeed, the well-known economist Dr. Harlan Hughes indicates that cow longevity is an important factor in sustainability and profitability of the cow/calf enterprise.

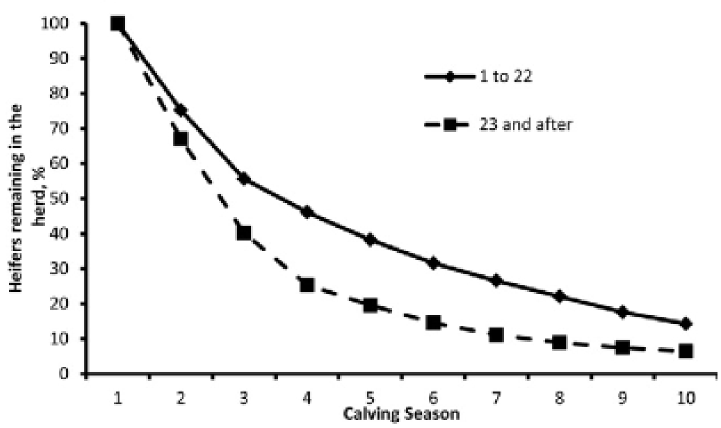

Figure 1. Impact of day of calving in first calving season on longevity of replacement heifers. Cushman et al 2013.

Estrus synchronization and AI are key technologies for increasing the number of heifers that conceive early in the breeding season and mitigating problems such as dystocia which impair future reproductive efficiency. However, heifers must be properly developed to be ready for a synchronization and AI program. Nutrition is the management tool under the most control by the producer. Due to the high cost of producing heifers recent research has focused on nutritional systems to decrease development costs and potentially enhance longevity. This paper will discuss the current concepts in nutritional development of beef heifers, and potential strategies and pitfalls with different nutritional management options. In addition, reproductive management techniques such as puberty induction and reproductive tract scoring for replacement heifers will be presented.

Early Calf Nutrition (Birth to 6 months)

In most operations, this period would be known as the preweaning period. Calves that are heavier at weaning or grow faster are pubertal at a younger age (Arije and Wiltbank, 1971; Wolfe et al., 1990; Weherman et al., 1996). It appears that weight per day of age from birth to weaning is a significant effector of age at puberty (Greer et al., 1983). While weaning weight and preweaning weight per day of age may be good predictors of younger age at puberty, these measures are a complex interaction of growth genetics, mothering ability, forage availability, and dam milk production (Greer et al, 1983; Gregory et al., 1991).

Recent research into early weaning (either planned or drought forced) and other calfhood nutritional strategies produced insight into the importance and influence of calf nutrition before 6 to 7 months of age. It appears this is a critical period in heifer development.

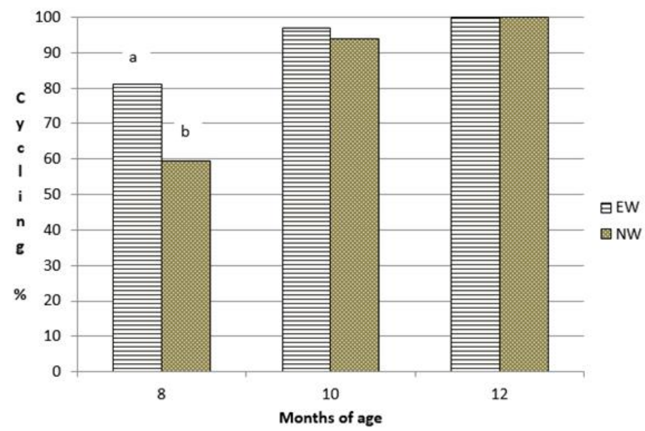

Figure 2. Effect of weaning age (early – EW or normal – NW) on percentage of cyclic heifers by month. [a, b] Effect of weaning time (P < 0.05). Adapted from Sexten et al., 2005.

Calves are usually early weaned to improve reproduction of the dam (weaning age 30-90 days) or in response to drought (weaning age 90-150 days). Regardless of early weaning age, heifers placed on high energy diets reached puberty at a younger age than their normal weaned counter parts (Myers et al., 1999; Sexten et al., 2005; Waterman et al., 2012; Figure 2). Similarly, research into stair-step feeding of early weaned heifers demonstrated that calves fed high energy diets from 4 to 6 months of age reached puberty 2 months earlier than heifers fed a stair-step regime where nutrition was limited during the same period (Cardoso et al., 2014). However, by the beginning of the breeding season similar percentages of heifers were cycling regardless of the timing of increased energy intake. Early age at puberty in early weaned heifers translates into either an improvement or no difference in pregnancy rates during the normal breeding season compared to normal weaned heifers (Day et al., 2001; Sexten et al., 2005; Waterman et al., 2012).

Whether as a result of early weaning (Sexten et al., 2005) or extremely high rates of gain while nursing their dams (Wehrman et al., 1996), heifers can exhibit precocious puberty. Precocious puberty is defined as cycles beginning at 4 to 8 months. While this is not an issue for early weaned heifers in drylot, heifers on pasture may be exposed to bulls resulting in pregnancy occurring in heifers with underdeveloped frame and pelvic area. In addition, heifers exhibiting precocious puberty may not continue to cycle, and need to resume cycles later (Nelsen et al., 1985).

Creep feeding or creep grazing can be used to increase preweaning nutrient intake and growth rate (Buskirk et al., 1996; Bagley et al., 1993; Morrison et al., 1984). These techniques increase the percentage of heifer cycling at the beginning of the breeding season or decrease age at puberty. However, they can also result in reduced future milk production and reduced performance of offspring due to an increase in adipose tissue deposition in the udder (Ferrell, 1982; Hall, 2013). While creep grazing is usually cost effective, creep feeding usually has a low economic return.

Post-Weaning Nutrition (7 to 14 months)

A majority of the research on nutritional impacts on heifer development and reproduction, including specific nutrients, focused on the post-weaning period (Patterson et al., 1992; Schillo et al., 1992). In most cow/calf operations, particularly range-based operations, producers are limited in management of preweaning nutrition other than grazing management. In contrast, post-weaning nutrition is under a high level of control by producers.

Rate of gain. For over 40 years, it has been well known that average daily gain (ADG) of heifers from weaning to breeding can dramatically affect age at puberty onset and reproductive performance (Wiltbank et al., 1969; Short and Bellows, 1971; Table 1.). Early on, it was suggested that if heifers attained a critical or “Target” body weight by the beginning of the breeding season then nutrition would not be the limiting factor in heifer reproduction (Lammond, 1970; See Target Weight Section). These early studies along with more recent research, resulted in the standard recommendation that an ADG of 1.25 lbs/ day to 1.75 lbs/day (0.57 kg/d to 0.80 kg/d) was needed for heifers between weaning and breeding to ensure nutrition was not limiting. While this recommendation is still sound and effective, more recent work has questioned the economic and physiological necessity of this level of nutritional input.

Table 1. Effect of feed level on reproductive performance in beef heifers

	Low	Medium	High
Gain, kg/day	0.23	0.45	0.68
Age at first estrus, d	434	412	388
Weight at first estrus, kg	237	247	255
Conception rate first 20 days of breeding season	30%	62%	60%
Overall conception rate	50%	86%	87%

Adapted from Short and Bellows, 1971

Sorting heifers into feeding groups based on their weaning weights for feeding management during the post-weaning phase is advantageous. By separating heifers into light and heavy weight feeding groups, the percentage of heifers attaining puberty by the beginning of the breeding season was improved in both groups (Varner et al., 1977). In addition, feed cost for heavy weight heifers was reduced. This simply means sorting heifers based on weights being above or below the average for the group. For large operations, three or four feeding groups may be optimum.

Pattern of gain. Weather, feed availability, economics, and, sometimes, mismanagement dictate that heifers do not always gain weight at the desired rate. In addition, work from dairy heifer development indicated that overfeeding at certain critical times in development may impair lifetime milk production. Multiple studies examined patterns of gain of heifer post-weaning from simple patterns of roughing heifers through the winter followed by rapid gains 60 days before breeding to more complex combinations of fast-slow-fast gain (Clanton et al., 1983; Lynch et al., 1997; Poland et al., 1998; Grings et al., 1999; Schmitz et al., 2014). In all cases, if heifers reached their target weight by the beginning of the breeding season, reproductive efficiency was not significantly impacted (Table 2).

Table 2. Impact of pattern of gain on pregnancy rates in replacement beef heifers[a].

	Pattern of Gain				
Study	**No. of heifers**	**Even gain**	**Slow - Fast**	**Fast - Slow**	**Fast-Slow-Fast**
Clanton et al., 1983	180	82.0 %	75.0 %	73.0 %	--
Lynch et al., 1997	160	87.4 %	87.2 %	--	--
Poland et al., 1998	96	75.0 %	--	--	89.6 %
Grings et al., 1999	210	81.8 %	--	--	86.6 %

[a] Within row no effect of pattern of gain ($P > 0.05$). From Hall, 2014.

Target Weight – 55% or 65%?

From a management perspective having a method to readily assess the nutritional progress of replacement heifers is critical. Over the years, it has been proposed that heifers must achieve a critical body weight or level of fatness in order for puberty to begin, but this in not correct (Hall, 1991; Hall et al., 1995). Nutrient availability to the portion of central nervous system that controls GnRH release is probably altered as somatic growth slows (Schillo, 1992). Signals relaying information on nutritional status to reproductive centers include leptin, NPY, and kisspetin (Zieba et al., 2005; Amstalden et al., 2014).

Even though heifers do not reach puberty at a particular weight or fatness, undernourished heifers do not attain puberty, and there exists a “threshold” weight below which heifers will not cycle (Kiser et al., 1978; Day et al., 1986). The target weigh concept was proposed which gave managers a goal of having heifers reach a percentage of their mature weight by the beginning of the breeding season (Lamond, 1970). After achieving this target weight, nutrition would not be the limiting factor in heifers becoming pregnant. For many years, 65% of mature weight has been the recommended target weight. This recommendation was based on sound science (Patterson et al., 1992). Both the research and practical experience indicated this target weight was effective over a large number of environments and breed types. The 65% target ensured a large percentage of heifers would become pubertal by the beginning of the breeding season, and these heifers had less calving difficulty compared to those developed to 55% (Patterson et al., 1992).

Recently both researchers and producers have questioned if 65% of mature weight by breeding was "too much". Heifers may have to receive considerable supplementation, especially in extensive operations, to achieve the 65% target weight. The question was asked, "Can we develop heifers to lower weights and what are the ramifications (both animal and economic)?"

Several studies have clearly shown that managing heifers to reach 55% of mature weight by the beginning in the breeding season does not reduce the percentage of heifers becoming pregnant in the first 21 days of the breeding season compared to heifer fed to a greater target weight (Funston, 2004; Roberts et al., 2009; Larson et al., 2009). In contrast, heifers developed to a 55% target weight had a 15% reduction in heifers pregnant during the first 21 d compared to heifers developed to 64% target weight (Eborn et al., 2013). There was an 11% reduction in heifers calving in the first 45 d of the calving season for heifers developed to 50% compared to 56% target weights (Martin et al., 2008). Most experiments indicated that cost of heifer development was reduced on a per pregnancy basis. However, to ensure acceptable pregnancy rates and proper size for calving, heifer MUST gain weight during the breeding season and continue to gain during the post-breeding season. Heifers still need to weigh 85% to 90% of mature weight at calving as 2-year-olds to minimize dystocia.

Does developing heifers to 55% target weight by breeding increase longevity? There exists concern that "over-developed" heifers that have been raised in drylot during the winter may have reduced longevity or leave the herd at a high rate. Nebraska researchers found no difference in longevity through 5 calvings of heifer raise to lighter target weights compared to traditional target weights (Funston and Deutscher, 2004). Studies comparing range-raised heifers supplemented with RUP to drylot heifers not receiving additional RUP found that level of RUP supplementation increased longevity (Mulliniks et al., 2013). The increase longevity was a function of level of RUP supplementation, but not target weight. Endocott and co-workers (2013) indicated that management of light target weight heifers after breeding was critical. If light weight heifers were restricted after breeding attrition rates of young cows were greater and retention beyond 5 years was lower compared heavy target weight heifers.

So should we all jump on the 55% band wagon? When a rough average is taken from the results of 7 experiments shown in Table 3, differences in heifer pregnancy rate at the end of the breeding season were only 2% in favor of the 65% target. Even though 5 out of 7 experiment demonstrated a numerical advantage to a 65% target weight, these differences are not significant. However, using 55% target weight will be fine for some operations, but not for others. A majority of the 55% target weight research has been conducted with crossbred or composite cattle which, due to heterosis, will reach puberty at a younger age than the purebred or straightbred breeds used to make the crosses. Eborn et al. (2013) noted a 10% reduction in heifer pregnancy rates in Angus heifers compared to MARCII composite heifers. *Bos indicus* influenced heifers had a 19% decrease in pregnancy rates when only developed to 55% compared to 65% target weight (Patterson et al., 1992). Much of the recent research has been conducted in extensive, resource-limited environments with well adapted cattle. Producers need to be aware of the genetics as well as the rate of reproductive development of their heifers when making target weight decisions.

Table 3. Impact target weight on pregnancy rates in replacement beef heifers.

	Target Weight (% of Mature Weight)*		
Study	**No. of heifers**	**55**	**65**
Patterson et al., 1992 (*Bos Taurus)*	137	84 %	89 %
Funston and Deutscher, 2004	240	92 %	88 %
Martin et al., 2008[a]	261	87 %	90 %
Roberts et al., 2009	397	87 %	92 %
Eborn et al., 2013	360	77 %	83 %
Mulliniks et al., 2013	191	91 %	84 %
Lardner et al., 2014	176	86 %	88 %
Bailey et al., 2014	203	74 %	77 %

*65% - Range 58% to 65%; 55% - Range 48% to 56%
[a]In this study 55 = 50% and 65 = 56%

Pregnancy rates to AI may be lower in heifers developed on a restricted feed compared to heifers receiving ad lib feed pre-breeding (Roberts et al., 2009; Bailey et al., 2014). The difference was particularly striking (approx. 20% difference) when heifers were synchronized without a progestin in the protocol. While some studies clearly indicate acceptable pregnancy rates in the first 21 days, others reported delays in establishment of pregnancy (see discussion above). Also, few studies employed AI. Those 55% target weight (range 48% to 55%) studies that did use AI often put bulls in immediately after AI (Roberts et al., 2007; Mulliniks et al., 2013). Although this is an industry standard in most commercial operations, it does not give us good information of the impact of lighter target weights on pregnancy rates to AI. It appears from calving data that the response to AI was acceptable, but further research is needed to study the impacts of lighter target weights on AI success.

Specific Nutrients

Understanding the mechanisms or signals which link nutritional status to reproduction is an active area of research. The goal has been to identify signals that then could be used to improve reproduction in undernourished or nutritionally challenged animals. While our understanding of the signals that communicate nutritional status of an animal to the centers of the brain that control reproduction is improving, it is far from complete and the signals are complex. Overall it appears that energy availability is the primary factor linking nutrition and reproduction (Schillo et al., 1992). This information is conferred via signals such as leptin, kisspeptin, and NPY to the hypothalamus to affect GnRH release which controls LH and FSH secretion (Zieba et al., 2005; Amstalden et al., 2014). In addition, energy substrates or metabolic signals can also act on the ovary to alter follicular growth, estrogen production and progesterone concentrations (Webb et al., 2004).

Practical applications have investigated the role of various forms of energy (starch, fiber, fat) or protein (rumen degradable protein- DIP; rumen undegradable protein – RUP) on reproductive efficiency. While the number of these studies is limited, the information that has been gained is helping to guide nutritional options for female beef cattle.

Energy. Starch, fiber and fat all are forms of energy for ruminants, but they produce different metabolic substrates and signals in the animal. Two research projects compared the effects of isonitrogenous- isoenergetic supplements on reproduction in developing heifers (Wuenschel, 2006; Howlett et al., 2003). Although the numbers of heifers were limited, both studies indicated no difference in reproductive efficiency in heifers fed different sources of energy (Table 4).

Table 4. Impact of source of energy in supplements for developing heifers on first service conception rate[a]

Supplement	Experiment 1	Experiment 2
Soyhulls	46 %	42 %
Whole Cottonseed	46 %	38 %
Whole Soybeans	-------	57 %
Corn/soybean meal	54 %	37 %

[a] No effect of supplement ($P > 0.05$)
Adapted from Wuenschel, 2006 (Experiment 1) and Howlett et al., 2003 (Experiment 2)

Increasing fat levels in developing heifer diets results in improvements, no effect or a negative effect on reproduction (Lammoglia et al., 2000; Cuddy et al., 2002). When whole cottonseed was used as a fat/energy source, heifers had increased pregnancy rates to AI and conceived earlier in the breeding season compared to their starch supplemented counterparts (Cuddy et al., 2002). In reviewing multiple studies on the impact of fat supplementation on developing heifers, Hess and co-workers (2008) concluded fat supplementation could increase pregnancy rates in heifers by up to 10% whereas Funston (2004) concluded there was no advantage to including fat in diets of well-developed heifers. There is limited evidence that more highly unsaturated fats may have a greater impact on reproduction. However, there was no difference in source of fat on pregnancy rates of replacement heifers (Shike et al., 2013; Long et al., 2014). Therefore, including fat in the diets of developing heifers should be considered only if it can be incorporated as an economical energy source.

If energy availability is critical, then will increasing gluconeogenic precursors such as propionate improve reproduction? There is limited evidence that supplementing calcium salts of propionate enhances pregnancy rates in young cows (Mulliniks et al., 2011). However, feeding supplemental propionate to developing heifers did not decrease age at puberty relative to control heifers (Lalman et al., 1993).

Protein. Foraged based diets are often high in DIP (rumen digestible intake protein) and MP (metabolizable protein – protein absorbed by the small intestine) might be limiting. Metabolizable protein is a combination of DIP and RUP (rumen undegradable or by-pass protein). Balancing heifer diets for metabolizable protein (MP) content did not improve growth rate or the percentage of heifers reaching puberty, but did improve heifer reproduction as 2-year olds (Patterson et al., 2003). Supplementing RUP into heifer diets has variable impacts on heifer growth and reproduction. It has improved or did not affect heifer growth or reproduction (Lalman et al., 1993; Kerley and Patterson, 2000; Mulliniks et al., 2013). It appears that the effect may depend on the MP status of the animal before supplementation with RUP or the level of RUP supplied. For example, heifers grazing range had improved pregnancy rates and remained in the herd longer if they received a supplement with 50% RUP, but there was no improvement if heifers consumed a supplement with 36% RUP (Figure 3).

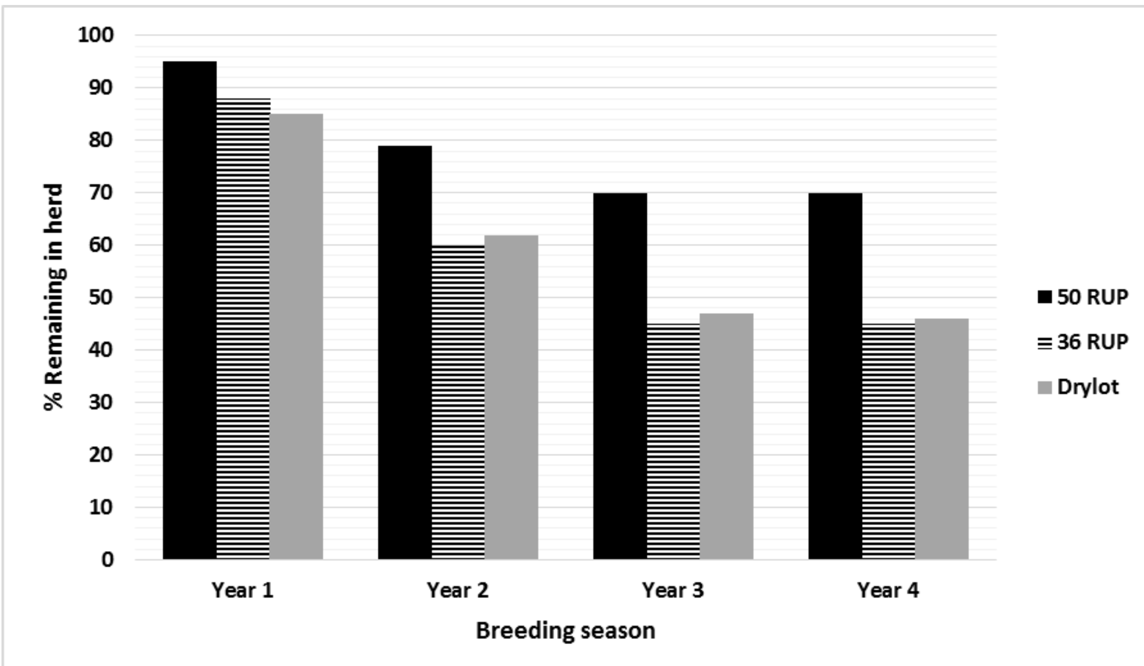

Figure 3. Impact of level of RUP supplementation during post-weaning development on longevity of heifers. 50 RUP = 36% CP supplement with 50% RUP; 36 RUP 36% CP supplement with 36% RUP; Drylot = control heifers.
Percentage remaining in herd differences – Year 1: 50RUP > 36 RUP > Drylot ($P < 0.05$);
Year 2, 3, and 4: 50 RUP > 36 RUP or Drylot ($P < 0.01$). Adapted from Mulliniks et al., 2013.

High levels of DIP may compromise oocyte quality, uterine environment, and embryo viability (Blanchard et al., 1990; Sinclair et al., 2000; Jousan et al., 2002). Most of these reports involved evaluated increased blood urea nitrogen (BUN) levels usually as a result of inclusion of urea in the diet. Producers are often concerned about grazing heifers on lush pasture such as wheat pasture because high concentrations of DIP in the forage may result in elevated BUN concentrations. Recent research by Oklahoma State indicates that grazing replacement heifers on wheat pastures does not impact reproductive efficiency compared to heifers developed in drylot (Bryant et al., 2011). It appears that as long as heifers are in a positive energy balance, they are not affected by increased BUN levels.

Dried distiller's grain plus solubles (DDGS) contains both fat and RUP. Initially, there was some concern about the high levels of RUP being detrimental to reproduction. Information on the effects of incorporating DDGS in developing heifer diets is limited. In one study, heifers fed DDGS had a 17% improvement in AI pregnancy rates, but similar overall pregnancy rates compared to heifers fed an isoenergetic-isonitrogenous starch/fiber-based supplement (Martin et al., 2007). Jaeger and co-workers (2012) found no advantage to including wet distiller's grains in heifer diets. Overall, there are no detrimental effects of using distiller's grains as a supplement in developing heifer diets as long as Sulphur levels in the diet are monitored.

Ionophores and Growth Promotants

Ionophores and growth promotants (implants) can increase growth rate; therefore, these tools may alter age at puberty. Inclusion of ionophores (lasalocid or monensin) increases feed efficiency and growth rate through improvements in digestive efficiency of the rumen. Addition of ionophores to developing heifer diets can hasten puberty onset by 15 to 30 days (Moseley et al., 1982). Therefore, use of ionophores is recommended in heifer development programs.

In contrast, the use of implants is generally discouraged despite some reports of improvements in reproductive efficiency. Most growth implants are steroids or have steroid like activity which alter the partitioning of nutrients to different tissues as well as increase the release of growth factors. The impacts of using Zeranol on developing heifers appears to depend on the timing and number of implants (Deutscher et al., 1986). In a review of the impacts of implants on heifers, Selk (1997) noted that the reported impacts on heifer pregnancy rate in implanted heifers ranged from a 10% decrease to a 19% improvement. He also found 13 studies indicating reductions in reproductive efficiency whereas 9 studies showed an improvement. More recently, Devine et al. (2015) reported that zeranol, but not TBA, delayed puberty in heifers. In addition, they found no difference in pregnancy rates between implanted or control heifers; however, pregnancy rates were only 72%. Quite simply, the variable results of implants on heifer reproduction indicate that they should not be used in a heifer development program.

Grazing Behavior and Heifer Development

A few studies indicate that a heifer's environment during the development period may affect her reproductive performance and longevity. Heifers that move from drylot to pasture immediately after AI have decreased AI pregnancy rates compared to heifers that were adapted to pasture before AI (Perry et al., 2013). The reduction in pregnancy rates is caused by increased activity in unadapted heifers resulting in decrease weight gains (loss) during the post-AI period (Perry et al., 2015). When moving heifers from drylot to pasture immediately after AI, supplementation of heifers mitigated the negative effects in unadapted animals (Perry et al., 2015). Nebraska researchers found that yearling heifers developed on corn residue had improved performance when placed on corn residue as pregnant heifers compared to heifers that had no previous experience grazing corn residue (Summers et al., 2014). Therefore, previous experience with or pre-AI adaptation to the grazing system used post-AI or during gestation may be important.

Phytoestrogens

Some plants, especially legumes, produce compounds with estrogen-like activity which are termed phytoestrogens. Phytoestrogens bind to the estrogen receptor and elicit similar actions to estrogen. Most phytoestrogens are “weak” estrogens indicating that they bind to the estrogen receptor less readily. Whole soybeans, alfalfa, and clover all contain phytoestrogens. In a review of the effects of photoestrogens in cattle, Wolclawek-Potocka and co-workers (2013) indicated that phytoestrogens may have negative effects on reproduction in cattle, and the brain, ovary and uterus can all be effected. In most of their studies, soy products were fed at a high percentage of the diet. In heifers fed soybeans as a protein and fat supplement in their diet, Nebraska researchers noted some alterations in response to synchronization and follicular development, but no detrimental effects on pregnancy rate (Harris et al., 2005). While ruminants grazing clovers in Australia had dramatic negative effects of phytoestrogens from those plants on reproduction (Erikson, 2006), US research on reproductive impacts from phytoestrogens when grazing legumes such as alfalfa is more limited. In general, producers need to be aware of the existence of phytoestrogens and their possible role in disrupting reproduction. Furthermore, producers need limit exposure to feeds containing high concentrations of phytoestrogens when possible.

Puberty Induction

Puberty can be induced by a short term (7 to 10 d) exposure to progestins (See Dr. Smith’s paper; Hall et al., 1997). The efficacy of puberty induction is related to how close heifers are to natural onset of puberty at the time of progestin exposure. In general, heifers will respond if they are within 30 d of puberty onset. In addition, heifers must be in good nutritional status to respond to progestins. Either MGA or CIDRs can be used to induce puberty in heifers. As indicated in previous papers in this proceedings, induction of puberty (cycles) in non-pubertal heifers is a key reason to employ an estrus synchronization protocol that includes a progestin.

Reproductive Tract Scoring

Reproductive tract scoring (RTS) is a method to evaluate reproductive development of heifers. Reproductive tract scores range from 1 = infantile to 5 = CL present. Use of RTS was previously discussed in this symposium by Drs. Smith and Patterson; however, the value of this tool and its present application in heifer selection warrants further discussion. Using RTS to select heifers that are good candidates for AI has been demonstrated by multiple studies which indicate heifers with RTS of 1 or 2 at the time of synchronization are most likely poor candidates for estrus synchronization and AI (Thomas et al, 2013; Gutierrez et al., 2014). In addition, it can identify heifers that have a greater likelihood of becoming pregnant early in the breeding season (Gutierrez et al., 2014).

While RTS is a good method for selecting heifers as well as a research tool. Adoption of this technology is appears to be limited. In 1994, it was reported that only 1.2% of the operations surveyed were using RTS (USDA-APHIS, 1994). When another survey on use of reproductive technologies was conducted 14 years later, RTS was not even listed as a technology on the survey (USDA-APHIS, 2009). Conducting RTS of heifers requires a skilled, trained palpator which is usually a veterinarian. Usually, it can be conducted along with pre-breeding vaccinations in order to reduce extra trips through the chute. Another drawback may be the limited number of RTS 1 or 2 heifers identified in well managed herds. Missouri and Washington researchers examined 8300 and 4000 heifers, respectively. Both studies reported that less than 5% heifers measured were RTS ≤ 2. The cost of conducting RTS must be weighed against the cost of synchronizing a limited number of heifers that would be expected to perform poorly. The RTS technology should still be considered as a tool for heifer selection, especially for 1) underdeveloped heifers; 2) operations that are moving to a reduced target weight; or 3) heifers of unknown origin or purchased heifers.

Using Heifer Development Options to the Ranch's Advantage

Obviously, there are a number of options or strategies that could be employed in developing heifers. Considerations in developing a plan for economically raising replacement heifers depend on individual ranch goals, available feedstuffs, environmental conditions, management level, grazing program, ability to supplement, and use of AI as well as marketing options for open heifers. However, there are some key strategies or decision points.

- Select replacements that were born early in the calving season
- Monitor pre-weaning growth and nutrition
    - Consider early weaning, if possible and beneficial
- Determine a comfortable/appropriate Target Weight for heifers in your operation.
    - Be aware of potential impacts to AI program
- Develop a planned nutritional program using local feedstuffs
    - Use a stair-step approach to gains
    - Include ionophores in diets, if possible
    - Consider a supplement containing RUP, especially if MP may be limiting
- Use feedstuffs and grazing environments similar to those heifers will be exposed to as cows.
- Avoid feeds with high phytoestrogen levels.
- Use estrus synchronization protocols that include progestins
- Consider RTS of all heifers.

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