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IMPLEMENTING PROFITABLE REPRODUCTIVE TECHNOLOGIES

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INTRODUCTION

Currently, beef is 22% of the world meat production, but it is estimated that beef production will need to double to meet the increase in meat demand by 2050. This increase is being driven by the increasing world population, economic growth in developing countries, and dealing with current hunger and malnutrition debt. So, how are beef producers going to meet the new demands? The goal for beef cattle producers is to obtain a calf from their breeding females each year. Reproductive technologies provide opportunities for producers to improve efficiencies of their breeding herd and continue to increase the pounds of beef produced per cow without increasing herd size. This is important because, in order to pay for themselves, or the resources used during their development, breeding females must produce 3-5 calves in their lifetime (Clark et al., 2005).

Reproductive technology refers to any manner in which there is increased management or human intervention in the goal of breeding cattle versus simply turning out a bull and letting nature run its course. These technologies include detection of estrus, synchronization of estrus or ovulation, use of artificial insemination (AI), and further, the use of sex-sorted semen. Producers can select many or a few reproductive technologies to assist with management of their cowherd to enhance optimal profitability.

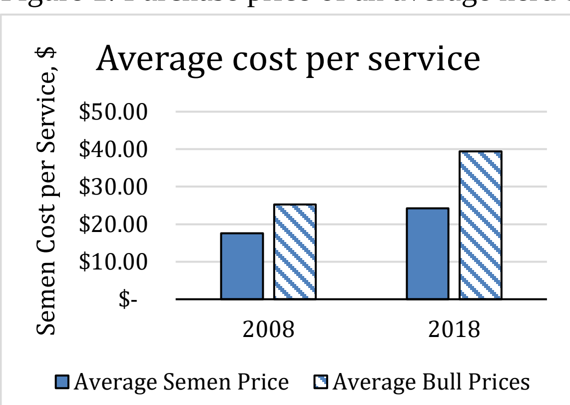
Although estrous synchronization of heifers and cows has been commercially available for over 30 years, beef producers have been slow to adopt this management practice. When asked about estrous synchronization, of the producers that did not use it, 18% said they were not convinced it was cost effective, 11% indicated it was due to time and labor demands, 9% indicated inadequate facilities, and 2% indicated prior poor experience. Furthermore, within the United States, fewer than 10% of beef animals are bred using AI (McBride and Mathews, 2011). Similar to reasons pertaining to the lack of adoption regarding estrous synchronization, the main reasons cited for the lack of adoption of AI were the time and labor required (Britt, 1987). When asked why they did not utilize AI, 29% indicated it was due to time and labor conflicts, 7% reported they were not convinced it would benefit their operation, 5% indicated insufficient facilities, and 2% indicated that they had tried and had a bad experience.

You may be asking “what is the benefit of utilizing AI over natural service?”. Use of AI allows producers to individually mate cows to selected sires thus matching genetics for economically important traits. Selection criteria for sires has focused on growth, calving ease and carcass characteristics. In addition to increasing the genetic potential, producing a more uniform calf can improve the producer's bottom-line. Reproductive technology, however, is more than just AI; estrous synchronization is a technology that can be used with natural service. The use of estrous synchronization allows more cows to conceive early in the breeding season, and research has reported that animals bred early in the breeding season have increased longevity in the herd (Cushman et al., 2013). Longevity of a beef female is very important to the sustainability and profitability of any beef operation, and ensures that females are in the herd long enough to produce enough calves to earn their keep and pay for themselves. Thus, reproduction is one area where technology and cost changes have occurred and where different management practices may help the competitive situation for operations.

COST PER SERVICE

Across all sizes of operations, 40% of operations purchase or use a specific bull for heifers (USDA, 2010). These bulls are generally selected for calving ease and low birth weight of their progeny, often sacrificing pre- and post-weaning growth potential. If that "heifer" bull who is selected based on calving ease is utilized on mature cows, calf growth is not optimized. In addition, over the past ten years the average price of a herd bull has increased 65% from $3,031 to $4,732 dollars (Figure 1). With current tight margins, producers may select a lower price bull to manage cost; however, calf performance may also be sacrificed. Semen cost per service (average bull price/30 cows per yr/4 yr) for these purchased bulls was $25.26 and $39.43 for 2008 and 2018, respectively. For a beef operation, this is a substantial expense. However, through artificial insemination farms have access to genetic-leading bulls in the industry. The average price increase over this same period of time has been only 23% per straw of semen (Figure 1).

Figure 1. Purchase price of an average herd bull between years 2008 ($3,031) and 2018 ($4,732) increased 56%, compared to only a 38% increase in the average price of a straw of semen over the same period of time ($17.62 and $24.24, respectively). Semen cost per service for herd bulls was calculated at average bull prices/30 cows per year/4 years. Data from Select Sires, personal communication and 2018 Angus Association Annual Report, page 4.



CALVING DISTRIBUTION

The time required to heat detect or breed on estrus has discouraged some producers from using AI. However, the development of fixed-time AI (FTAI) allows producers to utilize synchronization with similar conception rates to heat detection and breeding on estrus. When utilizing fixed-time AI, one concern some beginning producers have is the number of calves that will be born on a single day when so many conceive on a single day. Figure 2 shows the calving distribution for cows that conceive on the same day with FTAI varying by sire and cow genetics. Schafer (2005), studied gestation length of several different sires at various locations and found cows that conceived to FTAI calved over a period of 16 – 21 days. On average the maximum number of cows that calved on any one of those days was 16 - 20%. In addition, depending on the calving ease rating of the sire, cows may begin calving two weeks prior to their anticipated due date and conclude calving one week after the due date (based on 285 day gestation). This distribution suggests that use of FTAI will not result in an overwhelming number of cows calving on one day.

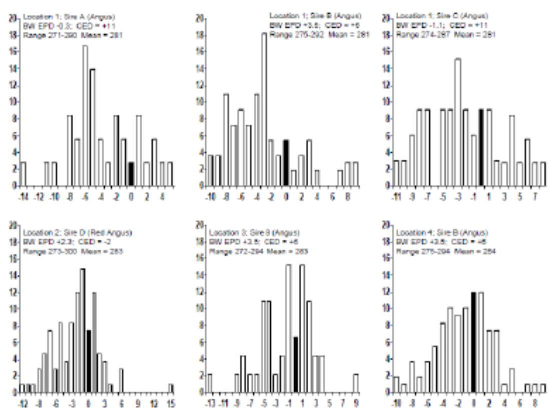


Figure 2. Calving distribution of cows conceiving to fixed-time AI (Schafer, 2005). Dark bar is anticipated due date based on 285 day gestation

To decrease the length of the calving season and to improve the genetic potential of the product, estrous synchronization and AI of cattle remains the most important and widely applicable reproductive biotechnology available (Seidel, 1995; Figure 3). Of the 35% of

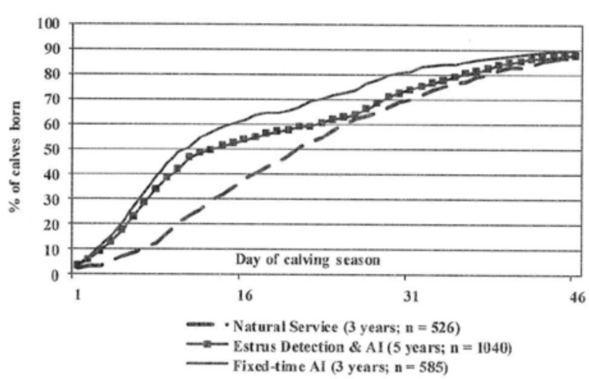


Figure 3**.** Cumulative calf crop for the first 46 days of the calving season over an 11 year period from the University of Missouri Thompson Farm. (Adapted from Patterson et al., 2006)

producers that did utilize estrous synchronization, all indicated it allowed for better management of time and labor (breeding and calving).

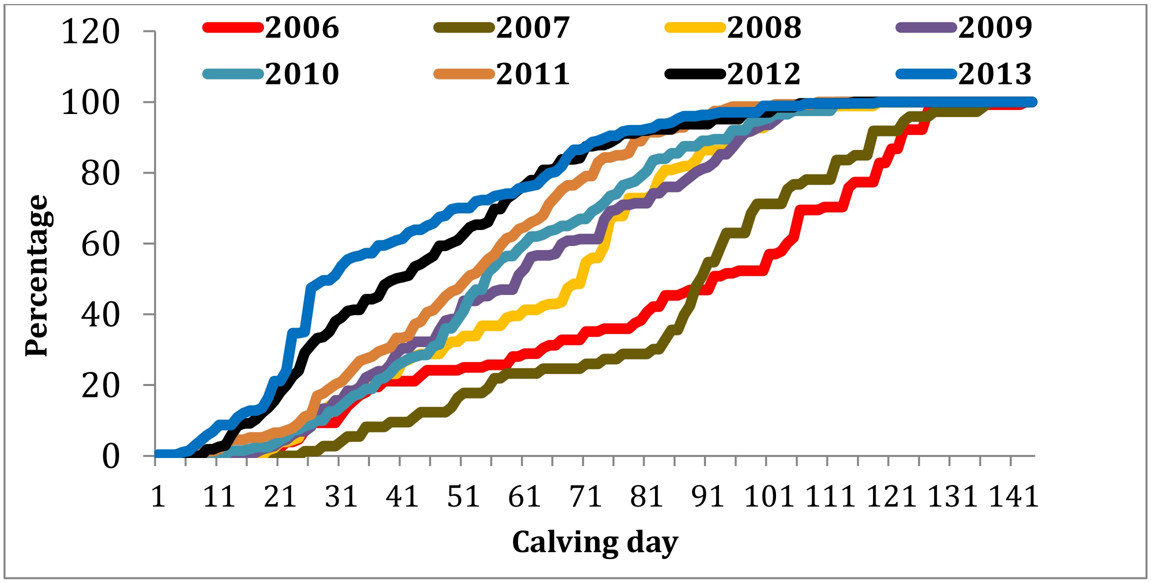


Figure 4. Cumulative calving by year for two years (2006 and 2007) prior to introducing TAI and five years (2008 to 2012) after introducing TAI (Lamb, personal communication).

Lamb (personal communication) implemented an extensive reproductive program on a 300 cow herd at the North Florida Research and Education Center (NFREC) in 2008. Through the use of an estrous synchronization and AI program, they were able to shorten the breeding season and increase calf value. Over a five years period of time using this program they were able to reduce the previous 120 day breeding season to 70 days (Figure 4). This provided a more compact calving season (more uniform calf crop) that increased the value of their calves ($124/calf: 2012 prices).

Estrous synchronization with natural service or AI has resulted in more calves during the first 21 days or first cycle of the calving season. With natural service, Lamb and coworkers (2008) reported a greater portion of the cows synchronized with a CIDR alone were pregnant at 14 days compared to non-synchronized cows. Steichen et al. (2013) reported a greater proportion of cows gave birth in the first 21 days with fixed-timed AI compared to cows mated via natural service (54.2 vs 39.5%, respectively). However, in the next 21 day period (d 22-42) a higher percentage of the natural service cows calved compared to the fixed timed AI cows. Walker et al. (2018) reported synchronized cows produced more calves in the first 10 days of the calving season. However, non-synchronized cows had a greater number of calves between days 11-21 and days 22 – 42. Increasing the uniformity of calves as well as producing older calves normally provide financial benefits.

MARKETING CALVES

Marketing calves each year is a challenge. Many operations market calves at weaning or shortly thereafter at their local market, hoping to receive good prices. Therefore the value of these calves at weaning is based mostly on weight and on the price being offered at their local market. Calves that are born later in the calving season weigh less at a fixed weaning date compared to their older herdmates. An analysis of weaning records from USDA – Meat Animal Research Center shows that one day of age difference at weaning translates to 2.4 pounds less weaning weight (R. Cushman, personal communication). This translates to a loss of approximately $3.84 per day, or $27 per week per calf as the calving season progresses (assuming a market price of $160/cwt). Given such economic ramifications, there is a clear advantage to having calves born as early as feasible in the calving season and/or maintaining a shorter calving season.

By implementing reproductive management practices, producers may more readily maximize the number of animals that conceive early in the breeding season, thus adding value to their calves, and creating more marketing opportunities for their operations.

There are numerous estrous synchronization protocol that producers can select from that will result in good conception rates if it fits their operational management (Bridges et al., 2014). However, management of the protocol is important to getting optimal results. Natural service versus artificial insemination following estrous synchronization will also impact the selection of the optimal protocol. This paper and presentation will not focus on the various reproductive technologies rather the results of using these technologies.

SHIFTING GENDER MAKE-UP OF CALF CROP

In addition to traditional AI, the commercialization of “sexed semen” can greatly impact the calf crop produced. Hall and Glaze (2013) reported a shift in gender ratio from 50:50 to 78:22 female (semen sorted for X chromosome), and 65:35 male to female ratio (semen sorted for Y chromosome), after only one use of sexed semen following estrous synchronization. Hall and Glaze (2013) reported that this allowed for the production of two loads of steers instead of one load of steers and one smaller load of heifers from a single small operation. This technology has been utilized in dairy cattle for several years, but has been slower to be adopted by the beef industry. Several studies have reported reductions in AI pregnancy rates when using sexed semen (Deutscher et al., 2002 with 3% to 13% reduction; Rhinehart et al., 2011 with 4% – 38% reduction; Meyer et al., 2012 with 17% reduction). However, Hall et al. (2010) reported similar pregnancy rates when using sexed semen compared to conventional semen, and further progress is continually being made to ensure similar sexed semen pregnancy rates compared to conventional semen. In a large field study, beef heifers and cows (n = 878) in six herds were synchronized with the 7-d CO-Synch plus CIDR protocol, and inseminated (AI) at the appropriate time after CIDR removal (cows 60 to 66 hrs; heifers 52 to 56 hrs). Estrus detection aids were applied at CIDR removal and estrus activity was determined at the time of AI. Overall, conventional semen had greater conception rates compared to gender-sorted semen (67.2 vs 52.4). This resulted in gender-sorted semen being 78% of conventional semen across all animals, however, gender-sorted semen was 89% of conventional semen among animals that had exhibited estrus (Perry et al., 2018). Therefore, use of sex-sorted semen in animals that have exhibited estrus could be a way to maximize pregnancies when using this technology.

CARCASS PERFORMANCE FOR PROGENY

South Dakota State University has conducted the Calf Value Discovery (CVD) Program since 1991. Based on performance records, the least profitable calves were the youngest calves in the CVD program. However, the CVD program does not know where these younger animals fall into each producer's calving distribution. The results for calf-fed steers are consistent with similar data sets showing that the most profitable cattle were those that were the fastest gaining, with the heaviest HCW, and a greater percentage grading Choice or higher (Walter and Hale, 2011).

Funston et al. (2012) followed calves from birth to harvest for several years. Calves were classified as being born in the first, second, or third 21-d period. Weaning weights followed the expected performance, older steers weighed more than the second group of steers and the 2nd group more than the 3rd group (Table 1). This pattern followed through to final feedlot weights and hot carcass weights. The oldest steers (groups 1 & 2) had more 12th rib fat than the youngest steers. A decrease in marbling score occurred from the oldest steers to the youngest animals. Marbling score is an indicators of quality grade. Hence, the percentage of steers grading average choice or higher was correlated to age, with the oldest group of steers grading higher within the USDA quality grade compared to the younger groups.

Table 1. Effect of calving period on feedlot performance and carcass characteristics of steer progeny

	Calving period		
Item	1	2	3
Calf birth BW, lb	81.4	83.6	83.6
Calf weaning BW, lb	523.6	495	448.8
Preweaning ADG, lb/d	2.09	2.11	2.11
Feedlot performance			
Feedlot ADG, lb/d	3.61	3.61	3.65
Final BW, lb	1,298	1,276	1,236
Carcass characteristics			
HCW, lb	816.2	803	776.6
12th rib fat, in	0.53	0.51	0.47
LM area	13.5	13.5	13.6
Yield grade	3.0	2.9	2.7
Marbling score	569	544	519
USDA average choice or greater	34	19	14
Carcass value, $	1,114	1,089	1,040

Adapted from Funston et al. (2012)

BENEFITS ON HEIFER CALVES

Cushman et al. (2013) reported that in addition to calves born earlier in the calving season being older and heavier at weaning, there was also potential benefits on heifers is regard to longevity within the herd. Their research showed that heifers that calved with their first calf in the first 21-d period of the calving season had increased longevity in the herd compared to heifers that calved in the 2nd or 3rd 21-d periods. Additionally, weaning weights of the first six calves born to heifers that calved in the 1st calving period of their first calving season were greater than those of heifers that calved in the 2nd or 3rd period of their first calving season (Figure 5).

In addition to following steers to harvest, Funston et al. (2012) followed heifer calves into their reproductive performance. There was a linear decrease in weaning and prebreeding weight from the oldest to youngest heifer calves. The heifers born in the 1st 21-d period (70%) had a higher percentage of animals cycling at the beginning of the breeding season compared to those heifers born in the 2nd 21-d (58%) or 3rd 21-d (39%). However, pregnancy rates were similar between the oldest heifers (1st and 2nd 21-d period, 90 and 86, respectively) and these groups were greater compared to youngest heifers (78%). The oldest group of heifers calved earlier than the younger heifers. Additionally, the heifers born in the 1st 21-d period had more calves born in the 1st 21-d period compared to heifers born after day 21 in the calving season.

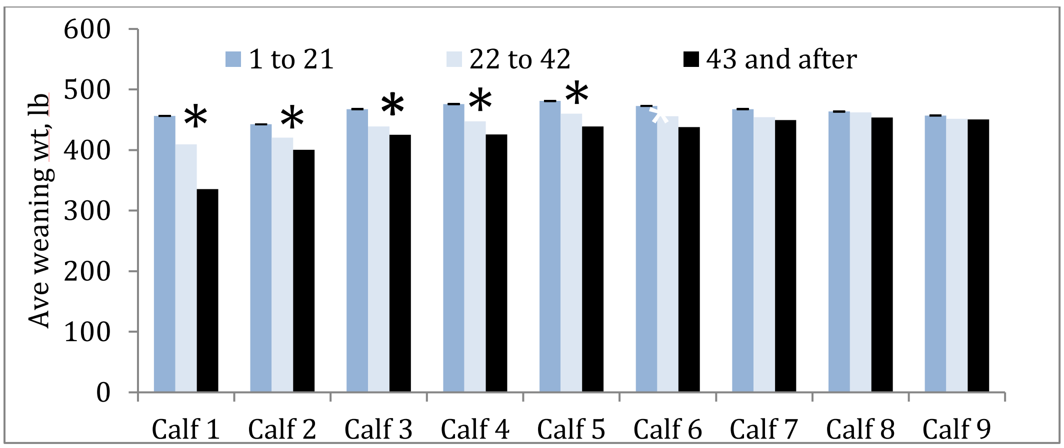


Figure 5. Calf weaning weights based on heifer calving period during their first calving season. (Cushman et al., 2013)

ECONOMIC IMPACT OF REPRODUCTIVE TECHNOLOGIES

Unfortunately, even with potential labor savings from a short calving season and with increased weaning weights from calves born early, the cyclic volatility in cattle prices often leads to lower gross incomes and difficulty in maintaining profitability (Dunn et al., 2005; Taylor and Field 1995). Therefore, to maintain profitability it is essential that farms seek a high value on the product they produce. The most efficient and economical method to facilitate genetic improvement of economically important traits in the beef industry is through AI with semen collected from genetically proven sires. Using AI decreases the performance costs of using a bull suited for heifers on cows. Calves from genetically proven AI sires are, in essence, value added products. Calves produced from superior sires should be more valuable to either sell or retain due to performance advantages in the feedlot and increased carcass value.

The relative value of steer and heifer calves depends on factors such as expected value of fed cattle, the price of corn and other inputs and market expectations related to the cattle cycle. However, steers typically trade at a premium to heifers of the same weight. Lighter weight steers and heifers generally have a lower value per head compared to heavier animals, even though the price per cwt. may be higher for the lighter cattle (Zimmerman et al. 2012). Lot size was also reported by Williams et al. (2012) to impact market price. They modeled price as a function of the natural log of lot size. As lot size increased, especially at small lot sizes (< 16 head), price sharply increased before leveling out at larger lot sizes. Similar sharp increases in prices for lot size were found and discussed by Bulut and Lawrence (2007) and Blank, Forero, and Nadar (2009). Zimmerman et al. (2012) also found a non-linear relationship for lot size; price paid increased at a decreasing rate as lot size increased. The make-up of a lot was also significant, as pens with high uniformity of weights and frames brought premiums of $2 per cwt., while non-uniform lots brought discounts of $1-3 per cwt. Based on the prices reported by Livestock Marketing Information Center for weeks from 10/18/14 to 11/8/14 ($288.81/cwt), the value for the calf crop produced by Hall and Glaze, (2013) would have increased from $7,885 to $9,451. Assuming increased costs of $15 per head more for sexed semen, this shows a potential increase in ranch income of $5,635 to $7,201 for calves sold from a 130 cow operation.

SUMMARY

In summary, to meet the growing demand for beef, there is increased pressure on producers to become more efficient in all aspects of production. As discussed, the inclusion of reproductive technologies is a tool to accomplish this goal. Estrous synchronization with natural service or AI can allow for more calves being born early in the breeding season allowing for maximal return and profit out of the calves. Artificial insemination and the selection of genetically superior bulls will complement the cow/heifer qualities and in turn increase the quality of the product produced. Furthermore, including sexed-semen as a reproductive technology, especially in those females that have expressed estrus, will first maximize conception rates, and secondly provide opportunity to skew the gender ratios of your lot allowing for potential increases in income.

CONCLUSION

Reproductive technologies provide producers with tools to manage their breeding/calving season for the optimal financial return. However, producers need to complete cost assessment to determine what fits their program.

- Estrous synchronization allow cows/heifers to calve earlier and produce a more uniform calf crop. This technology can be used with or without AI.

- AI has allowed to producers to individually select mating to enhance high growth rate or other desire characteristics such as quality grade.
- Sexed-sorted semen allows producers to skew gender ratio for their desired program.
- Older steer calves produced through good reproductive management has provided producers with high quality calves that perform well in the feedlot.
- Female progeny have an opportunity to have heifers calve earlier and provide more pounds of weaning weight through the first six calves.

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