The 30-day game changer - reproductive management strategies to increase the percentage of calves born earlier in the calving season

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Introduction

Estrous synchronization and artificial insemination (AI) are reproductive management tools that have been available to beef producers for over 40 years. Synchronization of the estrous cycle has the potential to shorten the calving season, increase calf uniformity, and enhance the possibilities for utilizing AI. Artificial insemination allows producers the opportunity to infuse superior genetics into their operations at costs far below the cost of purchasing a herd sire of similar standards. These tools remain the most important and widely applicable reproductive biotechnologies available for beef cattle operations (Seidel, 1995). However, beef producers have been slow to utilize or adopt these technologies into their production systems. In addition, choosing replacement heifers is a major decision with long-term economic implications for a beef herd, because a replacement heifer must wean enough calves to pay for her development costs or risk incurring a net loss for the operation (Mathews and Short, 2001). Ideally, producers would like to choose replacement heifers that will conceive and produce a calf regularly for five or more years to maximize profits. Heifers that calve early in the calving season as 2-year-olds have greater lifetime calf production than heifers that calve later in the season (Lesmeister et al., 1973)

Several factors, especially during early development of estrus synchronization programs, may have contributed to the poor adoption rates. Initial programs failed to address the primary obstacle in synchronization of estrus, which was to overcome puberty or postpartum anestrus. Additionally, these programs failed to manage follicular waves, resulting in more days during the synchronized period in which detection of estrus was necessary. This ultimately precluded fixed-time AI with acceptable pregnancy rates. More recent developments focused on both corpus luteum and follicle control in convenient and economical protocols to synchronize ovulation. These developments facilitated fixed-time AI (TAI) use, and should result in increased adoption of these important management practices (Patterson et al., 2003). Current research has focused on the development of methods that effectively synchronize estrous in postpartum beef cows and replacement beef heifers by decreasing the period of time over which estrous detection is required, thus facilitating the use of TAI (Lamb et al., 2001, 2006, Larson et al., 2006). This new generation of estrus synchronization protocols uses two strategies which are key factors for implementation by producers because they: 1) minimize the number and frequency of handling cattle through a cattle-handling facility; and 2) eliminate detection of estrus by employing TAI.

High priority needs to be placed on transferring these current reproductive management tools and technology to producers, veterinarians and industry personnel to ensure they are adopted at the producer level and to provide the necessary technical support to achieve optimum results. Because current management, breed, economic, location, and marketing options are producer specific, it is essential to ensure that transfer of this technology is not presented in blanket recommendations. Producers receiving all the necessary, applicable information packaged to include, but not limited to, protocol administration, economic implications, and genetic improvements to the cowherd are more apt to implement these tools into their management systems and achieve positive outcomes as a result. Without timely transfer of this technology within the United States, our research products and technology will be more effectively utilized in foreign countries competing with the United States to produce and market high quality, uniform beef products. The recent development of estrous synchronization protocols for TAI in beef cows has the potential to alter reproductive performance in numerous herds.

Influence of calving date of replacement beef heifers

Replacement heifers that calve early in their first calving season remain in the herd longer (Burris and Priode, 1958; Lesmeister et al., 1973). Researchers have investigated the long-term ramifications of calving early as a heifer (Kill et al., 2012). An examination of the performance of heifers (n = 16,549) over a 21-year period at USMARC demonstrated that heifers that calved in the first 21 days of their first calving season were more likely to produce a fifth calf than those that calved later (Figure 1). These heifers weaned a heavier calf each year through their sixth calving season. Thus, identifying replacement heifers that will calve early is of great economic benefit to the cow-calf producer.

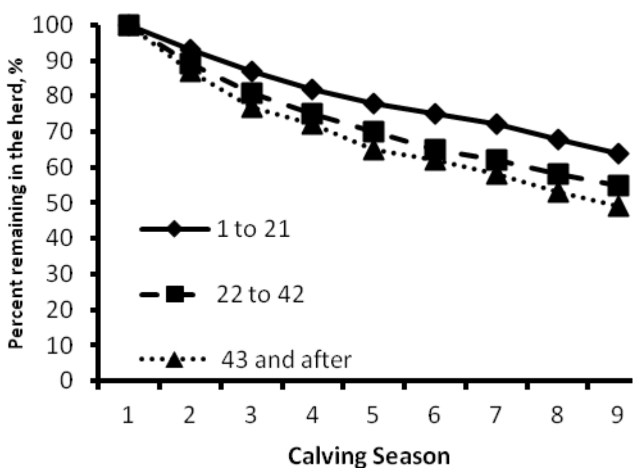

Figure 1. Herd survival analysis for heifers based on calving period during the first calving season as a heifer. Heifers that calved in the first 21 days of their first calving season were more likely to remain in the herd to produce a fifth calf.

More recently, age at puberty in crossbred beef heifers (n = 418) by twice daily observation for behavioral estrus. One week before the yearling heifers initiated their first breeding season, they were evaluated for antral follicle count by transrectal ultrasonographic examination of the ovaries (Cushman et al., 2009), an indicator of the number of primordial follicles in the ovary (Cushman et al., 1999) and an indicator of fertility in beef heifers (Cushman et al., 2009) and dairy cows (Mossa et al., 2012). Heifers were placed with fertile bulls for 60 days and allowed to calf normally. Retrospectively, antral follicle numbers at ultrasonography were analyzed with calving group as a fixed effect and age in days as a co-variate. Heifers that calved in the first 21 days had greater numbers of antral follicles at ultrasonography before breeding than those that calved in the last third of the calving season (Table 1).

There was no difference in age at puberty between the three calving groups. Thus, there appears to be a relationship between the ovarian reserve and calving day; however, histological evaluation of the microscopic populations of follicles in the ovary will allow us to better understand the mechanisms that associate this increased number of antral follicles with earlier calving and increased fertility. .

Table 1. Influence of calving day as a heifer on age at puberty and antral follicle count at pre-breeding ultrasonographic examination.

	Calving Period, d			
	1-21	22-42	>42	*P*-value
Heifers	222	129	67	-
Age at Puberty, d	315.2 ± 2.8	318.3 ± 3.6	317.9 ± 5.2	0.76
Antral Follicle Count[1]	23.0 ± 0.5[a]	21.7 ± 0.7[ab]	20.6 ± 0.9[b]	0.05

[1]Age in days was included in the model as a co-variate. Ultrasonography was performed and at breeding soundness exam approximately 2 weeks prior to the first breeding season.

Economic Implications of Combining Artificial Insemination with Estrus Synchronization (ES)

Incorporation of ES and AI has potential to influence economic efficiency of cow/calf enterprises (Sprott, 1999). Modeling exercises demonstrated a potential increased return of \$25 to \$40 per calf born from AI breeding for producers who decide to dedicate the time and effort required to successfully implement an AI protocol (Johnson, 2005). In addition, 72% of respondents to a survey administered at the *Applied Reproductive Strategies in Beef Cattle* workshops estimated the additional value of calves from AI breeding compared with natural service breeding to be over \$20, whereas 48% of respondents estimated the additional value at over \$50 (Johnson et al., 2011). Modeling of data generated from the sales of the Show-Me Replacement Heifer, Inc. revealed a premium of \$18.69 per pregnant heifer with a calf from AI breeding, and a premium of \$24.30 per pregnant heifer that was due to calve during the first 30 d of the calving season (Parcell et al., 2006). The \$18.69 economic advantage for AI pregnancies may need to be adjusted upward, as using estrous synchronization and AI may result in a greater proportion of cows calving within the first 30 d of a breeding season (Larson et al., 2006).

In an analysis which investigated the incorporation of ES and AI compared to natural mating in a cow/calf production setting (Rodgers et al., 2012). Suckled beef cows (n = 1,197) from 8 locations were assigned randomly within each location to 1 of 2 treatment groups: 1) cows were inseminated artificially after synchronization of ovulation using the 7-day CO-Synch + CIDR protocol (TAI; n = 582); and 2) cows were exposed to natural service (NS) without estrous synchronization (Control; n = 615). Within each herd, cows from both treatments were maintained together in similar pastures and were exposed to bulls 12 h after the last cow in the TAI treatment was inseminated. Overall, the percentage of cows exposed to treatments that subsequently weaned a calf was greater for TAI (84%) than Control (78%) cows. In addition, survival analysis demonstrated that cumulative calving distribution differed between the TAI and Control treatments (Figure 2). According to these data, not only are more calves weaned per cow exposed to ES and TAI, on average, but calves may be older at weaning and have had the opportunity to gain more weight. In addition, increased returns plus decreased costs (\$82.32), minus decreased returns plus increased costs (\$33.18) resulted in a \$49.14 advantage per exposed cow in the TAI treatment compared to the Control treatment (Table 2). Location greatly influenced weaned calf weights, which may have been a result of differing management, nutrition, genetic selection, production goals, and environment. We concluded that estrus synchronization and TAI had a positive economic impact on subsequent weaning weights of exposed cows.

This increase in weaning weight may have the greatest potential to offset the cost of ES and TAI systems. Although the improvement in genetics is a significant and long-term improvement, many producers have a desire for an immediate recovery of costs. Such costs can be recovered with the increase in total pounds produced. The increase in total pounds produced was due to cows producing more weaned calves which tend to be older and heavier. It is clear that the benefits of ES in combination with AI will continue to be realized and incorporated into beef production systems, with a subsequent improvement in efficiency of beef cattle operations.

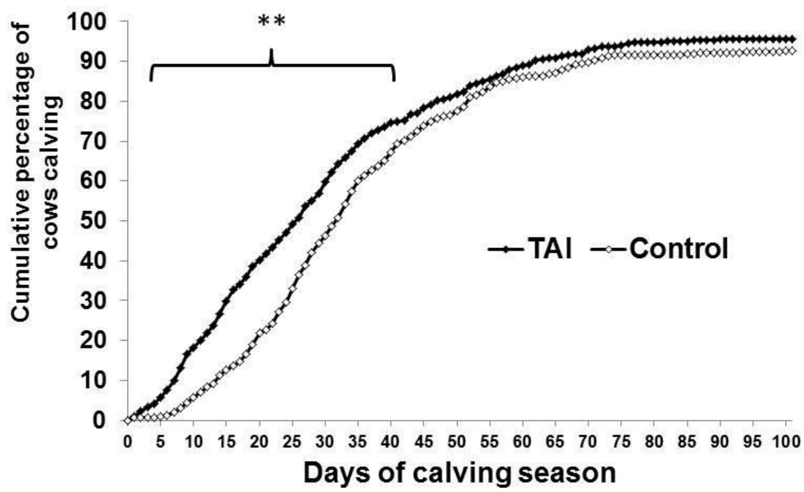

Figure 2. Survival analysis of the percentage of cows calving by day during the calving season. ** Cumulative calving percentage differs ($P < 0.05$) between TAI and Control treatments.

Impact of Utilizing Multiple Reproductive Technologies – A Case Study

An example of the influence of utilizing multiple technologies on the subsequent value of the calf crop is reflected in a case study conducted at the University of Florida - North Florida Research and Education Center (NFREC) located in Marianna, FL. This case study was conducted during the spring 2008 to spring 2013 breeding seasons, in a cow/calf operation consisting of 300 cows. Prior to 2008, the herd was exposed to a 120 d breeding season. The goal was to reduce the breeding season to 70 d within 4 yr. In order to achieve this, it was decided that all females in the operation were exposed to the following criteria: 1) replacement heifers must become pregnant during the first 25 d of the breeding season; 2) every cow will be exposed to ES and TAI; 3) each cow must produce a live calf every year and calve without assistance or they will be culled; 4) every cow must provide the resources for the genetic potential of the calves and each calf she produces must be genetically capable of performing; 5) No supplemental feeding was offered to cows that failed to maintain body condition; and 6) any cow with an undesirable temperament or disposition was culled. As a result of incorporating multiple reproductive management practices, the breeding season was reduced from 120 to 70 d and almost all cows calve prior to initiation of the subsequent breeding season and are exposed to a single TAI on the first day of the breeding season (Figure 3). The net result is a more compact calving season (Figure 4) that has increased the value of calves (in current dollars) by $169 per calf or an annual increase in calf value for the 300 head operation of $50,700 per year (Table 3).

In conclusion, in most cases the land available for grazing is being utilized and portions of existing land are actually being transitioned from grazing land to crop land or even being overtaken by expanding urban development. The net result is either an unchanging or decrease in land available to support grazing beef herds. Therefore, the long-term sustainability of beef production systems likely depends on the intensity of management and production level achieved with existing resources (Galyean et al., 2011). Reproductive technologies allow producers to maximize the potential of existing resources which will be imperative if our industry is to rise to the challenge of providing an affordable nutritious protein source to an expanding global population for generations to come.

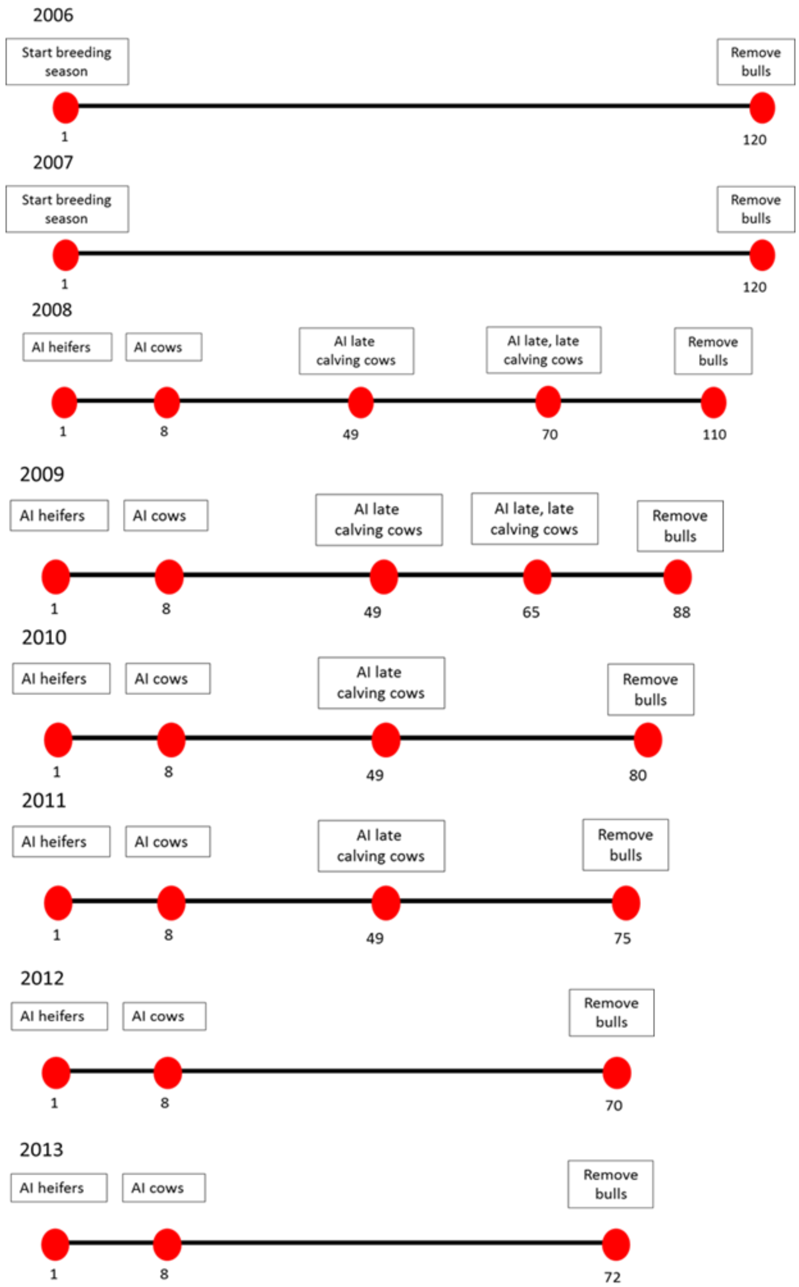

Figure 3. Overview of breeding season length and artificial inseminations schedule from 2006 to 2013

Table 2. Partial budget analysis for cows exposed to estrous synchronization followed by natural service compared to cows exposed only to natural service (expressed in US dollars; Rodgers et al., 2012)[1]

Item	Increased returns[2]	Decreased costs[3]	Decreased returns[4]	Increased costs[5,6]	Gain or loss	Net additional costs[7]	Additional weight, kg[8]	Breakeven price[9]
Herd sensitivity analysis:								
1	45.71	42.81	0	33.18	55.34	-9.63		
2	31.19	21.41	0	33.18	19.42	11.77	4.43	67.26
3	56.74	48.93	0	33.18	72.49	-15.75		
4	123.15	48.93	0	33.18	138.90	-15.75		
5	-10.49	37.46	0	33.18	-6.21	-4.28		
6	44.64	24.79	0	33.18	36.25	8.39	3.15	47.94
7	30.65	32.74	0	33.18	30.21	0.44	0.17	2.51
8	55.12	24.79	0	33.18	46.73	8.39	3.15	47.94
Overall[10]	47.09	35.23	0	33.18	49.14	-2.05		

[1]All returns and costs based on a weaning weight of exposed cows.
[2]Additional weight attributed to estrous synchronization (ES) and fixed-time artificial insemination (TAI) per weaning weight of exposed cows × selling price ($121.00/45.5 kg).
[3]Annual NS bull costs: annual operating costs: grazing and supplemental feed ($365.00), veterinary medicine ($40.00), annual ownership costs: depreciation ($557.00), interest cost ($151.00), death loss ($33.00): purchase price ($3270.00).
[4]Decreased returns attributed to fewer NS bulls to be culled are included as a negative value in the decreased costs calculation.
[5]Labor hours (0.41 h) per ES/TAI cow at $10.00 per hour.
[6] Supplies: Prostaglandin = $2.07/dose, CIDR = $8.76, GnRH = $2.00/dose × 2 doses,
Miscellaneous. $0.25, Semen $14.00/unit.
[7]Net additional costs as increased costs minus decreased costs.
[8]Additional weight per exposed cow to cover net additional costs at $121 per 45.5 kg (only in situations where additional costs were noted).
[9]Overall breakeven prices ($ per 45.5 kg) to cover additional costs with additional 17.5 kg pounds weaned per cow exposed to treatment.
[10]Calculated using a bull to cow ratio of 1:17.

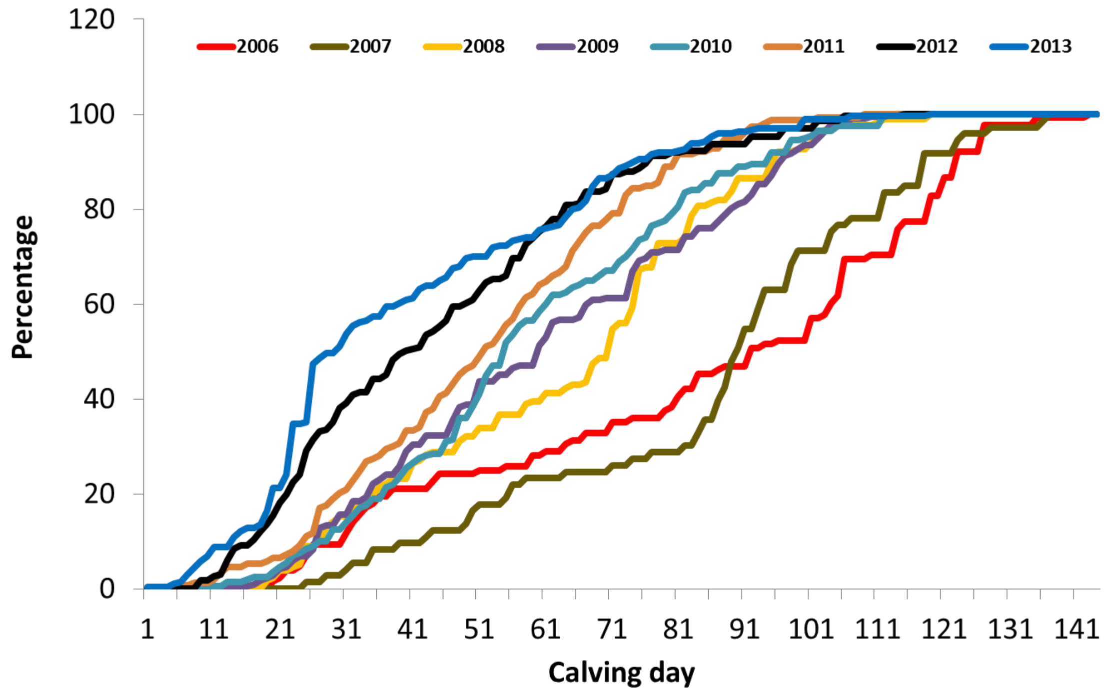

Figure 4. Cumulative calving by year for two years (2006 and 2007) prior to introducing TAI and five years (2008 to 2013) after introducing TAI.

Table 3. Breeding season characteristics and change in calf value by incorporating a TAI program into the NFREC Beef herd

	Year							
Item	2006	2007	2008	2009	2010	2011	2012	2013
Overall PR, %	81	86	84	86	82	94	92	93
Mean calving day[a]	79.2	80.9	59.2	56.2	53.7	47.2	39.5	38.7
Breeding season length, d	120	120	110	88	80	75	70	72
Difference from 2006/2007	0	0	21.7	24.7	27.2	33.7	41.4	42.2
Per calf increase in value[b], $	0	0	$87	$99	$109	$135	$166	$169
Per herd increase in value[c], $1,000	0	0	$26	$30	$33	$40	$50	$51

[a] Mean calving day from initiation of the calving season
[b] Increase calf value based on increased weaning weight compared to 2006/2007 mean calving day with 500 lb calf valued at $2.00/lb
[c] Increase calf value based on 300 head cow herd.

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