SYNCHRONIZATION OF ESTRUS FOR NATURAL SERVICE AND BULL POWER AFTER FIXED TIMED ARTIFICAL INSEMINATION

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Introduction

Although estrus synchronization and artificial insemination are tools that have been available for producer utilization for decades, incorporation of these tools has been limited in the beef cattle sector. In fact, the majority (95.7 % surveyed) of beef producers in the United States report utilizing bulls only in their herds (NAHMS, 2009). Reports suggest producers have greater concerns about the difficulty of these procedure (17.8% surveyed) and labor/time involved (37.3%) than those concerned with the efficacy of estrus synchronization (2.3%) or artificial insemination (1.6%; NAHMS, 2009). Utilization of estrus synchronization has been reported to shorten the breeding season, initiate cyclicity in some anestrus animals, and increase the number of animals bred early in the breeding season (Lucy et al., 2001; Larson et al., 2009). Furthermore, there seems to be a misconception that in order to use estrus synchronization, artificial insemination must be utilized. This mindset, or similar concerns have likely limited the amount of estrus synchronization conducted in the beef industry in conjunction with natural service. The objective of this presentation is to provide information regarding utilization of estrus synchronization coupled with natural service as a viable option for beef cattle producers. Additionally, we will discuss the factors associated with bull requirements following fixed time artificial insemination.

Calving Early in the Season

One of the main benefits of estrus synchronization is the ability to increase the proportion of calves born early in the calving season. Funston et al. (2012) investigated the impact of calving distribution on beef cattle progeny performance. Calving data collected over a 14 year period were analyzed with calves being classified as being born in the first, second, or third 21 days of the calving season within a given year (Table 1). Steer progeny born in the first 21 d of the calving season were approximately 29 and 46 pounds heavier ($P < 0.01$) at weaning than steer progeny born in the second and third 21 days of the calving season, respectively. This difference can be attributed to calf age, as calf adjusted 205-d weaning weights do not differ ($P = 0.77$) among treatments. Differences in body weights among groups are maintained ($P < 0.01$) through slaughter as hot carcass weights were 13 and 26 pounds greater for calves born in the first 21 days compared with calves born in the second or third 21 days respectively. Additionally, carcass value was greatest ($P < 0.01$) for calves born during the first 21 days of the calving season (Funston et al., 2012). Together these data highlight the production and economic advantages of managing cows to calve early in the calving season.

There are also obvious production benefits for the cow as it allows for greater post-partum intervals prior to the breeding season which could potentially increase the ability for the cow to become pregnant early in the subsequent breeding season. Researchers at the U.S. Meat Animal Research Center (USMARC) in Clay Center, Nebraska analyzed the calving records of 16,549 replacement

Table 1. Impact of calving period on steer progeny performance (adapted from Funston et al., 2012)

	Calving Period[1]				
Item	1	2	3	SEM	P-value
n	431	287	53		
Birth date, day of year	73[a]	91[b]	116[c]	2.40	<0.01
Calf weaning BW, lb	524[a]	495[b]	449[c]	11	<0.01
Calf adjusted 205-d BW, lb	539	539	543	11	0.77
HCW[2], lb	816[a]	803[b]	777[c]	7.7	<0.01
Carcass value, US$	1,114[a]	1,089[b]	1,040[c]	13	<0.01

[1]1= called in the first 21 days; 2 = calved in the second 21 days; 3= calved in third 21 d of the calving season.
[2]Hot carcass weight.

heifers born from 1980 to 2000 (Cushman et al., 2013). Animals were placed in 1 of 3 calving groups (first, second, or third 21-day period) based on calving date as a 2 year old heifer. Heifers that calved in the first 21 days remained in the herd longer ($P < 0.05$) than those calving for the first time in the second or third 21 days of the calving season. Coincidentally, age when diagnosed as open was greater for cows that calved in the first 21 days as a 2 year old (8.2 ± 0.3 years) compared to those calving in the second (7.6 ± 0.5 years) or third 21 days (7.2 ± 0.1 years) of the calving season (Cushman et al., 2013). Additionally, pregnancy rate was greater for cows calving in the first 21 days each year from second breeding season through the sixth breeding season compared with cows from either the second or third 21 day calving groups. This improvement in pregnancy rate and overall increased herd retention is likely a function of improved physiological status in the cows calving in the first 21 days as a heifer. Due to the earlier calving date in cows that calved in the first 21 days compared to second or third 21 days, postpartum interval was 113 days compared to 92 and 71 days in second and third 21 day calving groups, resulting in a greater amount of time for uterine involution and preparing for the next breeding season.

Estrus Synchronization and Natural Service

There are numerous factors associated with implementing a sound natural service mating program coupled with estrus synchronization. This presentation will focus on female response to synchronization products and protocols and limit the amount of discussion placed on bull libido, age, and soundness. These topics are covered in previous presentations (Dahlen, 2013; Dalton, 2018). Although nearly all approved heifer and cow synchronization protocols could be considered viable for synchronizing estrus prior to bull turn out, producers should be mindful of protocol costs and labor demands prior to implementation. Prostaglandin in known to lyse the mature corpus luteum, thus for effective administration, this product should be given between days 6 and 16 of the estrous cycle. The challenge for most producers is not knowing which day of the estrous cycle each cow is on, thus knowledge of the herd or cattle should be utilized to select a protocol that would be most effective. In a non-synchronized herd, it can be assumed that on any given day approximately 5% of the herd should display estrus (21 day estrous cycle, 1 day ÷ 21 day cycle). This would mean approximately 55% of the animals in the herd would have a corpus luteum that should respond to PG administration, while 45% will either have a developing (d 1-5) or regressing (d 17-21) corpus luteum. Two injections of PG administered 11 to 14 days apart have been found

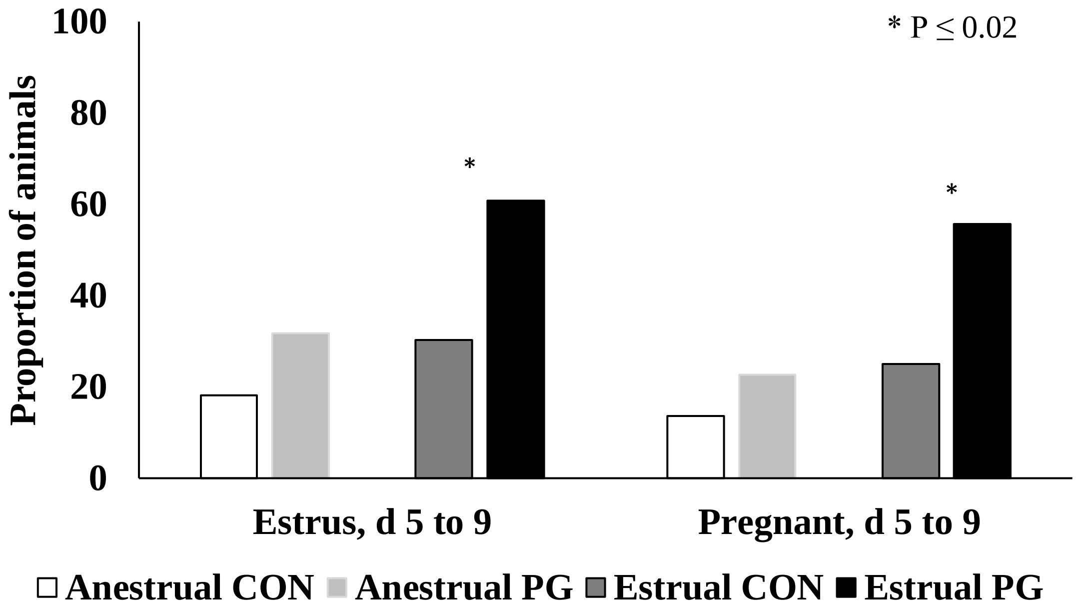

Figure . Influence of single injection prostaglandin (PG) administered 96 hours after bull turn in (adapted from Whitter et al., 1991)

to be an effective method for synchronizing estrus in cattle (Wiltbank et al., 1967; Inskeep, 1973; Cooper, 1974). A single injection of PG can be administered effectively to synchronize estrus; however, best results are reported when administration of PG occurs after bulls are turned in with cows. Whitter et al. (1991) determined PG administered 96 hours after bull turn out resulted in an increase in the proportion of cows displaying estrus (+30.5%) from days 5-9 of the breeding season and increased proportion of cows pregnant (+30.7%) during this same time compared to saline treated animals. It should be noted that these animals were determined to be estrual prior to the breeding season. There were no differences reported among treatments in anestrual cows.

Table 1. Effect of estrus synchronization and natural mating system on reproduction and calf production (adapted from Larson and Funston, 2009)

	Estrus Synchronized			
Item	No	Yes[1]	SEM	P-value
n	2075	521		
Calf birth date, day of year	86	85	1	0.23
Calved first 21 days, %	61	73	2	< 0.001
Calved second 21 days, %	33	23	2	< 0.001
Calf weaning BW, lb	482	502	9	< 0.001

[1] Estrus synchronized via a single injection prostaglandin administered 108 hours after bulls turned in with cows.

Furthermore, Larson et al. (2009) reported a 13% increase in the proportion of heifers calving in the first 21 days of the calving season when a single injection of prostaglandin was administered approximately 108 hours after bull turn-in (Table 1). Weaning weights did not differ ($P = 0.58$); however, postpartum interval would have been greater in the synchronized group of heifers which would likely aid in improving the proportion of the synchronized heifers becoming pregnant in the subsequent breeding season.

Recently, our group utilized 259 Angus-based cows to determine the effectiveness of 2 estrus synchronization protocols coupled with natural service on reproductive efficiency and economic viability in extensive rangeland systems. Cows were stratified by days post calving and randomly assigned to 1 of 2 synchronization protocols: 1) Select Synch + CIDR or 2) a single injection of prostaglandin administered 4.5 d after exposure to bulls. Heat detection aids were placed on cows at d 0, corresponding with day of CIDR removal and bulls placed with cows at a 1:20 bull:cow ratio for a total of 60 d. Estrus was monitored twice daily for 10 d to identify animals responding to the synchronization protocol. Thirty days after the first 10 d of bull exposure and 45 d after bulls were removed, blood samples were collected on each cow to diagnose pregnancy. Estrus response was greater ($P < 0.01$) over the first 8 d of the breeding season for CIDR cows (44 ± 4.3%) than prostaglandin treated (29 ± 3.8%) cows. Similarly, early pregnancy rates (64 vs 65 ± 4.2%) and overall pregnancy rates (97 vs 98 ± 1.8%) were similar ($P \geq 0.97$) between treatments. Cows treated with the CIDR protocol calved earlier ($P = 0.02$) when compared with prostaglandin treated cows (65 vs. 72 ± 1.9 Julian d, respectively). Similarly, the proportion of cows calving within the first 21 d of the calving season was greater ($P = 0.05$) for cows receiving the CIDR protocol compared to prostaglandin treated cows. Despite a greater percentage of CIDR cows calving in the first 21 d, calf weaning body weight was similar ($P = 0.90$) among treatments. Cost of synchronization between the 2 estrus synchronization systems was $18.41/cow less for the PG treated compared to CIDR treated cows. Increased synchronization costs associated with the CIDR protocol are directly related to the cost of the CIDRs, as well as, additional labor required for the CIDR protocol. As expected CIDR treated cows had an increased estrus response, however, overall reproductive performance of young cows was similar when comparing CIDR and prostaglandin treated based synchronization protocols.

Bull to Cow Ratio for Natural Service

Prior to turning bulls out with cows when using natural service, bull hierarchal order should be established. Additionally, based on results from Pexton et al. (1990), experienced bulls (≤ 2 years of age) had improved pregnancy rates per serviced female and overall pregnancy rates compared with yearling bulls. Additionally, yearling bulls had a greater number of mounts compared with both 2 and 3 year old bulls (207, 120, 86, respectively). These behavioral aspects of breeding could lead to fewer females being serviced over the course of the breeding season and lower herd fertility. Although not every cow is going to respond to the synchronization protocol, it is important to consider decreasing bull:cow at the beginning of the breeding season when a greater proportion of cows should come into heat over a short time frame. Healy et al. (1993) reported a 7 percentage point decrease in 28 day pregnancy rates for synchronized heifers at a 1:50 bull to heifer ratio compared to counterparts in a 1:16 bull to heifer ratio pasture. It is suggested producers use a 1:15 to 1:25 bull to female ratio in instances that females have undergone estrus synchronization.

Bull to Cow Ratio after Fixed-Time Artificial Insemination

Following fixed-time artificial insemination (FTAI), cows are typically placed with bulls for the duration of the breeding season. The challenge for many is determining the proper bull to female ratio during this period. Given the parameters set in the previous section for bull to female ratios:

1:15 to 1:25, it could be determined that a producer calculate the necessary bull power based on herd historical AI pregnancy rates, or use the theoretical 50% rate to cut bull power in half assuming 50% of cows AI bred will become pregnant and maintain the pregnancy.

Summary of AI and final pregnancy rates of varying bull to female ratios in reported literature (adapted from Nielson and Funston, 2016).

Synchronization Protocol	AI Method[a]	Female age[b]	Number of females	Breeding Season Length, d	AI Pregnancy Rate, %[c]	Final Pregnancy Rate,%[d]	Reference
NORMAL[e]							
7 day CIDR + PG (no GnRH)	HD	Cows	96	30	43.1	76.4	Lake et al., 2005
16 d CIDR + GnRH (2 d) + PG (1 wk)	HD	Heifers	65	28	40.8	72.8	Devine et al., 2015
Synchromate B	HD	Cows	89	65	52.7	79.7	Fanning et al.,1995
MGA + PG	HD	Cows	50	62	44.3	87.3	Berke et al., 2001
Select Synch	HD + TAI	Heifers and cows	80	46	56.3	92.1	Ahola et al., 2005
Co-Synch + CIDR	TAI	Cows	194	50	NR[f]	91.7	Cooke et al., 2012
Co-Synch + CIDR	TAI	Heifers	88	50	NR	82.5	Cooke et al., 2012
Synchromate B	TAI	Heifers	239	42	NR	73.5	Mulliniks et al, 2013
Co-Synch + CIDR	TAI	Cows	188	50	47.5	97.4	Thomas et al., 2009
MGA or 14 day CIDR	TAI	Heifers	1,385	50	61.5	91.5	Vraspir et al., 2013
Co-Synch + CIDR	TAI	Heifers	80	53	48.0	91.5	Bryant et al., 2011
Co-Synch + CIDR	TAI	Cows	102	-	41.4	70.2	Moriel et al., 2012
NORMAL Mean			2,806		56.1	87.8	
INTERMEDIATE[g]							
MGA-PG	HD	Heifers	104	60	67.0	92.0	Harris et al., 2008
5 or 7 d CIDR	TAI	Cows	138	40	55.8	77.5	Gunn et al., 2011

MGA-PG	HD + TAI	Heifers	500	61	49.7	93.0	Funston and Meyer 2012
2 shot PG	HD	Cows	34	30	54.5	90.9	Alexander et al., 2002
8 day half-cuemate	TAI	Heifers	316	50	29.8	64.6	Butler et al., 2011
INTERMEDIATE Mean			1,092		46.5	82.6	
HALF[h]							
MGA- PG	HD	Heifers	399	60	72.5	94	Summers et al., 2014
Co-Synch + CIDR	TAI	Heifers	191	45	NR	88.7	Mulliniks et al., 2013
MGA- PG	HD	Heifers	100	60	46.0	90.0	Harris et al., 2008a
MGA- PG	HD	Heifers	100	60	59.0	90.0	Harris et al., 2008b
MGA- PG	TAI or HD	Heifers	299	60	59.0	93.0	Funston and Larson, 2011
MGA- PG	HD	Heifers	1,005	60	58.7	91.0	Vraspir et al., 2013
MGA- PG	HD + TAI	Cows	121	60	48.5	87.0	Post et al., 2005
MGA- PG	HD	Heifers	64	29	NR	82.1	Sexten et al., 2005
MGA + 2 shots EB	TAI	Heifers	118	39	37.2	73.5	Baptiste et al., 2005
5 or 7 d Co-Synch + CIDR	TAI or HD	Heifers	2,660	85	52.8	88.3	Gutierrex et al., 2014
HALFMean			5,057		55.6	89.2	

[a]HD= heat detect; TAI= timed artificial insemination.
[b]Female age as reported as either cows or heifers.
[c]Percentage of female that conceived to AI.
[d]Percentage of females determined pregnant at the end of the breeding season.
[e]NORMAL = 1:20 to 30 bull to female ration following estrus synchronization and AI.
[f]NR AI Pregnancy rate not reported.
[g]INTERMEDIATE= 1:31 to 1:49 bull to female ratio following estrus synchronization and AI.

[h]HALF= 1:50 to 60 bull to female ratio following estrus synchronization and AI.

A review of the literature by Nielson and Funston reported

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