CONTROL OF ESTRUS WITH NATURAL SERVICE

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Introduction

The United States beef industry is dominated by herds that rely solely on bull breeding. The percentage of operations that relied only on bull breeding was 95.7% and of beef cows maintained, 98.3% were at least exposed to a bull during the breeding season (Figure 1; NAHMS, 2009).

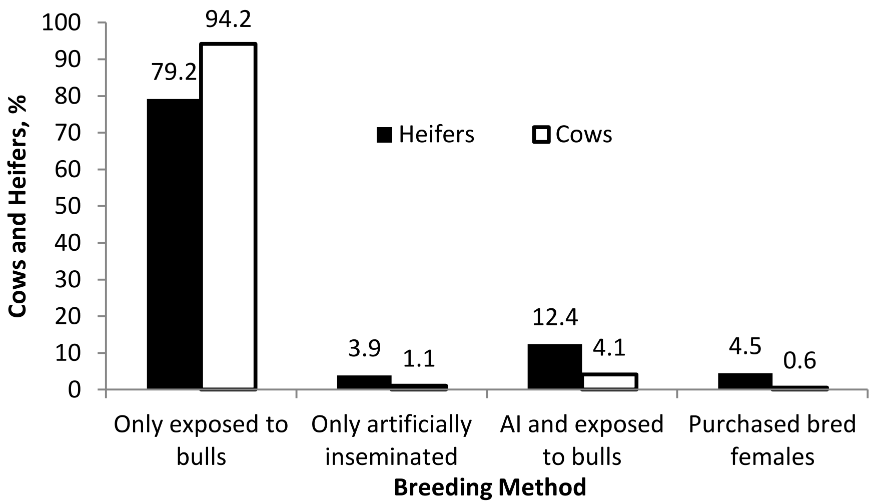

Figure 1. Percentage of heifers and cows bred by breeding method for calving in 2007. Adapted from NAHMS, 2009.

Synchronization of estrus with natural service breeding systems may offer opportunities for cattlemen in terms of greater season-ending pregnancy rates (Whittier et al., 1991) and conceiving earlier in the breeding season (Lamb et al., 2008) which may result in calves born earlier in the calving season and greater subsequent weaning weights (Larson et al., 2010).

In addition, in circumstances where synchronization products have been administered to cattle and a planned artificial insemination date is no longer a possibility (semen not delivered, semen tank ran dry, injured technician, etc.), breeding synchronized cows will bulls may be the only way to salvage a bad situation. In these instances it would be useful to know about the protocols used for synchronizing cows for natural service breeding and note that these protocols can be quite different than those used to synchronize females for AI.

This review will focus on bull factors and cow factors that contribute to the success of synchronization with natural service, along with protocol options for synchronization with natural service and several other important considerations

Bull Factors that Influence Success

One of the most frequent questions received regarding synchronization with natural service is the question of stocking rates; how many synchronized cows should one bull be expected to breed? In order to fully explore this question factors such as age, breeding soundness, and libido need to be evaluated before actually stocking rates are explored.

Age. When different ages of bulls were evaluated for breeding success and behavior in single-sire pastures notable differences were observed (Table 1; Pexton et al., 1990). As bulls become older the overall number of times the bulls mounted cows was reduced; but, no differences were present in the number of services (mount + intromission + ejaculation) among bulls of different ages. The greater number of mounts by yearling bulls reflects the fact that breeding is a learned behavior (Chenoweth, 1983) which bulls perfect with successive years of experience.

Table1. Breeding behavior and fertility of bulls of different ages.

	Age of Bull		
	Yearling	Two	Three+
Number of bulls	29	36	27
Females per bull	20.1	26.2	27.8
Number of mounts	207^{a}	120^{b}	85.8^{b}
Number of services	54.5	37.6	40.5
Estrus females serviced, %	69.4	73.8	72.0
Pregnancy rates of serviced females, %	39.6^{a}	59.4^{b}	62.2^{b}
Overall pregnancy rate, %	30.9^{a}	41.5^{b}	49.9^{c}

$^{a\text{-}c}$Means within row lacking common superscript differ ($P < 0.05$; Adapted from Pexton et al., 1990).

A smaller proportion of females that were serviced by yearling bulls became pregnant compared with those serviced by 2 and 3 year old bulls, and overall pregnancy rate was increased when older bulls were used (Pexton et al., 1990). Taken together, these results highlight the fact that **experienced breeding bulls (2+ years of age**) are the best candidates to use for synchronization with natural service.

Breeding Soundness. Breeding soundness examinations (BSE) include a physical evaluation, measurement of scrotal circumference, and an evaluation of semen motility and morphology (Society for Theriogenology, 1993). Recommended timing of BSE is prior to the beginning of each breeding season with enough time in advance of turnout to find new bulls if several bulls are categorized as “unsatisfactory” during the exam. Bulls could also have classification “deferred” and scheduled for a re-evaluation at a later time, or as “satisfactory” when no issues are noted according to the BSE criteria.

When cows were bred to bulls in either the satisfactory or deferred categories (termed “questionable” prior to 1993), a greater proportion of females bred to bulls classified as satisfactory breeders (46.6%) were pregnant at the end of the breeding season compared with females bred to bulls with classification deferred (36.5%; Farin et al., 1989). No differences, however, were observed among BSE classification in number of times bulls mounted females, number of services, or percentage of females serviced. Thus, a breeding soundness exam is an indication of potential fertility and not an indication of libido.

A measure not directly obtained in a routine breeding soundness exam is the concentration of sperm in the ejaculate. Questions about whether bulls breeding large groups of synchronized females would use all available sperm reserves and have no sperm remaining to impregnate cows are answered by a close look at sperm production. Production of semen in mature bulls is approximately 5×10^6 (5 million) spermatozoa per minute (Chenoweth, 1983). A commercial dose of AI semen may contain ~20 million sperm, which would only take a bull 4 minutes to produce. *Bos taurus* bulls in single- or multi- sire breeding pastures exposed to synchronized females bred on average 1 cow every 30 minutes over a 30 hour period of synchronized estrus (Farin et al., 1982). Based on the frequency of breeding and speed of natural sperm production it does not appear that the number of sperm present in ejaculates after heavy mating loads is limiting the number of cows a mature bull can successfully breed.

In addition, no differences in breeding soundness exam scores or individual components of scores (scrotal circumference, sperm morphology, and motility) were observed when exams performed prior to a 5 day synchronized breeding period were compared with those taken immediately after (Williams et al., 1988). This is evidence that the motility and morphology of semen, as measured by a BSE, were not impacted by the frequency of breeding.

Libido. High libido, or sex drive, is something that is certainly required of bulls that will be stocked with synchronized females. Service capacity tests place bulls in close proximity to immobilized females and evaluate sexual behavior over a fixed period of time (usually ~10 minutes). Bulls with high activity levels are classified as high libido bulls and bulls with "high" libido performed a greater number of mounts and services, and serviced a greater proportion of females in estrus compared with "medium" libido bulls (Farin et al., 1989). The greater proportion of females serviced, however, did not translate to a greater proportion of cows becoming pregnant by the end of the breeding season. Service capacity tests, therefore, give an indication of libido but not necessarily fertility.

Bulls that would be ideally suited for use in situations where a synchronization program is used with natural service mating would be those that have the combination of **high libido** and yearly **BSE classification of "satisfactory"**. If producers find on-farm service capacity tests impractical on their operations, careful observation of bulls during the breeding season may give an indication of libido. Watch for yearling (and mature) bulls that aggressively seek and breed females as potential candidates for servicing synchronized females in upcoming years.

Concerns of bulls "falling in love" and spending too much time with a single female were not realized in many cases (Pexton et al., 1990). However, four general conditions were responsible for bulls breeding a single female a high number of times (Pexton et al., 1990): 1) few females were in estrus, 2) inexperienced bulls shortly after turnout, 3) bulls that were fatigued toward the end of the breeding season, and 4) permissive females present in pasture.

One phenomenon that is recurrent throughout the literature is that fact that bulls are naturally selective about which females they will breed. A great range in number of services per female bred during a period of receptivity exists (ranging from 1 to 27 services in one report; Pexton et al., 1990). The number of services a single bull performs is typically much greater than the number of females in a breeding group. In some cases bulls will return to a previously bred female rather than breed a non-bred female that is showing all signs of behavioral estrus with other females. The proportion of females observed in behavioral estrus that were actually bred ranges from 60 to 80%, and bulls with high libido breed a greater proportion of females in estrus compared with bulls of medium libido (Farin et al., 1989). The reason that 20 to 40% of females in heat are not bred remains unknown. As the breeding season progresses and fewer females are receptive, however, bulls will likely become less selective.

Age, breeding soundness, and libido all ultimately contribute to generate minimum recommendations for bulls to consider for breeding with synchronized females:

- Age of 2+ years with previous breeding experience
- Complete Breeding Soundness Exam rated as "satisfactory" including physical exam
- High libido

Stocking Rate. Once bulls that meet the minimum requirements are identified for use in synchronized breeding scenarios, a final decision on stocking rates must be made. Several studies that have looked at the question of stocking rates of bulls breeding synchronized cows can help us understand the options available.

When stocking rates ranging from 7 to 51 synchronized females per bull were evaluated a slight linear decrease in the proportion of estrus females serviced was observed (Pexton et al., 1990). This study, however, was not able to determine the optimal stocking rate for bulls breeding synchronized females.

A study comparing different bull stocking rates among groups of heifers synchronized with an MGA/prostaglandin $F_{2\alpha}$ (PGF) protocol highlighted several differences in reproductive performance among groups (Healy et al., 1993; Table 2). No differences in pregnancy rate within the first 6 days or the entire 28 day breeding season were observed among synchronized heifers stocked at a rate of 1 bull per 25 heifers or 1 bull per 16 heifers. The estimated days to conception, however, was less in heifer stocked at 1:16 (8 days into breeding season) compared with heifers stocked at 1:25 (11 days into breeding season).

Table 2. Effect of bull to heifer ratio on pregnancy status and date of conception.

	Bull:Heifer Ratio*			
	1:50	1:50	1:25	1:16
	Non-Synchronized	Synchronized		
Number of bulls in pasture*	2	2	4	6
Day 6 pregnancy rate, %	40	38	41	53
Day 28 pregnancy rate, %	82	77[a]	83	84[b]
Estimated day of conception after turnout	10[a]	10[a]	11[a]	8[b]

*Each pasture had 100 heifers with different number of bulls present to reach each respective stocking rate.
[a,b]Means within row lacking common superscript differ (*P* < 0.05; Adapted from Healy et al., 1993).

An economic analysis of the stocking rates tested revealed that a stocking rate of 1:25 was the optimal mating load of all the treatments studied and it was hypothesized that perhaps bulls in non-synchronized breeding scenarios could be stocked at rates greater than the traditional 1:25 or 1:30 (Healy et al., 1993). In addition, authors theorized that the greater opportunity for heifers in the 1:16 stocking rate pastures to be bred by a greater number of bulls compared with the 1:25 stocking rate pasture may be responsible for earlier date of conception in the 1:16 treatment compared with the 1:25 treatment. Indeed, we expect females stocked with multiple bulls to be bred by multiple bulls. Of the heifers that had been serviced in pastures containing two bulls, 50% had been serviced by both bulls present in the pasture (Farin et al., 1982).

Cow Factors that Influence Success

Many of the factors that contribute to the success of synchronized breeding systems that rely on the use of AI are just as important to consider when determining whether a synchronized natural service breeding system is appropriate for your operation. Cows must be far enough postpartum and females must be in sufficient body condition to achieve optimal benefit from synchronization. Days postpartum and body condition score are indicators that females may be in appropriate physiological status to initiate cyclicity, and estrus is essential to make bull breeding systems work.

Options for Synchronization with Natural Service

Much research with modern estrus synchronization protocols has focused on making the window of time over which cows ovulate as small as possible. This small window of ovulation time in a group of cattle is essential for optimization of fixed-time artificial insemination pregnancy rates. Many of these protocols include GnRH administered two to three days after PGF to facilitate fixed-time AI (see Lauderdale, 2009 for review). In the case of bull breeding it is imperative that GnRH is not administered near breeding as cows may subsequently not show estrus and therefore not be bred via natural service.

1×PGF. In a 21 day estrous cycle, cattle will respond to administration of PGF from roughly days 6 to 17 of the cycle by killing, or lysing, a mature *corpus luteum* (CL) present in their ovaries which will subsequently allow them to come into heat over the next 5 day period. When a single injection of PGF was compared with two injections of PGF 13 days apart for synchronizing natural service bull breeding no differences were observed in proportion of heifers pregnancy within 5 days of the breeding season (average of 53% of heifers; Chenoweth and Lennon, 1984). In addition, both treatments receiving PGF had a greater proportion of heifers pregnant in the first 5 days of the breeding season compared with the proportion of untreated heifers that became pregnant in the first 21 days of the breeding season (33.7%). Overall pregnancy rates, however, were not different among untreated heifers and those that received either PGF treatment, and days to conception or calving data were not reported (Chenoweth and Lennon, 1984).

day 4 or 5 PGF. This method allows bulls to acclimate to breeding pastures and breed roughly 19-20% of cyclic females before the synchronization protocol is initiated. An injection of PGF is administered 4 or 5 days after bull turnout and females show heat over the next 5 days (days 6 to

10 of the breeding season). Using this method a large portion of cyclic females would be in heat within the first 10 days of the breeding season with a majority of breeding activity occurring around day 8 of the breeding season.

A greater proportion of suckled beef cows given PGF 4 days after bull turnout were in heat and became pregnant from days 4 to 9 of the breeding season compared with cows given saline (Whittier et al., 1991). In addition, 6.5% more cows calved that had been given PGF 4 days after bull turnout compared with saline-treated cows (Whittier et al., 1991). It was hypothesized that the improvement in proportion of cows calving was due to cyclic cows that did not conceive to the synchronized estrus having more opportunities to become pregnant during the breeding season. Whereas the proportion of cows calving in the first 21 days of the calving season was greater in suckled beef cows treated with PGF 108 hours (4.5 days) after bull turn out compared with untreated cows, no differences were observed in season ending pregnancy rates (Larson et al., 2009).

In contrast, the overall pregnancy rates at the end of the 25 day breeding season were reduced in heifers treated with PGF 5 days after bull turnout (73.1%) compared with untreated heifers (78.3%; Larson et al., 2010). However, a greater proportion of calves were born in the first 21 days of the breeding season for PGF treated heifers (87.1% of calves born) compared with untreated heifers (77.4% of calved born) which resulted in steer calves that were heavier at weaning for heifers treated with PGF compared with untreated heifers (Larson et al., 2010).

The difference among studies in the impact of season ending pregnancy rates is unclear. Perhaps cows and heifers react differently to administration of PGF 4 or 5 days after bull turnout. Alternatively, administration of PGF on day 5 of the cycle may result in a portion of bred females aborting and subsequently having difficulty becoming pregnant during the remainder fo the breeding season. A fixed time insemination protocol in suckled beef cows that included administration of PFG 5 days after administration of GnRH and a CIDR resulted in 89% of females undergoing luteolysis (Bridges et al., 2012). Perhaps day 4 is a more appropriate timing of PGF delivery as the CL is younger and less responsive to PGF (Louis et al., 1973).

7 day CIDR. We (Lamb et al., 2008) explored a method of synchronizing suckled cows with only a CIDR for several reasons. The first reason was that withholding PGF from a synchronization protocol would allow a synchronized estrus with a more gradual distribution of estrus compared with the peak in estrus activity observed when PGF is administered at CIDR removal (Lamb et al., 2006). The second reason for using a CIDR in a natural service synchronization protocol is to initiate cyclicity in a portion of non-cycling females (Stevenson et al., 2003) and subsequently get them pregnant earlier in the breeding season.

Fifteen locations were used in the study and overall pregnancy rates varied from 59.3 to 98.9%. No differences in overall pregnancy rates were observed among treatment for either pregnancy rates up to day 30 of the breeding season or in season ending pregnancy rates (68.2 and 88.9% for CIDR and 66.7 and 88.6% for control, respectively; Lamb et al., 2008). The average days to conception, however, was shorter for cows in the CIDR treatment (20.1 days) compared with cows in the control treatment (23.2 days). In addition, there was an interaction among treatment and days postpartum which revealed that the CIDR-treated cows that benefited most from the

CIDR insertion were those that were further postpartum (Figure 2). Based on these data, though no direct measures of cyclic status were taken, our interpretation was that cows that are likely cyclic at the time of CIDR insertion are most likely to respond to synchronization with the 7 day CIDR method.

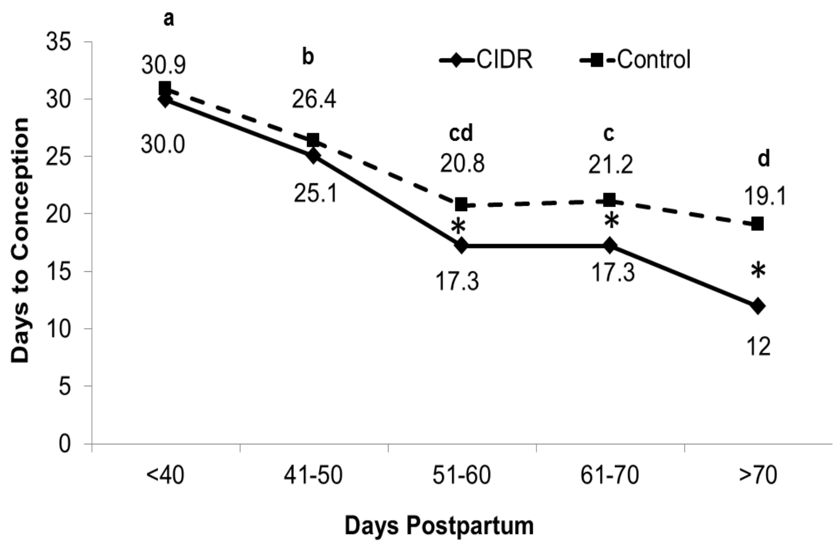

Figure 2. Interval to conception from initiation of the breeding season at various days postpartum. Days postpartum×treatment ($P < 0.05$). [*]Treatments within days postpartum differ ($P < 0.05$). [a-d]Days postpartum differ ($P < 0.05$; Adapted from Lamb et al., 2008).

Other Considerations

In addition to those protocols listed above, Select Synch, Synchro-Mate B, and 14 day MGA/PGF protocols have all been successful methods of synchronizing cows and heifers for natural service breeding. Producers wishing to use long-term progestin-based protocols (14 day MGA/PGF, 14 day CIDR, etc.) need to be aware of the impact long-term exposure to progestins can have on fertility of breeding to the estrus immediately after progestin removal. A persistent follicle is a follicle that did not ovulate during the progestin exposure that has subsequently lost the ability to result in a successful pregnancy (Ahmad et al., 1995). Based on our current knowledge, if long term progestin-based protocols are used for synchronizing estrus with natural service it is imperative that a window of 17 to 19 days passes prior to administration of PGF to ensure absence of persistent follicles

On a final note: Breeding synchronized females with natural service bulls is a strategy that will work for some people and not for others. In either case (synchronized or non-synchronized bull breeding) producers are encouraged to closely monitor breeding pastures for breeding activity and injuries throughout the breeding season. Though not all problems will be seen (such as the case with changes in semen quality after the yearly BSE), identifying issues early in the breeding season will allow time to replace bulls that need to be replaced and salvage the remainder of the breeding season.

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Notes