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G. Cliff Lamb
North Central Research and Outreach Center, University of Minnesota

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SUCCESSFUL AI AND SYNCHRONIZATION SECRETS: IT'S IN THE DETAILS

G. Cliff Lamb
North Central Research and Outreach Center
University of Minnesota

INTRODUCTION

Estrous synchronization and artificial insemination (AI) are reproductive management tools that have been available to beef producers for over 30 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.

Several factors, especially during early development of estrous synchronization programs, may have contributed to the poor adoption rates. Initial programs failed to address the primary obstacle in synchronization of estrous, 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 estrous 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.

Alas, the extensive nature of most beef cattle operations and labor intensity associated with reproductive technologies, such as AI and synchronization tends to drive people away from utilizing this technology, yet the financial and genetic advantages have been extensively documented. Ultimately, the single largest reason for the failure of an AI program is due to poor management, resulting in poor reproductive performance, which causes poor responses to reproductive management. Therefore, producers should use synchronization and AI to enhance the profitability of a well-managed operation, but should not use synchronization and AI to obtain a well-managed operation!! Focusing on the details to taking care of the health, nutrition, and other management factors are critical to the success of an AI program.

As cattle producers we need to be aware that numerous short- and long-term factors contribute to females conceiving to a AI, maintaining the embryo/fetus to term, delivering the calf without assistance, and raising and weaning a healthy calf.

EFFECTS OF POSTPARTUM ANESTRUS ON FERTILITY

The factor that most limits the conception of suckled beef cows to AI and synchronization is the proportion of cows that are not cycling (Short et al., 1990). Continual presence of a suckling calf prolongs and delays the reinitiation of estrous cycles (Williams, 1990). Insufficient nutrient intake and poor body condition are also limiting factors, but temporary or permanent calf removal usually initiates estrus within a few days (Williams, 1990). Young cows generally are more prone to have prolonged anestrus because of their additional growth requirements (Short and Adams, 1988, Short et al., 1990). The first priority is maintenance of essential body functions to preserve life. Once maintenance is met, remaining nutrients accommodate growth. Finally, lactation and the initiation of estrous cycles are supported. Older cows have no growth requirement, thus nutrients are more likely to be available for milk production and initiation of estrous cycles. Because of this priority system, young, growing cows generally produce less milk and are anestrus longer after calving. When the incidence of cyclicity was determined in 3,269 cows at the beginning of the breeding season, the major limiting factors that were found to affect the rate of cyclicity at the beginning of the breeding season included the age of the cow, body condition, and days postpartum (Stevenson et al., 2003).

Generally, beef cows do not experience a period of negative energy balance because they fail to produce the quantity of milk that dairy cows produce; however, beef cows need to be in good enough condition to resume estrous cycles after parturition and overcome general infertility, anestrus, short estrous cycles, and uterine involution just to maintain a yearly calving interval. For producers with shorter calving intervals with cows in good condition, the probability of a pregnancy is generally very good. But in herds that utilize calving seasons of greater than 60 days, maintaining a 365 day calving interval becomes increasingly more difficult (Figure 1; Short et al., 1990)

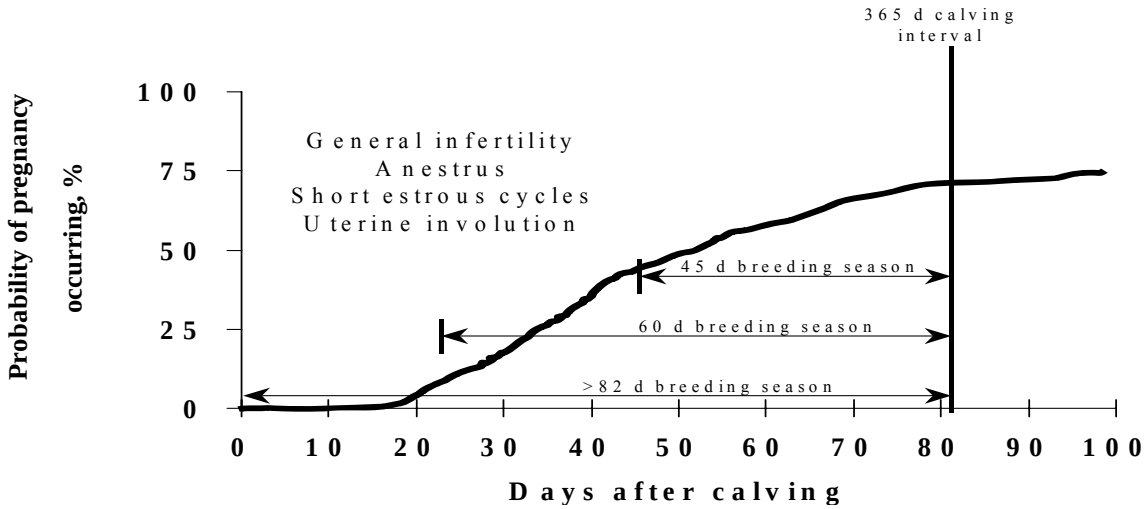

Figure 1. Relationship of length of breeding season to fertility during the postpartum period (Short et al., 1990)

NUTRITIONAL MANAGEMENT CONSIDERATIONS

Body condition score as an indicator of reproductive efficiency.

Body condition scoring (BCS) is a reliable method to assess the nutritional status of recipients. A visual body condition scoring system developed for beef cattle uses a scale from 1 to 9, with 1 representing emaciated and 9 obese cattle (Whitman, 1975). A linear relationship exists between body weight change and body condition score, where an approximate 40 kg weight change is associated with each unit change in BCS (using the 1 to 9 scale). Managers of breeding age females should understand when cows can be maintained on a decreasing plane of nutrition, when they should be maintained on an increasing plane of nutrition, or when they can be kept on a maintenance diet. Understanding the production cycle of the cow and how to manipulate the diet will improve the ability of the females to conceive to AI (Mapletoft et al., 1986; Beal, 1999; Lamb et al., 2001; Larson et al., 2006).

Body condition score at calving has been shown to be a more predictable indicator of the duration of postpartum anestrus than prepartum change in either weight or BCS (Whitman, 1975; Lalman et al., 1997). When cows were thin at calving or had a BCS of 4 or less, increased postpartum level of energy increased the percentage of females exhibiting estrus during the breeding season. Body condition score at parturition and breeding are the dominant factors influencing pregnancy success, although body weight changes during late gestation modulate this effect. However, altering poor body condition after parturition may reduce the negative impact on reproduction, but seldom overcomes or eliminates those negative effects. A recent study (Stevenson et al., 2003b), using blood samples at initiation of the breeding season to determine estrous cycling status, demonstrated that only 47.2 % of the cows were cycling at the onset of the breeding season. However, as BCS increased, the percentage of cows that were cycling also increased. It is important to note that when cows had a body condition of less than 4 at the beginning of the breeding season, only 33.9% had resumed their estrous cycles.

Prepartum nutritional effects on reproduction.

The general belief is that cows maintained on an increasing plane of nutrition prior to parturition usually have a shorter interval to their first ovulation than cows on a decreasing plane of nutrition. Energy restriction during the prepartum period results in a low BCS at calving, prolonged postpartum anestrus, and a decrease in the percentage of cows exhibiting estrus during the breeding season (Perry et al., 1991). Pregnancy rates and intervals from parturition to pregnancy also are affected by level of prepartum energy (Perry et al., 1991). Conversely, when prepartum nutrient restriction was followed by increased postpartum nutrient intake, the negative effect of prepartum nutrient restriction was partially overcome; however, the effectiveness of elevated postpartum nutrient intake depended on the severity of prepartum nutrient restriction (Perry et al., 1991; Lalman et al., 1997). The effect of BCS prior to calving also has implications for calf birth and weaning weights. When cows were fed to achieve a BCS of either 4 or 6 prior to calving, body weights were greater and calf birth and weaning weights (with similar genetics) also were greater for those cows in a BCS of 6 (Spitzer et al., 1995). Despite the greater birth weights, there was no difference in calving difficulty, demonstrating the added advantage

for recipients to wean calves with greater weaning weights. In addition, there tended to be an increased number of cows calving with a medium BCS that were cycling at the beginning of breeding season and after a 60-day breeding season than cows in poor condition, resulting in a greater proportion of cycling cows at various stages of the breeding season (Spitzer et al., 1995).

Postpartum nutrition.

Numerous studies document that increasing nutritional levels following parturition increase conception and pregnancy rates in beef cows (Wiltbank et al., 1962; Whitman, 1975). Increasing the postpartum dietary energy density increased body weight and BCS and decreased the interval to first estrus (Lalman et al., 1997). However, suckled beef cows in relatively poor body condition gaining in excess of 1 kg/d while consuming an 85% concentrate diet did not resume cyclic ovarian activity before 70 d postpartum (Lalman et al., 1997). Therefore, although an enhanced plane of nutrition after calving may partially overcome the negative effects of poor prepartum nutrition, the added stress and negative impact of suckling and lactation also must be considered.

A major impact on postpartum fertility is the length of the breeding season. Having a restricted breeding season has many advantages, such as a more uniform, older calf crop, but most importantly a breeding season of 60 d or less increases the percentage of females cycling during the next breeding season. If the breeding season is shortened, then all cows have a higher probability for pregnancy during the next breeding season. Strategic feeding to obtain ideal BCS can be achieved by understanding the production cycle of the cow. The period of greatest nutritional need occurs shortly after calving; a cow is required to produce milk for a growing calf, regain weight lost shortly before and after parturition and repair her reproductive tract to become pregnant within 3 mo after calving. During this stage, a cow usually is consuming as much feed as she can and adjusting BCS at this time often is futile. Cows usually are grazing and tend to consume their full protein, vitamin and mineral requirements; however, the grass is often lush with a high percentage of moisture which occasionally can cause a deficiency in energy (NRC, 1996).

CONTROL OF THE ESTROUS CYCLE BY SYNCHRONIZATION

Advances in protocols for beef cows.

Preliminary studies identified significant improvements in fertility among cows that received MGA prior to the administration of PGF2α compared with cows that received only PGF2α (Patterson et al., 1995). When cows received a CIDR for 7 d and an injection of PGF2α the day before CIDR removal, estrus synchrony and pregnancy rates were improved (Lucy et al., 1991). When GnRH was given 6 or 7 d prior to PGF2α, 70 to 83% of cows were in estrus within a 4 d period (Twagiramungu et al., 1995).

The use of GnRH to control follicular wave emergence and ovulation and PGF2α to induce luteolysis led to the development of the Ovsynch protocol for dairy cows (Pursley et al., 1995). Combining the second injection of GnRH with TAI (CO-synch) proved to be more practical than estrus detection for beef producers because it had no negative

effects on fertility (Geary et al., 2001). However, a disadvantage of this protocol is that approximately 5 to 15% of suckled beef cows exhibit estrus prior to, or immediately after the PGF2α treatment (Lamb et al., 2001). Unless these cows are detected in estrus and inseminated, they will fail to become pregnant to TAI. Therefore, we hypothesized that the addition of a CIDR to a GnRH-based protocol would prevent the premature occurrence of estrus and result in enhanced fertility following TAI. Overall pregnancy rates were enhanced by the addition of a CIDR to a GnRH-based TAI protocol (59 vs. 48%, respectively). The CIDR delayed the onset of ovulation, resulting in more synchronous ovulation, and induced cyclicity in noncycling cows (Lamb et al., 2001). However, the efficacy of these CIDR-based TAI protocols had not been evaluated concurrently with AI protocols requiring detection of estrus in suckled beef cows. Therefore, we implemented and coordinated a multi-state, multi-location experiment to discern whether a GnRH-based + CIDR protocol for TAI could yield pregnancy rates similar to protocols requiring detection of estrus (Larson et al., 2006). Results demonstrated that the TAI protocol yielded pregnancy rates that were similar to the estrus detection protocol, even though 35% of the cows were in postpartum anestrous at the time of treatment. Utilizing a similar protocol on recipients using FTET would be practical and effective in yielding high pregnancy rates in recipients (Beal, 1999). For best results producers should consider utilizing protocols recommended by the Beef Reproduction Task Force. These protocols can be found in AI manuals and through the Beef Reproduction Task Force Website (http://westcentral.unl.edu/beefrepro/).

Advances in protocols for beef heifers.

Early studies in beef heifers demonstrated that feeding MGA for 14 d followed by PGF2α 17 d later was an effective method of estrous cycle control in heifers (Brown et al., 1988; Patterson et al., 1989). However, when heifers were treated with PGF2α 19 d after the 14 d MGA feeding period, there was no difference in fertility but estrus was more synchronous (Lamb et al., 2000). Following the success of this protocol, researchers began to include GnRH in estrus synchronization protocols for TAI. However, addition of GnRH to the the above protocol failed to increase pregnancy rates following TAI in heifers (Wood-Follis et al., 2004). Estrus synchronization using GnRH followed by PGF2α successfully synchronized heifers, but the above MGA-PGF2α protocol led to greater synchrony of estrus and, therefore, tended to be more effective (Lamb et al., 2003).

Development of a TAI protocol in beefs heifers has not been as straightforward as in cows, especially considering that at the time of estrus synchronization, a majority (greater than 85%) of heifers have attained puberty (Lamb et al., 2006). The primary reason for failure of TAI in heifers appears to be the inability to synchronize follicular waves with GnRH. After an injection of GnRH at random stages of the estrous cycle, 75 to 90% of postpartum beef cows ovulated (Thompson et al., 1999; El-Zarkouny et al., 2000), whereas only 48 to 60% of beef and dairy heifers ovulated in response to the same treatment (Macmillan and Thatcher, 1991; Pursley et al., 1995; Moreira et al., 2000). We have found no difference in synchrony of estrus or pregnancy rate in CIDR-treated heifers whether or not GnRH is administered at CIDR insertion, suggesting that response to GnRH in heifers at CIDR insertion may be of limited value (Lamb et al., 2003).

In a large, multi-location (12 locations) study using GnRH, PGF2α, and CIDR, GnRH did not enhance pregnancy rates following estrus detection but the addition of a CIDR to a GnRH-based TAI protocol yielded similar pregnancy rates to those utilizing estrus detection (Lamb et al., 2006). Nevertheless, a bewildering fact remains that the average pregnancy rate for these protocols ranged from 53 and 58 %, whereas pregnancy rates in MGA (with PGF2α administered 19 days after MGA removal) or a long-term CIDR (with PGF2α administered 16 days after MGA removal) protocols followed by PGF2α have been reported to range from 60 and 75 % (Lamb et al., 2000, 2003; Dahlen et al., 2003; Patterson et al., 2003; Kojima et al., 2004; Wood-Follis et al., 2004). Further research is required to understand methods of estrous cycle control in heifers to develop estrus synchronization protocols for TAI.

Resynchronization of estrus.

Reinsemination of nonpregnant cows at the first eligible estrus can be facilitated by resynchronization of the estrous cycle (Van Cleef et al., 1996), which would have wide application in intense embryo transfer programs. To most effectively condense the calving season, the second round of estrus synchronization needs to begin before the pregnancy status of the animals is known. Although resynchronization with a progestin increased synchronized return rates of nonpregnant females (Stevenson et al., 2003a; Colazo et al., 2006), resynchronization with CIDR devices and estradiol cypionate or estradiol benzoate decreased subsequent conception rates to AI (Stevenson et al., 2003a). In contrast, further studies did not note a decrease in fertility when estrogens were utilized for resynchronization with a CIDR (Cavalieri et al., 2007). Furthermore, insertion of a CIDR for 13 d on the day of embryo transfer 7 d after estrus (Purcell et al., 2005) or from 5 d after TAI until day 21 (Thielen et al., 2006) was effective in resynchronizing estrus in non-pregnant cows, but insertion of a CIDR failed to enhance fertility compared to controls.

ADDITIONAL CONSIDERATIONS FOR A SUCCESSFUL AI PROGRAM

Record Keeping.

Maintaining a sound recording keeping system is a key to success in any reproductive management system. For synchronization to work, producers need to know when their cows calved, whether the cow had a difficult birth, and what the birth weights of all calves were. We aim at starting a synchronization protocol when cows are greater than 45 days from calving; however, if your cow had a difficult birth or large calf, perhaps it would be wise to wait an extra few weeks. Without accurate records, these decisions can be extremely subjective.

Facilities.

With synchronization, you can expect many more females to be in heat at a single time than without synchronization. Plus, females will need to be pushed through the chute for injections more frequently than usual; therefore, working facilities need to be able to accommodate the extra work. Not only should you consider reliable holding and sorting pens, but also a good solid alley and chute system. Anticipating an increase in facility

use will certainly ensure a successful synchronization program. Utilizing facility designs that have proven to make cattle handling that is less stressful for animals will enhance fertility. Well designed facilities and the use of breeding barns also reduces the stress level on producers and AI technicians.

Labor.
Reliable labor is an issue that many people neglect to consider when planning a synchronization program. Detecting when cows are in heat is important for the success of a synchronization program. Any labor associated with this process needs to know exactly how cows act when they are in heat. In many cases, this is often when a program fails. A producer feels that they have more important things to do than spend time heat checking. They will often leave for the "more important" job or leave the heat checking to a less than competent individual. The end result is poor estrus response or poor conception rates.

Many more factors need to be considered, such as using a proficient AI technician. Many AI companies now have the ability to provide a full set of services that reduces the ability of producers to inject, insert implants, and AI. Utilizing these resources certainly provides the potential to enhance the overall success of the program. Regardless of the system that you use, be sure to follow the directions on the drug label and don't take short cuts, believing that it will be more simple and save time. Invariably this is when results are at their poorest.

CONCLUSION

For a synchronization and AI program to be effective, numerous factors need to be put in place to ensure success. Nutrition, estrous cycle control, and female management are all responsible for the success or failure in a given program. Producers, AI technicians, veterinarians, and all members of the reproductive management team need to be aware of the short- and long-term factors that contribute to females conceiving to AI, maintaining the embryo/fetus to term, delivering the calf without assistance, raising and weaning a healthy calf.

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