General Management Considerations to Improve Success of Artificial Insemination*

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Introduction

Although artificial insemination is the most powerful tool available for genetic improvement, cow calf producers have been slow to adopt this technology due to the time and labor associated with estrous detection and a market structure that until recently has not provided an incentive to cow calf producers for genetic improvement. However, adoption of fixed-time artificial insemination protocols (FTAI) has been increasing due to a changing market structure that recognizes and provides an economic incentive for genetic improvement (e.g. premiums) combined with the development of FTAI protocols that result in pregnancy rates similar to AI following detection of estrus. FTAI protocols that result in pregnancy rates similar to AI following detection of estrus result in calves being born early in the calving season resulting in more pounds of calf weaned, which is a tremendous economic gain. A successful FTAI program is dependent upon optimization of the number of healthy cycling females at the beginning of the breeding season, careful attention to sire selection, implementation of an appropriate estrus synchronization protocol, low stress cattle handling, purchase of high quality semen, proper semen handling and insemination technique, and good nutritional management before and after FTAI. Most importantly, implementation of a successful FTAI program requires careful thought and attention to detail. The purpose of this paper is to review the major factors affecting the success of a FTAI program. Emphasis will be given to management considerations that should be implemented before, during, and after FTAI.

Importance of early conception

Calving date for first calf heifers may impact cow longevity and productivity. Calving late in year one increases the proportion of cows that either calve later next year or do not conceive (Burris and Priode, 1958). Research has indicated heifers having their first calf earlier in the calving season remained in the herd longer and had greater calf weaning weights compared with heifers that calved later in the calving season (Cushman et al., 2013). Therefore, heifers calving earlier in the calving season have greater potential for longevity and lifetime productivity.

Decreasing the calving period has far reaching implications across the cow-calf enterprise and beyond. Calf age is the single most important factor impacting weaning weight in cow-calf operations so herds with more concentrated calving distributions are expected to have heavier weaning weights compared with herds that do not. Effects of calving early in the calving season potentially extend much further into beef systems, including improved pregnancy percentages and subsequent calving distributions the next calving season, increased cow longevity, lower

*Adapted in part, from: M.F. Smith, G.A. Perry, J.A. Atkins, E.M. Jinks, K.G. Pohler, and D.J. Patterson. 2011. Keys to a successful estrus synchronization and artificial insemination program. Proc. Appl. Reprod. Strategies in Beef Cattle. Joplin MO pp. 105-121 replacement rate, positive influences on carcass quality and value, reduced labor requirements, increased returns on feed inputs and improved overall sustainability.

The importance of maximizing the proportion of cows that conceive early in the breeding season cannot be overemphasized in a beef herd. Data from the University of Nebraska reported that heifers born during the first 20 days compared to the second or third 20 days of the calving season had greater weaning weights, prebreeding weights, and precalving weights; more heifers cycling by the start of the breeding season; and higher pregnancy rates. Heifers that conceive early in the breeding season have greater longevity in the herd which increases profitability. Furthermore, steer progeny born during the first 20 days compared to the second or third 20 days of the calving season had greater weaning weights, increased hot carcass weights, higher marbling score, and greater carcass value (Funston et al., 2012a). Consequently, the advantages of calves born early include improved end product quality as well as increased reproductive performance of heifers. Management strategies for increasing the proportion of early calving heifers and cows are discussed below.

Factors Affecting Pregnancy Rate

When it comes to reproductive management the things you do well do not compensate for the mistakes you make. Instead, the mistakes you make cancel out all the things you do well. This is best illustrated by examining the primary factors that affect pregnancy rate. In an AI program, pregnancy rate is the product of estrous detection rate and conception rate (Pregnancy rate = estrous detection rate x conception rate; see definitions below). The following definitions can be applied to an entire breeding season or to the synchronized period (period of time during which estrus is expressed after treatment with an estrus synchronization protocol [normally 5 to 7 days]).

Pregnancy rate – total number pregnant during the breeding season/ number of females exposed to breeding (expressed as a percent).

Estrous detection rate – total number of females detected in estrus/number of females exposed to breeding (expressed as a percent).

Conception rate – percentage of females that become pregnant to a designated insemination.

The effect of a decrease in estrous detection rate and/or conception rate on pregnancy rate can be seen in Table 1. Assume that 100% of the heifers have attained puberty and that you are able to detect 95% of the heifers in estrus during the synchronized period. With a conception rate of 70% the pregnancy rate would be: 95% estrous detection rate x 70% conception rate = 67% pregnancy rate! If we hold conception rate at 70% and decrease estrous detection rate to 75%, due to fewer animals cycling or less time spent detecting estrus, the pregnancy will be reduced to 53%. Alternatively, if estrous detection rate remains at 95% but conception rate is decreased to 50% due to compromised semen quality or poor insemination technique, the pregnancy rate would decrease to 48%. Finally, a decrease in both estrous detection rate and conception rate will decrease pregnancy rate from 67% to 38%. Therefore, understanding the effect of estrous detection rate and conception rate on pregnancy rate and the importance of attention to detail in every aspect of an estrus synchronization program is essential!

Table 1: Effect of estrous detection rate and conception rate on pregnancy rate in cattle.

Estrous detection rate	Conception rate	Pregnancy rate
95%	70%	67%
75%	70%	53%
95%	50%	48%
75%	50%	38%

Things to Do Before Estrus Synchronization and Fixed-time Artificial Insemination

Where do I start? When implementing an estrus synchronization and AI program the first decision should be where to start. Estrus synchronization and AI do not have to be used in combination. Estrus synchronization can be used in combination with natural service or AI. There are clear benefits to reproductive management of a herd from using estrus synchronization in combination with natural service (e.g. increase the proportion of females that conceive early). Two estrus synchronization protocols that are relatively low cost and have been effective in combination with natural service include: 1) Feed MGA (0.5 mg/hd/day) for 14 days to heifers and turn bulls in 10 days after MGA withdrawl, and 2) Turn in bulls (day 1 of breeding season) and inject all heifers and cows with prostaglandin $F_{2\alpha}$ (PGF) on day 4. Advantages of the preceding MGA protocol include no trips through the chute and a portion of the prepuberal heifers will be induced to cycle earlier; however, you have to feed MGA daily for 14 days and each heifer needs to receive the correct dose. The advantage of the PGF protocol is that you only have a single trip through the chute (PGF injection); however, all the heifers and cows need to be cycling in order to respond to PGF. Prepuberal heifers or noncycling cows will not respond to PGF since they do not have a corpus luteum. Once you become comfortable with implementing an estrus synchronization protocol in combination with natural service it is not difficult to make the next step to using AI instead of natural service.

What can I expect in terms of pregnancy rate? When beginning an AI program it is essential to have realistic expectations regarding the pregnancy rate. As previously discussed, pregnancy rate is the product of estrous detection rate and conception rate. It is important to remember that a pregnancy rate of 67% to a single insemination is good whether you are talking AI or natural service. For natural service, expected pregnancy rates are normally 60 to 70% during 21 days of breeding assuming the bulls are fertile and that 100% of the heifers and cows are cycling. However, a pregnancy rate of 60 to 70% over 21 days is unusually high for natural service since rarely are all the heifers and cows cycling at the start of the breeding season. In a FTAI program, all the cows are injected with GnRH (to synchronize ovulation) and inseminated at a predetermined time. Since there is no estrous detection with FTAI, estrous detection rate becomes the proportion of heifers and cows that ovulate in response to GnRH injection at insemination. It is normal for the pregnancy rate to be higher following FTAI compared to protocols that are dependent upon estrous detection since ovulation is induced and semen is deposited in all the cows in a FTAI protocol. In an estrous detection protocol only the females detected in estrus are inseminated and females that are anestrus or not detected in estrus are not inseminated.

Are my heifers and cows good candidates for an estrus synchronization protocol? The first question to ask is "Over the past few years what has been the pregnancy rate in my heifers or cows after a 60 to 80 day breeding season?" If the pregnancy rate at the end of the breeding season has been less than 85% there may be management issues that should be addressed before initiating a synchronization and AI program. If the pregnancy rate in your herd over the past few years has been ≥ 85% then you need to evaluate whether your heifers and cows are good candidates for an estrus synchronization and AI program.

Criteria for heifers. Studies in numerous species provide evidence that diet during development can mediate physiological changes necessary for puberty. In cattle, several studies have reported inverse correlations between postweaning growth rate and age at puberty and heifer pregnancy rates. Thus, postweaning growth rate was determined to be an important factor affecting age of puberty, which in turn influences pregnancy rates. This and other research conducted during the late 1960s through the early 1980s indicated puberty occurs at a genetically predetermined size, and only when heifers reach their target BW can increased pregnancy rates be obtained. Guidelines were established indicating replacement heifers should achieve 60 to 65% of their expected mature BW by breeding. Traditional approaches for postweaning development of replacement heifers used during the last several decades have primarily focused on feeding heifers to achieve or exceed an appropriate target BW and thereby maximize heifer pregnancy rates. Intensive heifer development systems may maximize pregnancy rates, but not necessarily optimize profit or sustainability. Since inception of target BW guidelines, subsequent research demonstrated that the growth pattern heifers experience before achieving a critical target BW could be varied. Altering rate and timing of BW gain can result in compensatory growth periods, providing an opportunity to decrease feed costs. Recent research has demonstrated that feeding replacement heifers to traditional target BW increased development costs without improving reproduction or subsequent calf production relative to development systems in which heifers were developed to lighter target BW ranging from 50 to 57% of mature BW (Funston et al., 2012b). A more comprehensive discussion of heifer development will be presented by Dr. John Hall.

Heifers that will be used for breeding purposes should not have received growth promoting implants. Previous studies report that implanting heifers within 30 days of birth impairs uterine function and decreases subsequent pregnancy rates. Implanting heifers as yearlings is also detrimental to reproduction (Tibbitts et al., 2017).

Criteria for postpartum cows. To increase the number of cows cycling at the beginning of the breeding season, they should have calved unassisted, be in good body condition at calving, disease-free, and allowed an adequate period of recovery from calving to the subsequent breeding season. Postpartum cows that are good candidates for an estrus synchronization program normally meet each of the following criteria: 1) body condition score at calving of ≥ 5 (1= emaciated; 9 = obese), 2) mean postpartum interval of the cows to be synchronized should be ≥ 40 days at the beginning of the protocol. This does not mean that each cow should be ≥ 40 days postpartum but that the mean of the entire group to be synchronized should be ≥ 40 days. If the estrus synchronization protocol you plan to use includes CIDR administration, each cow should be a minimum of 21 days postpartum at the time of CIDR insertion, and 3) low incidence of calving difficulty since dystocia will lengthen the postpartum interval.

How do I choose an AI sire and where do I obtain the semen? Sire selection is of critical importance and can have a long term effect within a herd, particularly when heifers are retained as replacements. When choosing a sire the following questions need to be addressed: 1) Will I raise my own replacement heifers or purchase them? and 2) How will I market my calves? Answers to the preceding questions will determine the traits that need to be emphasized. If a producer raises his or her own replacement heifers then selection pressure should be placed on maternal traits such as milk, maternal calving ease, stayability, etc. However, if replacement heifers are purchased off the farm then emphasis on maternal traits in your herd would not be important. When selecting a sire, you need to think about how you will be paid (e.g. pounds of weaning weight, carcass weight, carcass quality) and let this affect your sire selection decisions. Producers that sell their calves at weaning need to place selection pressure on preweaning growth; whereas, producers that retain ownership and market their calves on a grid should emphasize carcass weight, marbling, and ribeye area.

Other genetic traits that have been demonstrated to influence the capacity of a cow to sustain reproduction and be retained include traits that contribute to calving difficulty, level of milk production, and mature size. The genetic changes that have occurred in response to selection for growth and milk production over the last several decades (American Angus Association; American Hereford Association; American International Charolais Association) have undoubtedly resulted in greater nutritional demand to sustain these production traits, leading to greater challenges in sustaining reproduction in nutrient sparse environments. The concept of interaction between genetic potential for production and environment is the basis for recommendation that producers consider selection of breed type or genetic potential of their cattle to match production environment. Converse to this strategy of matching genotype to environment is the recommendation that producers feed their heifers and cows to some target weight or BCS, without consideration of the environmental abundance of associated resources, in an attempt to assure relative high rates of reproductive success. An alternative interpretation of this approach may be that modification of the nutritional environment is needed to sustain a high production potential genotype. The long-term sustainability of this approach needs to be given greater consideration (Roberts et al., 2015).

Expected progeny differences (EPDs) are an effective selection tool and are reported to be 7 to 9 times more effective at generating a response to selection than focusing on measurements of individual performance, which is strongly affected by environment. Use AI sires with high accuracy EPDs and where the semen has been collected from a certified semen services (CSS) facility. Avoid using unproven bulls and do not be hesitant to seek advice from individuals in the AI industry to help make this important management decision.

Another consideration when selecting a sire is whether the bull's semen has worked in FTAI programs. Differences among sires in pregnancy rate to FTAI have been noted; however, the same differences in pregnancy rate may not occur when cows are detected in estrus and inseminated according to the AM/PM rule. Therefore, just because an AI sire has a good conception rate following estrous detection does not ensure he will perform equally well when ovulation is induced and insemination occurs at a predetermined time. It is a good idea to ask an AI representative if there is information available regarding how a bull has worked in a FTAI program.

Which estrus synchronization protocol should I choose? When choosing an estrus synchronization protocol there are a number of issues to consider including whether you want to detect estrus and inseminate according to the AM/PM rule, inseminate at a predetermined time, or detect estrus for 72 to 84 hr (depending upon the protocol) and inseminate any cows not detected in estrus at a fixed-time. There is an estrus synchronization protocol sheet for heifers and cows that appears in the catalogs of the major AI companies and there are protocols that fit each of the preceding synchronization approaches. Other items to consider include the proportion of females that are cycling as well as the time, labor, and cost of the protocol.

If a significant number of animals are not cycling at the time of implementing an estrus synchronization program, it will be necessary to utilize a progestin-based protocol. Two progestin products that are commercially available for estrous synchronization include Melengestrol Acetate (MGA) and the CIDR (Controlled Internal Drug Release). An advantage of progestin treatment is that a proportion of the prepuberal heifers and anestrus postpartum cows will be induced to begin cycling. In cycling heifers, administration of MGA or CIDRs does not affect the time of corpus luteum regression. However, once corpus luteum regression has occurred, progestin administration can prevent a cow or heifer from showing estrus and ovulating. Consequently, progestin administration in cows that have experienced corpus luteum regression will delay the expression of estrus and ovulation until after progestin withdrawal.

At the start of a breeding season, most herds consist of a mixture of cycling and anestrous females. An effective estrous synchronization protocol must be able to induce a fertile estrus or ovulation in both anestrous and cycling heifers and cows. A short luteal phase usually occurs in prepuberal heifers and postpartum beef cows following the first ovulation (Perry et al., 1991; Werth et al., 1996). This short exposure to progesterone is believed to be necessary for reprogramming the reproductive axis to resume normal estrous cycling. Therefore, in herds that have a large proportion of prepuberal heifers or anestrous cows, progestin pretreatment before induction of ovulation can initiate estrous cycling status and eliminate or at least reduce the occurrence of short estrous cycles.

When should I administer the prebreeding vaccines? Reproductive diseases, including bovine viral diarrhea (BVD), vibriosis, leptospirosis, and infectious bovine rhinotracheitis (IBR), can induce abortion in cattle and decrease profitability (Daly 2007ab). Consequently, a prebreeding vaccination program in combination with careful attention to biosecurity practices and reducing stress/disease transmission within a herd should be included in a herd health program. Since time and labor associated with trips through the chute have been a deterrent to implementating an estrus synchronization program, many producers want to combine prebreeding vaccines with administration of estrus synchronization products. A common question is "Can I administer prebreeding vaccines in combination with estrus synchronization products without decreasing the pregnancy rate to AI?" The answer to this questions depends on how quickly immunity will be established following vaccination and whether or not the vaccine itself will adversely affect reproductive performance and (or) the response to an estrus synchronization protocol (Daly, 2007b). In regards to the first issue, there is a lag time between vaccination and the establishment of immunity that will depend upon factors such as: 1) whether or not the animals were previously vaccinated, and 2) the type of vaccine – modified live (MLV) or killed vaccine. In general, animals that were previously vaccinated will respond more quickly than animals that are naive to the vaccine and the immune response is normally more rapid to MLV compared to killed vaccine.

Injection of heifers with the IBR virus (wild type and modified live) around the time of breeding resulted in ovarian lesions (particularly within the corpus luteum; Van Der Maaten and Miller 1985; Smith et al., 1990) and decreased conception rates (Miller et al., 1989; Chiang et al., 1990; Miller 1991). Several studies report that vaccinating naive heifers with MLV around time of breeding decreased pregnancy success (Miller et al., 1989; Chiang et al., 1990; Miller 1991). Furthermore, when heifers were vaccinated intravenously with MLV the day after breeding, necrotic lesions were found in the CL and ovaries 9 to 14 days after vaccination and heifers with severe luteal damage had decreased concentrations of progesterone (Van Der Maaten et al., 1985). Heifers vaccinated with a MLV vaccine on the day of the second PGF injection had decreased conception rates compared to control heifers not only for the insemination immediately after vaccination but also for the subsequent insemination. Vaccinated heifers had a first service conception rate of 30% and a second service conception rate of 57%; however, control heifers had a first service conception rate of 78% and a second service conception rate of 100% (Chiang et al., 1990). Furthermore, heifers infected with IBR at or near estrus had disrupted luteal function. In most heifers the next estrous cycle was normal, but in some heifers normal estrous cycles were delayed for up two months (Miller and Van Der Matten, 1985). However, when heifers that were previously vaccinated against IBR were administered IBR vaccine either at estrus synchronization or 30 days before insemination there was no detrimental effect of vaccination on pregnancy rate to fixed-time AI or overall pregnancy rate. (Stormshak et.al., 1997). Although the latter studies report that administering IBR vaccine at initiation of estrus synchronization to heifers previously vaccinated at weaning did not reduce pregnancy rate, an advantage of administering prebreeding vaccines 30 days or more before insemination is that there is adequate time for the buildup of immunity before the heifers are inseminated.

General recommendations for prebreeding vaccinations include the following: 1) Replacement heifers should be vaccinated before and at weaning. The immune response of an individual heifer to a single vaccination is not known; therefore, heifers should receive an initial vaccination followed by a booster when dictated by the vaccination protocol, 2) Both heifers and cows should receive a booster vaccination approximately 30 days before breeding. If it is absolutely necessary to give a modified live vaccine less than 30 days prior to breeding, the vaccine should be administered as soon as possible and only to animals that were vaccinated both before and at weaning. Animals that have not previously been vaccinated (naïve animals) should not be vaccinated near the time of breeding. For additional information on reproductive diseases and the timing of prebreeding vaccines the reader is referred to Daly (2007ab).

Things to Do at Estrus Synchronization and Fixed-time Artificial Insemination

Animal identification and facilities. Individual animal identification and accurate records allow producers to manage animals on an individual basis. When handling animals for synchronization, double check their ear tags for legibility and clip hair from the ears to facilitate reading the tags. Records should include detailed calving, breeding, and pregnancy information. At insemination, document the animal ID, date, time, AI technician, and sire. These records will allow producers to track the reproductive efficiency of individual animals, as well as the skill of the technician.

Stress can suppress the expression of estrus and decrease conception rates. Working facilities should be designed to minimize stressing animals during handling. A well-designed facility will include sorting pens, a crowding tub, and an operable head gate or breeding box for animal restraint. The facility requirement will vary depending on the number and type of animals that will be inseminated as well as the estrus synchronization protocol being used. With a fixed-time AI program, facilities should be sufficient to handle the insemination of all animals within 2 to 3 hrs. Many AI companies or county extension offices have portable breeding chutes available to producers if needed.

Cattle temperament and pregnancy rate. Temperament will vary among animals and is both a safety and production (growth, reproduction, carcass quality) issue. In general, an excitable temperament is a fear-based response that is not breed dependent, and can adversely affect reproduction (Cooke, 2010). Three common methods of evaluating temperament in cattle include exit velocity, chute score, and pen score. Exit velocity is a measurement of the speed with which an animal covers a specific distance after release from a squeeze chute and can be measured in feet per second or on a 1 to 5 scale (1 = slow; 5 = very fast). Chute score is a measure of an animals behavior in a squeeze chute (1 = quiet; 5 = excited) and pen score is a measure of an animal's response to a person when it enters a small pen and interacts with a person inside the pen (1 = quiet; 5 = excited). An excitable temperament in beef cattle is reported to decrease feed intake (Brown et al., 2004; Nkrumah et al., 2007), alter metabolism and nutrient partitioning (Cooke et al., 2009a; Cooke et al, 2009b), and decrease the probability of pregnancy during the breeding season compared to calm herd mates (Cooke, 2010). Attempts to adapt beef females to handling had a beneficial effect on pregnancy in replacement heifers but not older cows (Cooke, 2010). When Bos indicus-cross heifers were exposed to four weeks of human interaction and handling, temperament was improved and there was an increase in the proportion of heifers that reached puberty by 12 months and an increase in the proportion of heifers that become pregnant early in the breeding season (Cooke, 2010).

Implementation of an estrus synchronization protocol. Estrus synchronization protocols must be followed precisely. Each product must be administered at the correct dose on the correct day (refer to protocol sheet) and in some cases at the right time of day. For example, the interval from PGF to GnRH and insemination must be in accordance with what is recommended in the protocol sheet (e.g. 66 ± 2 hr for the CO-Synch + CIDR protocol). The recommended time of insemination relative to PGF injection is based on research trials and should be strictly adhered to. In addition, estrus synchronization products must be stored, handled, and administered correctly. For specific tips on handling estrus synchronization products see Figures 1 and 2. Should a mistake occur in product administration or the treatment timeline seek advice immediately from a veterinarian, an extension agent specializing in reproduction, or a representative from an AI company. To minimize the probability of making a mistake, a good practice is to write each of the days of treatment, the product name, dose to be administered, and the day of insemination on a calendar and ask a trusted veterinarian, extension specialist, or AI company representative to review it before beginning the protocol. The Estrus Synchronization

Planner is an excellent tool to aid in the planning of a synchronization program (see beefrepro.info under resources).

Understanding the basic principles of the bovine estrous cycle and how the products synchronize estrus and ovulation can be helpful in reducing the probability of administering the wrong product on a certain day. For more information on how estrus synchronization protocols synchronize estrus and ovulation refer to the article in the appendix entitled "Physiological Principles Underlying Synchronization of Estrus" or see the web based course entitled "Fundamentals of Beef Reproduction and Management:Focus on Estrus Synchronization (http://animalsciences.missouri.edu/extension/beef/estrous_synch/).

Figure 1. Proper handling and administration of GnRH and PG products.

- All injections of GnRH and PG products should be given intramuscularly (IM)
- Wear latex gloves when administering GnRH and PG products
- An 18 gauge 1 ½ inch needle is recommended for these injections
- Change needles frequently
    - Make sure that injection sites are free of manure and dirt, which may cause infection
    - Injecting cattle during wet weather increases the potential for infection
- **Always** follow manufacturer's recommended storage, dosage and administration procedures

What should I do if a storm is going to hit near during the synchronized period? A storm or major low pressure system may affect the pattern of expression of estrus in cattle during the synchronized period. Depending upon the temperature change or level of stress there may be a decrease in estrus expression during the synchronized period. If utilizing a FTAI protocol you should inseminate at the scheduled time regardless of estrus expression, provided the heifers or cows meet the criteria for being good candidates for an estrus synchronization program (see previous section). Alternatively, if using a protocol that requires estrous detection you should inseminate according to estrus expression (AM/PM rule) and consider using a cleanup AI (inject GnRH) at 72 to 84 hr after PGF injection.

Proper insemination technique. High pregnancy rates to FTAI are dependent upon a series of events including proper storage and thawing of semen as well as depositing semen in the correct location (uterine body). When synchronizing heifers or cows for FTAI an important question to ask is "How many animals can I (we) inseminate properly in a designated period of time?" The answer to the question will determine how many heifers or cows you synchronize and whether you will require assistance with the insemination process. Representatives of AI companies are available to assist with the entire estrus synchronization and AI process. They can assist you with choosing an appropriate FTAI protocol, administration of the estrus synchronization products, sire selection, purchase of semen, and insemination. If you choose to inseminate the heifers or cows yourself remember that the location of semen placement within the reproductive tract will have a significant impact on pregnancy rates. It is important to deposit the semen in the body of the uterus (target area) and not the cervix. Deposition in the cervix will significantly reduce the pregnancy rate to FTAI; whereas, placing the semen beyond the uterine body into one or both of the uterine horns is not beneficial. During the artificial insemination process it is important to know where the tip of the AI catheter is at all times. Some helpful tips when performing AI include: pay careful attention to the storage of semen, make sure the thaw unit is at the correct temperature (95°F), and follow the AI company's recommendations for thawing semen.

Figure 2. Proper handling and administration of progestins for estrus synchronization.	
Controlled Internal Drug Release (CIDR)	
1)	Be sure to wear protective (e.g. latex) gloves when handling CIDR inserts.
2)	The CIDR applicator should be rinsed in a disinfectant solution (Nolvasan or Chlorohexidine). There should be two buckets each containing a disinfectant solution. The applicator should be washed free of debris in the first bucket and then rinsed clean in the second. By keeping the same washing sequence the disinfectant in the second bucket will remain relatively clean for a sustained period of time. This sequence of events will improve sanitation from animal to animal and reduce the likelihood of infection.
3)	Fold the wings of the CIDR and insert it into a clean applicator. The CIDR will protrude approximately one inch from the applicator.
4)	Apply lube to the end of the applicator.
5)	Wipe the vulva clean before inserting the applicator.
6)	When inserting the CIDR make sure that the nylon tail is curved downward. If the tail is pointed upward it will be easier for other animals to pull out the CIDR thus reducing retention rate.
7)	Gently insert the applicator containing the CIDR in an upward manner similar to the insertion of an AI catheter.
8)	Push the applicator as far forward as possible, deposit the CIDR by pressing the plunger, and slowly remove the applicator.
9)	To prevent other animals from removing the CIDR, the nylon tail can be clipped such that only 2 ½ inches protrude from the vulva.
10)	At CIDR removal, gently but firmly pull on the nylon tail until it is removed. Be sure to dispose of the CIDR properly.
Melengestrol Acetate (MGA)	
1)	MGA is an orally active feed additive that should be fed once a day at the recommended dose - 0.5 mg in a 3 to 5 lb carrier. Do not top dress MGA on other feeds. Provide adequate bunk space - 18-24 inches per animal.
2)	Allow heifers to adjust to carrier prior to MGA administration.
3)	MGA is approved by the FDA for heifers intended for breeding (suppression of estrus) and for heifers fed in confinement for slaughter for increased rate of weight gain, improved feed efficiency, and suppression of estrus.
4)	Use of MGA as part of any estrus synchronization protocol in beef cows constitutes and extra label use of medicated feed that is prohibited by the Animal Medicinal Drug Use and Clarification Act and regulation 21 CFR 530.11(b).

Things to Do after Fixed-time Artificial Insemination

Nutrition. Regardless of whether you are developing heifers to attain a target weight or feeding cows to attain adequate body condition at calving (BCS ≥ 5), nutrition prior to calving and up to the the start of the breeding season is of obvious importance. However, nutrition following breeding can also affect embryonic development and survival. A dramatic change in diet or feed intake following FTAI that results in weight loss can negatively impact pregnancy rate.

Heifer development systems will vary depending upon availability of pasture, forage, and supplements. In some cases heifers are developed on pasture or native range and provided a supplement such as dried distillers grains plus solubles (DDGS). Alternatively, heifers maybe developed in a feedlot and not have access to pasture or range until near the start of breeding. A study was conducted to evaluate the preceding management strategies for heifer development (Salverson et.al., 2009). Heifers were developed on pasture with a DDGS supplement or maintained in a feedlot until estrus synchronization and turnout to grass in the spring. Heifers developed on pasture gained more weight following turnout and had higher pregnancy rates compared to heifers developed in the feedlot. It is not clear whether the increased weight gain in pasture-developed heifers was due to differences in grazing behavior and(or) physiological differences between groups. Interestingly, grazing behavior preferences are learned relatively early in a calf's life (Provenza and Balph, 1988) and heifers that grazed from weaning to breeding had better grazing skills during the subsequent grazing season compared to heifers maintained in a feedlot (Olson et.al., 2002; Salverson et.al., 2009. Therefore, in the preceding study heifers developed on pasture were likely able to graze more efficiently which resulted in a higher average daily gain on pasture and a higher pregnancy rate. In summary, it is essential to ensure that heifers and postpartum cows do not experience significant weight loss following AI.

Although the strategy to feed heifers to initiate reproduction and feed the cow herd to sustain reproduction is widely propagated in the beef cattle industry, long-term implications that this approach has on overall production efficiency are not well documented. This management approach removes most, if not all, selection against less efficient animals in a herd. Recent reviews describe benefits of developing heifers to lower target weights than currently recommended by feeding less feed or lower-quality feeds (Funston et al., 2012b) and managing cows with periods of limited or insufficient nutrient availability (Funston et al., 2012c) to enhance production efficiency. The underlying strategy of this approach is that maintaining animals at lighter BW reduces NEm and provides greater opportunity for compensatory responses to small improvements in nutrient environment. It is also expected that implementation of this approach for lifelong management results in adaptation or selection of cows and their offspring that maintain reproductive function under limited nutrient environments, such as occurs during drought or extreme winter stress and in semiarid or arid landscapes, to a greater extent than animals developed or maintained with plentiful or unlimited feed inputs (Roberts et al., 2015).

When can I ship cattle after breeding? In beef cattle, fertilization rate is frequently 90 to 100% however, pregnancy rate by day 30 to 40 after a single insemination rarely exceeds 70% and calving rate is even lower. Embryonic and fetal mortality may represent the largest economic loss to cow-calf producers (Geary 2006). Pregnancy losses before day 42 post insemination are generally referred to as embryonic loss and range from 20 to 44% (Humbolt, 2001); whereas, pregnancy losses after day 42 are called fetal loss and are approximately 4% in beef cattle. Factors affecting embryonic/fetal loss are numerous and include genetic abnormalities, fescue toxicosis, plant toxins, excess protein, heat stress, reproductive diseases, an effect of the sire, and handling or shipping stress.

In some cases producers ship cattle a long distance to summer or winter pasture following estrus synchronization and AI. Therefore, a common question is "Will shipping stress decrease the pregnancy rate to FTAI?" Shipping cattle on a trailer can induce stress and lead to embryonic/fetal mortality. Pregnancy losses are believed to be due to changes in the uterine environment that adversely affect embryo growth and development. The effect of time of shipping on pregnancy rates following insemination is shown in Table 2. Transporting cattle on a trailer decreased pregnancy rates by about 10% between days 5 and 42 after insemination and by 6% between days 45 and 60. The best time to ship cattle is before synchronization or within 4 days of FTAI.

Table 2. Effect of time of transport after insemination on pregnancy rates. †

	Days after insemination that transportation occurred			
	1 to 4	8 to 12	29 to 33	45 to 60*
Synchronized pregnancy rate	74%	62%	65%	
% pregnancy loss compared to transportation on days 1 to 4		12%	9%	6%*
Breeding season pregnancy rate	95%	94%	94%	

*Loss in heifers compared to percent pregnant prior to transportation (pregnancy determined by transrectal ultrasonography).
†Data adapted from Harrington et al., 1995, and T.W. Geary unpublished data

How do I determine what may have gone wrong during a FTAI program?

Occasionally the pregnancy rate following FTAI is much lower than expected. Trying to identify the root cause of a decreased pregnancy rate can be a daunting task due to the countless factors that can impact pregnancy rate following AI. When trying to trouble shoot what went wrong you should systematically work through the possibilities and not assume anything was done correctly – evaluate all the possibilities! A list of questions that may provide a systematic approach to identifying the problem is provided in Figure 3. Additional points to consider are included below.

Figure 3. Was pregnancy rate to FTAI lower than expected?
1) What was the pregnancy rate in your heifers or cows after 60 to 80 days over the past few years? If less than 85% there may be other issues that should be addressed before initiating an estrus synchronization and AI program.
2) What was the nutrition (protein, energy, phytoestrogens, etc) and mineral program before and after FTAI?
3) Did the animals meet the criteria for being good candidates for an estrus synchronization protocol (see earlier section)?

4)	Did you use fixed-time AI or did you breed following detection of estrus? If you inseminated following detection of estrus, how frequently did you detect estrus (when did you begin and when did you end), what criteria did you use for detecting estrus, and when did you inseminate relative to detecting estrus?
5)	What bull did you use and is there evidence that semen from this sire has resulted in acceptable pregnancy rates when using fixed-time AI or AI following estrous detection?
6)	What protocol did you use and exactly when did you administer each of the products? You will need to confirm that the correct products were administered at the correct dosages and at the correct times. It is helpful to record on a calendar which product was administered on a particular day so you can check back to see if a mistake was made.
7)	Was the biological activity of the various products compromised? You will need to verify that the products were not out of date and were stored and administered properly.
8)	If using fixed-time AI, when did you inseminate the heifers or cows? Did you record who inseminated each animal? This will be helpful in identifying if there is a technician problem.
9)	Where did you obtain the semen, how was it stored, and was the semen thawed correctly?

What are the most common mistakes when implementing an estrus synchronization and AI program?

One of the most common problems accounting for reduced pregnancy rates following FTAI is that the heifers or cows do not meet the criteria for being good candidates for an estrus synchronization and AI program (see previous section). The second problem is poor choice of an estrus synchronization protocol and (or) protocol compliance. If you have a mixture of cycling and anestrus animals at the beginning of estrus synchronization treatment, you need to use a protocol that includes a progestin (e.g. CIDR or MGA).

Progestin treatment will increase the proportion of prepuberal heifers and anestrus cows that will respond to the protocol. Furthermore, it is essential that each heifer or cow receives the correct estrus synchronization product, at the correct dose, and on the appropriate day. A third problem is that the facilities don't allow the cattle to be inseminated properly within a 2 to 3 hr time period and (or) cause undue stress on the cattle. With a FTAI protocol you have to carefully consider how many animals you can inseminate properly within the designated time period (e.g. 66 ± 2 hr for CO-Synch + CIDR protocol) with a minimum of stress. As previously mentioned, renting a breeding barn (Figure 1) or contracting with an AI company that has breeding barns available can alleviate the problems associated with marginal facilities.

Biological activity of the estrus synchronization products. It is not uncommon to hear someone blame a particular estrus synchronization product or the protocol for poor results. The commercially available products are effective when properly stored and administered. Furthermore, the protocols have been shown to consistently work in a variety of environments. The estrus synchronization protocols listed in the AI catalogs published by Select Sires, ABS Global, Genex, and Accelerated Genetics have been thoroughly tested in the field in a number of herds by numerous investigators in many states.

Rarely does one find that the biological activity of a particular product has been compromised provided the product has been stored properly, administered at the appropriate dose on the correct day of the protocol, and that the expiration date has not been exceeded. It is not uncommon for PGF or GnRH products to be administered at the wrong dose or to be injected subcutaneously instead of in the muscle. Intramuscular injections should be administered using an eighteen-gauge, 1.5 inch needle to minimize the possibility of back flow.

Potential problems associated with feeding melengestrol acetate (MGA). Occasionally there can be problems with feeding melengestrol acetate (MGA) if you don't pay attention to a few simple guidelines (Figure 3). The most common problem is that a heifer does not receive the correct dose (0.5 mg/hd/day). If a heifer does not receive enough MGA she may express estrus during the period of MGA feeding. Therefore, it is a good idea to watch the heifers for estrous activity as they come to the bunk. Alternatively, if a heifer receives more than the appropriate dose, expression of estrus may be delayed following the end of MGA feeding. To ensure that each heifer has an opportunity to receive the correct dose, MGA should be fed once daily in 3 to 5 pounds of carrier and each heifer should have 18 to 24 inches of bunk space. To be confident there is adequate bunk space and to train the heifers to come to the bunk it is a good idea to feed the carrier without MGA for a few days before the start of MGA treatment. At the end of 14 days of MGA feeding, heifers will express estrus within 2 to 5 days; however, heifers should not be inseminated at this estrus since pregnancy rates will be reduced. Be sure to inseminate the heifers at the designated time specified in the protocol.

Potential problems associated with CIDRs. Controlled Internal Drug Release (CIDR) is an intravaginal device that contains progesterone and acts like an artificial corpus luteum. Information on the proper handling and administration of CIDRs is provided in Figure 3. Normally there are few problems associated with CIDR treatment. CIDRs should not be inserted in cows that are less than 21 days postpartum because the probability of inducing cyclicity is low. CIDR insertion should be performed as cleanly as possible in order to reduce the risk of spreading disease (see Figure 3). When removing CIDRs it is not uncommon to detect a whitish discharge which is due to vaginal irritation from the wings of the CIDR and does not necessarily mean the animal has a vaginal infection. A difference in conception rate or pregnancy rate has not been detected between CIDR-treated animals that do or do not have a discharge.

Summary

There are significant benefits to genetic improvement and reproductive management that can be gained from the implementation of an estrus synchronization and AI program in heifers and postpartum beef cows. Artificial insemination in beef cattle is more practical than ever due to advances in FTAI, identification of sires with highly accurate EPDs, and a market structure that can identify and reward producers for the quality of their cattle. Above all, a successful estrus synchronization and AI program is dependent upon being proactive, well organized, and attention to detail. The success of these systems hinges on many factors. A check list of tips for a successful estrus synchronization and AI program is provided in Figure 4.

Figure 4. Check list of tips for a successful estrus synchronization and AI program.

Things to do before fixed-time artificial insemination

- Keep accurate calving, breeding, and pregnancy records.
- Animal identification should be clear and easily readable.
- Ensure herd health and disease prevention with a well-designed prebreeding vaccination protocol. Vaccinate females a minimum of 30 days before the breeding season begins.
- Decide which estrus synchronization protocol best fits your breeding program, facilities, and personnel (see protocol sheets in AI catalogs).
- Ensure all products are purchased and on-hand prior to initiation of the protocol.
- Prepare the calendar of actions to ensure protocol compliance.

Sire selection

- Determine if you will purchase or raise replacement heifers.
- Decide how you will market your calves.
- Select proven AI sires with high-accuracy EPDs that match performance goals.
- Purchase semen from a Certified Semen Services (CSS) collection facility.
- Prepare or update your semen inventory.
- Make sure females meet the criteria for being good candidates for estrus synchronization.

Heifer criteria

- Heifers may be developed utilizing a variety of resources, research over the past decade has demonstrated acceptable pregnancy rates in heifers developed from 50 – 57% of mature body weight.
- Expose additional heifers beyond replacement needs to determine how your genetics responds to a lower input system if implemented.

Cow criteria

- Synchronize and inseminate only cows with BCS at calving of ≥ 5 (1 = emaciated; 9.0 = obese).
- The average days postpartum of the group of cows to be synchronized should be ≥ 40 by the start of estrus synchronization and experience a minimum of dystocia.

Things to do at the time of estrus synchronization and artificial insemination

- Meticulously follow the estrus synchronization protocol!
- If detecting estrus, spend as much time observing the animals as possible.
- Use a minimum of one person to detect estrus per 100 head of cattle.
- Use estrous detection aids to facilitate visual observation of estrus.
- Use a properly trained technician for AI.

Things to do after fixed-time artificial insemination

- To distinguish between AI and bull bred pregnancies at pregnancy diagnosis, you should wait approximately 10 days to turn in clean up bulls after AI.
- Pregnancy check by 75 days after AI via ultrasound or 80 to 90 days after AI via rectal palpation to distinguish AI from bull bred pregnancies.
- If cattle need to be shipped do so between days 1 to 4 after AI and avoid shipping cattle between days 5 to 42 after AI.
- Maintain breeding females on an adequate nutrition and mineral program.

PAY ATTENTION TO DETAILS!

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