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Systems to Facilitate Multiple Services of Artificial Insemination in Beef Herds

Estrus synchronization and artificial insemination (AI) provide unique benefits to any reproductive program. Estrus synchronization can tighten the calving distribution, producing a more uniform crop of calves at weaning and increasing reproductive success in the following breeding season. With AI, semen from bulls with elite genetic merit can be used to speed genetic progress for economically relevant traits. These technologies are most commonly implemented in conjunction with natural service programs, such as when a single service of AI at the start of the breeding season is followed by bull exposure for remainder of the season. However, performing an additional AI service for females that fail to conceive initially may be a profitable opportunity for many operations, and completely replacing the need for natural service bulls through exclusive use of AI is of increasing interest to many producers. In these systems, the cost and labor saved on bull acquisition, feed, and other maintenance expenses can be greater than the cost of products and labor commonly cited as a barrier to the use of AI.

Economic considerations

Benefits of performing additional AI services or using AI exclusively will vary based on the reproductive goals of the operation and the size of the herd. When considering the cost of a reproductive program, total bull cost may be summed and divided across the number of cows covered by the bull. This can be conceptualized as a "breeding charge" on a per cow basis.

In many cases, performing AI at the start of the breeding season can decrease the number of bulls required natural service as the fact that a number of cows are already pregnant allows each bull to cover more cows. The change in the bull:cow ratio effectively reduces the natural service "breeding charge" per cow. When AI reduces the number of bulls maintained by the operation for natural service, overall cost of bull ownership and maintenance are reduced. However, when the requirement for clean-up bulls does not decrease in proportion to the decreased numbers of cows requiring natural service, the overall bull "breeding charge" may actually increase dramatically as each bull services fewer cows (Table 1). Additionally, costs of estrus synchronization and AI must now be considered. Though this can be the case for operations of any size, smaller herds are generally less likely to realize cost-savings from a decreased need for bulls. For more better understanding of costs associated with bull ownership or to calculate the specific cost of bulls in your operation, consider the Annual Bull and Per Cow Cost Calculator (http://agecoext.tamu.edu/resources/decisionaids/beef) developed by the Department of Agricultural Economics at Texas A&M.

When considering the opportunity to reduce bull costs through use of AI, operations should carefully consider whether systems that facilitate multiple AI services could be economical given the size of the operation. If implemented effectively, systems that involve even just two to three AI services and no natural service may be a more economical option to achieve desired pregnancy rates when the number of calves produced via natural service does not justify the cost of maintaining a bull.

Sire selection considerations

Criteria considered for the selection of natural service sires differs across animals in the herd based on age class, genetics, and production goals. For example, calving ease is often the primary consideration when selecting bulls to service heifers, while production traits may be prioritized producing calves in older cows. Unfortunately, compromises in sire selection decisions are often made for smaller operations as the need to use bulls in breeding programs for both heifers and cows is anticipated. Artificial insemination greatly simplifies the use of multiple sires, allowing more targeted sire selection based on the class of animal.

This benefit is magnified when performing multiple services of AI as sire selection can differ during the

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breeding season according to the relative value of calves produced in different portions of the calving distribution. For example, females may be bred to sires with excellent genetic merit for maternal traits at the first AI service, with the intention of retaining replacement heifers from the earliest born calves. In subsequent services, terminal cross sires could be selected to increase growth of later-born calves destined for finishing.

Furthermore, when using AI, sires can be changed from year-to-year without selling and purchasing new bulls. In addition to providing greater overall flexibility, this allows operations that develop their own heifer calves as replacement candidates to avoid inbreeding. Though operations with fewer cows require fewer bulls, the rate of bull turnover is often high as bulls must be replaced after only two years to prevent sire-mating daughters. The length of time that the bull remains in the herd can dramatically affect the bull "breeding charge" per cow as previously described.

Crossbreeding systems are an ideal way to maximize heterosis and breed complementarity but are often disregarded because of the need for two or more sire breeds and/or multiple breeding groups. Individualized sire selection through AI-only systems make crossbreeding feasible, since sires can be used selectively for individual females within a single management group. For more information on the benefits and types of crossbreeding systems, see MU Extension publication G2040, Crossbreeding Systems for Small Herds of Beef Cattle (https://extension.missouri.edu/publications/g2040).

Table 1. Cost of natural service bulls if beginning the breeding season with or without one or more AI services.

		Operation size			
	Number of cows	10 cows	50 cows	100 cows	500 cows
	Number of bulls assumed	1 bull	2 bulls	4 bulls	20 bulls
Natural service	Calves resulting from AI	0	0	0	0
	Calves resulting from natural service	9	45	90	450
	Bull cost per cow exposed	$200	$100	$80	$80
	Bull cost per calf produced by natural service	$222	$89	$89	$89
One AI service + Natural service	Calves resulting from AI	7	35	70	350
	Calves resulting from natural service	2	13	27	135
	Bull cost per cow exposed	$200	$80	$80	$80
	Bull cost per calf produced by natural service	$1,000	$308	$296	$296
Two AI services + Natural service	Calves resulting from AI	8	42	85	425
	Calves resulting from natural service	1	7	13	67
	Bull cost per cow exposed	$200	$80	$80	$80
	Bull cost per calf produced by natural service	$2,000	$571	$615	$597
Total AI	Calves resulting from AI	9	46	92	462
	Calves resulting from natural service	0	0	0	0
	Bull cost per cow exposed	$0	$0	$0	$0
	Bull cost per calf produced by natural service	-	-	-	-

This table illustrates the cost of producing natural service calves based on herd size, the number of bulls required, and the number of AI services performed, if any. Bull cost as included assumes an example annual ownership and operating cost of $2,000 per bull and a bull:cow ratio of 1:25. Conception rate to AI was assumed to be 70% for the first service and 50% for the second service. Final pregnancy rate was assumed to be 90% in all programs. Note that, if using one or more AI services, costs associated with natural service bulls can actually be quite high unless a lower bull:cow ratio is used. For operations that are willing to use fewer natural service bulls or even eliminate the use of natural service bulls, use of multiple AI services could actually reduce breeding costs.

Implementation

When considering methods for AI-only systems, inputs such as labor and product costs must be weighed against goals for total pregnancy rates or length of the breeding season. In most cases, it will be most practical to begin the breeding season with use of an estrus synchronization protocol. For more information on selecting an estrus synchronization protocol for the first AI service, see MU Extension publications G2024, Estrus Synchronization Recommendations for Artificial Insemination of Beef Cows (https://extension.missouri.edu/publications/g2024), and G2025, Estrus Synchronization Recommendations for Artificial Insemination of Beef Heifers (https://extension.missouri.edu/publications/g2025).

Synchronization will result in a large proportion of the herd expressing estrus prior to the first AI service. This synchrony of estrus will carry over to some degree among females that fail to become pregnant to the first AI service and return to estrus in the next cycle. However, the period of hours or days over which females express estrus will be longer during the return to estrus than it was during the first period of estrus expression, due to inherent differences in cycle length and other factors. Although timed AI protocols have greatly decreased the labor associated with carrying out a first AI service, different considerations apply when attempting to carry out a second AI service for females that failed to conceive to the first AI service.

Estrus detection

Estrus detection is the most rapid and cost-effective method for accomplishing additional AI services. As pregnant animals are not expected to return to estrus, cows that express behavioral estrus may receive a second AI service without threatening existing pregnancies. This strategy provides an opportunity to detect estrus and breed all animals without the delay required for pregnancy diagnosis. Likewise, avoiding the use of products for resynchronization make it an economically attractive option. Visual detection of estrus can be time consuming, however.

Animals that respond to the initial synchronization protocol are expected to return to estrus within a range of 17-24 days after the first AI service. However, note that a small percentage of animals may return to estrus prior to this window, such as those that failed to respond to some portion of the initial synchronization program or those that undergo a "short cycle" following synchronization. Given that this is typically only a small percentage of animals, a practical approach is often to focus heat detection efforts on days 17 to 24 after the initial AI service (Figure 1). The use of tools such as estrus detection aids can greatly simplify monitoring animals. To learn more about best practices and methods for estrus detection, see MU Extension publication G2021, Detection of Estrus in Beef Cattle Herds (https://extension.missouri.edu/g2021).

Pregnancy diagnosis

The earliest time at which pregnancy may be detected depends on the method of diagnosis. A skilled veterinarian using ultrasound can accurately detect pregnancy at 28 days after AI, while biochemical tests may be used a few days sooner. Unfortunately, waiting to determine pregnancy status via either method involves missing an opportunity to service nonpregnant animals that returned to estrus. Overall, the delay required to detect pregnancy is one of the greatest challenges to achieving a condensed calving season with multiple services of AI. For a complete discussion of timing and methods of pregnancy diagnosis, see MU Extension publication G2042, Determination of Pregnancy Status in Beef Herds (https://extension.missouri.edu/publications/g2042).

Resynchronization protocols

Estrus synchronization products can be used for resynchronization to facilitate a second AI service. However, since some females will likely have become pregnant to the first AI service, certain products should not be used in resynchronization unless pregnancy status as been confirmed. Prostaglandin F2a (PG) will cause abortion if administered to pregnant females, so it is critical that any use of PG in resynchronization programs be restricted to only females that have been confirmed to be nonpregnant.

Resynchronization protocols are designed to shorten the period of time over which nonpregnant females return to estrus, in order to facilitate a second service of AI. One strategy is to insert a CIDR for a period of time prior to the anticipated return-to-estrus. Note that GnRH should not be administered at CIDR insertion if using this approach, as this could extend the length of the estrous cycle. If a fixed-time AI program was used to facilitate the first AI service, a CIDR may be inserted on Day 12 or 13 following fixed-time AI. The CIDR is typically suggested to be removed on Day 19 for heifers and on Day 20 for cows (Figure 2). Again, PG should not be administered at CIDR removal when using this approach, as administering PG would result in abortion among females that were already pregnant. If desired, an estrus detection aid may be applied at CIDR removal to facilitate accurate detection of estrus. Because this approach involves handling females that are potentially pregnant during the critical period of maternal recognition of pregnancy, low-stress stockmanship and good animal handling facilities/conditions should

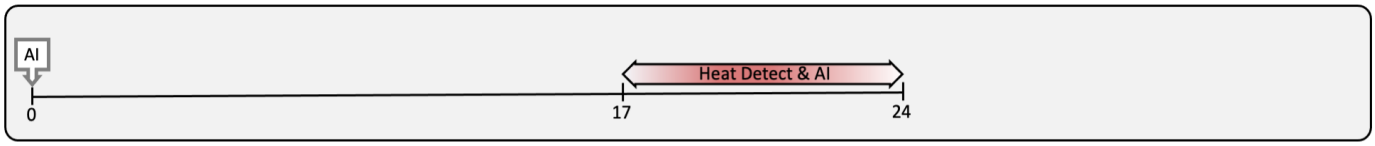

Figure 1. A practical approach to carry out a second AI service is to focus heat detection efforts on days 17 to 24 after the initial AI service. Animals that respond to an initial synchronization protocol are expected to return to estrus within a range of 17-24 days after the first AI service. A small percentage of animals may return to estrus prior to this window, such as those that failed to respond to some portion of the initial synchronization program or those that undergo a "short cycle" following synchronization.

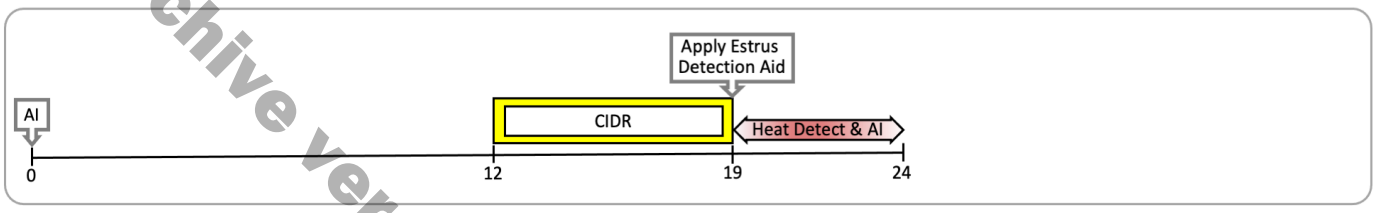

Figure 2. If a fixed-time AI program was used to facilitate the first AI service, a CIDR may be inserted on Day 12 or 13 following fixed-time AI. The CIDR is typically suggested to be removed on Day 19 for heifers and on Day 20 for cows. Use of this approach for resynchronization can reduce the number of days required for heat detection when performing a second AI service.

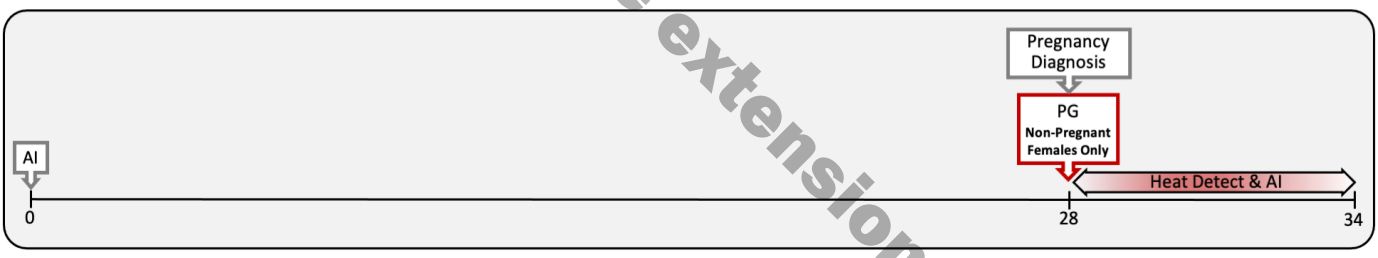

Figure 3. If an accurate early pregnancy diagnosis is performed after a first AI service, one approach to facilitate a second AI service is to administer PG to all cows that are confirmed nonpregnant at the time of an early pregnancy diagnosis. This can be performed as early as 28 days after the first AI service as show here. Note that PG should only be administered to females confirmed as nonpregnant. Estrus detection and AI may be performed in the subsequent days. A long period of estrus detection will likely be required (approximately 6 to 7 days, as show here), and not all nonpregnant females administered PG for resynchronization will go on to express estrus.

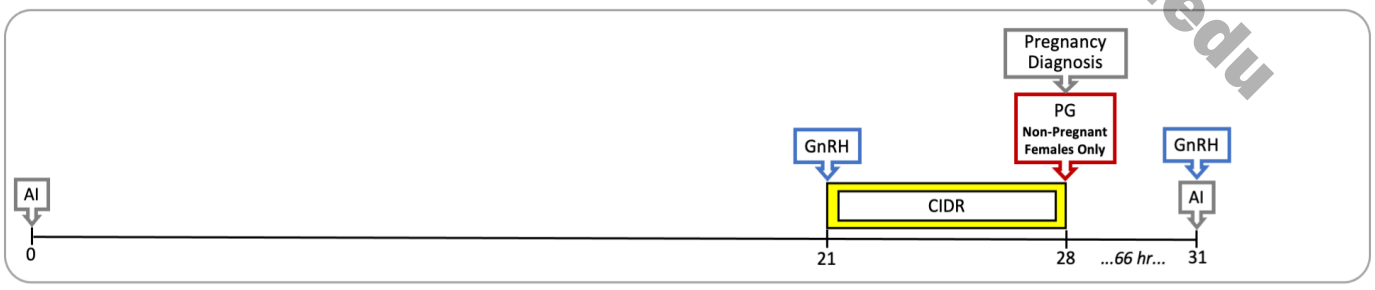

Figure 4. With careful planning, a resynchronization protocol can be scheduled so that the final step of the protocol occurs on the same day as an early pregnancy diagnosis. Seven days prior to pregnancy diagnoses, a CIDR is inserted and GnRH is administered to all females. On the day of pregnancy diagnosis, the CIDR is removed from all females. Note that PG should only be administered to females confirmed as nonpregnant.

be a priority. Peer-reviewed research results using this resynchronization approach are somewhat limited but suggested minimal cause for concern related to pregnancy loss under the conditions of the experiments. However, it should be noted that a CIDR is one of the more costly products involved in estrus synchronization, and this protocol involves using a CIDR among all heifers, including those that may have become pregnant to the first AI service.

Another method of resynchronization is to administer PG to nonpregnant females when they are confirmed to be nonpregnant. One reasonably effective approach is to administer PG to all cows that are confirmed nonpregnant at the time of an early pregnancy diagnosis, which can be performed as early as 28 days after the first service AI (Figure 3). Estrus detection and AI may be performed in the subsequent days; however, it should be noted that a long period of estrus detection will likely be required (approximately 6 to 7 days), as timing of estrus expression will vary between females. Whether a cow will express estrus in the days following PG administration depends on whether a mature, PG-responsive corpus luteum (CL) is present on the ovary. So, not all nonpregnant females administered PG for resynchronization will go on to express estrus.

Resynchronization protocols that incorporate use of GnRH and a CIDR can improve synchrony of estrus and increase the proportion of nonpregnant cows that express estrus following resynchronization. This can allow the second AI service to be performed as a timed AI. Neither GnRH nor a CIDR pose a threat to existing pregnancies; therefore, protocols involving GnRH and a CIDR may be initiated prior to pregnancy diagnosis if a carefully planned schedule is followed. If the resynchronization protocol can be scheduled so that the final step of the protocol occurs on the same day as an early pregnancy diagnosis, PG can then be administered to females confirmed as nonpregnant at this time (Figure 4). Again, note that PG should not be administered unless females are confirmed as nonpregnant, since administering PG to all females would result in abortion among females that were already pregnant. One downside of this approach is that GnRH and CIDR products are administered to all animals, including those that are pregnant. However, this cost could be offset by the labor savings of performing timed AI rather than detecting estrus for multiple days following resynchronization.

For detailed information regarding the function, handling considerations, and proper administration of estrus synchronization products, see MU Extension publication G2022, Guide to Estrus Synchronization Products (https://extension.missouri.edu/publications/g2022).

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