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Optimizing Pregnancy Rates Using Artificial Insemination

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Artificial insemination (AI) offers the opportunity to use semen from high-accuracy, genetically superior sires at a fraction of the cost of purchasing a herd bull of similar genetics. In addition, using estrous synchronization in combination with AI gives every female the opportunity to conceive on the first day of the breeding season. This can increase the number of calves born earlier in the calving season and increase weaning weights of calves.

A portion of the economic advantages resulting from implementing AI is related to the number of calves born in a herd from AI sires. The benefits are threefold: an immediate increase in sale value, long-term benefits of infusing superior genetics into the herd, and improvements to herd productivity and profitability from more cows calving at the beginning of the calving season.

Therefore, understanding and managing the factors that contribute to optimizing AI pregnancy rates can improve profitability in beef herds implementing estrous synchronization and AI. This publication will review how factors related to cows, bulls, management and weather all contribute to the success of an AI breeding program.

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Before Implementing Estrous Synchronization and Artificial Insemination

Before implementing estrous synchronization and fixed-time AI, it is important to evaluate the herd's current reproductive performance. Pregnancy rates to natural service breeding in a defined breeding season can highlight the existing fertility status of the herd and if there may be management factors to address before implementing AI. Herd pregnancy rates of at least 85% within a 60-day breeding season should be observed before implementing estrous synchronization and fixed-time AI. Lower pregnancy rates in defined natural service breeding seasons may highlight gaps in nutritional or herd health management that need to be addressed before utilizing reproductive technology.

Estrous synchronization and AI require careful planning and attention to detail. Approved synchronization protocols, including those involving heat detection and/or fixed-time AI for use in cows and heifers, can be found at https://beefrepro.org/protocols/.

Cow Factors That Influence Success

Nutritional Status

Nutritional status leading up to the breeding season plays a major role in achieving pregnancy. A Body Condition Score (BCS) is a subjective, visual observation used to evaluate nutritional status of cattle. The target BCS at the time of breeding is approximately 5 on a scale of 1 to 9 (1 = emaciated, 9 = obese). Cattle at a BCS of 5 will not have a visible spinal outline, while hook/pin bone outlines and the last 1 to 2 ribs are visible. Additionally, cattle at a BCS 5 will not have fat accumulated in the brisket, flank or tail head areas.

The plane of nutrition is equally as important as BCS. The ideal scenario is to have cows on an increasing plane of nutrition leading up to the time of breeding. Cows that calved in heavy condition and are losing body condition leading up to the breeding season will likely experience lower pregnancy rates. The energy demands required after calving to repair the uterus and produce milk for a growing calf may not be met by feed intake alone. In that case, fat stores are mobilized to meet the body's energy demands (also known as a state of negative energy balance).

In addition to energy (which drives BCS), making sure that protein, vitamin and mineral requirements are being met leading up to breeding season is important. A good time to start managing the BCS of females is around the time of weaning. While long before the breeding season starts, energy and protein requirements are lowest at this stage of production, and adding body condition, if needed, is most economical.

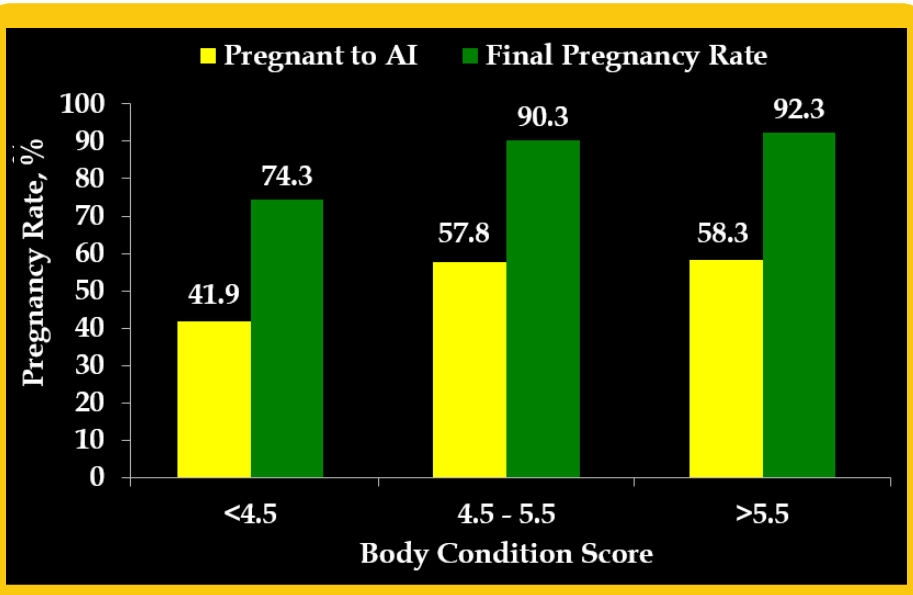


Figure 1. The impact of body condition score at the time of breeding on pregnancy rate with AI and season-ending pregnancy rates in beef cows from NDSU herds. (NDSU illustration)

Calving Distribution and Days Postpartum

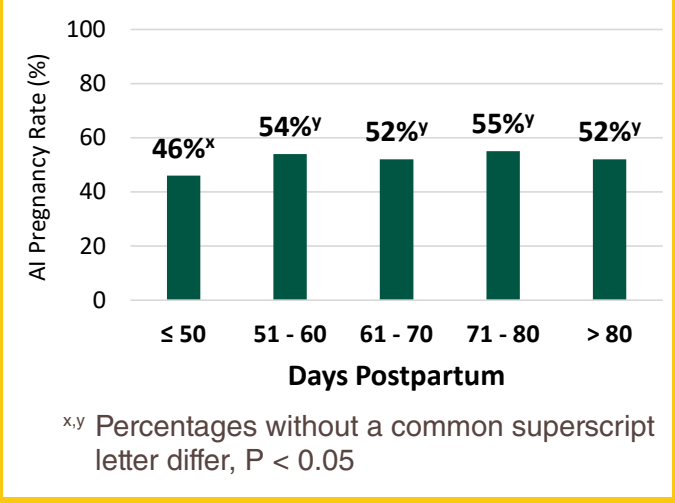
Days postpartum (DPP) refers to the number of days since an animal has given birth and is a key indicator of potential reproductive performance in the following breeding season. After giving birth, a period of recovery time is necessary before females can resume normal and regular estrous cycles (postpartum interval). In general, 2-year-olds have a longer postpartum interval than mature cows. As DPP increases, the likelihood of a cow returning to normal estrous cycles also increases. In an ideal situation, cows should be at least 45 DPP at the time of breeding. Cows calving within 30 days of the start of the next breeding season are less likely to respond to an estrous synchronization protocol, which can negatively impact AI pregnancy rates. By keeping calving date records, the proportion of females calving in the first 42 days (two estrous cycles) of the calving season is easily noted. Success with estrous synchronization and AI is most likely if at least 60% of the herd is calving in this time period. If that is not the case, it may be beneficial to use synchronization with natural service, or alternatively, sort the herd based on calving date and use multiple synchronization and AI events within the herd three to four weeks apart. This allows for late-calving cows to reach an appropriate DPP before estrous synchronization and AI.

Reproductive Tract Scores in Heifers

A Reproductive Tract Score (RTS) in heifers is assigned based on uterine size and ovarian structures. This process can be used to eliminate heifers with poor breeding potential and identify any freemartin heifers. As RTS increases from 1 to 5, the proportion of females likely to respond to estrous synchronization and conceive to AI also increases (Figure 3).

Reproductive Tract Scores should be assigned approximately 45 days in advance of the breeding season to allow time for any necessary changes to the nutritional program. Consider removing all RTS 1 heifers from the replacement pool. For an AI breeding program, it is recommended that 50% of all heifers should have an RTS of 4 or 5 going into the breeding season.

Figure 2. First-service AI pregnancy rates in suckled beef cows (ages 1 to 12) after estrous synchronization. (Adapted from Larson et al., 2006. Journal of Animal Science)



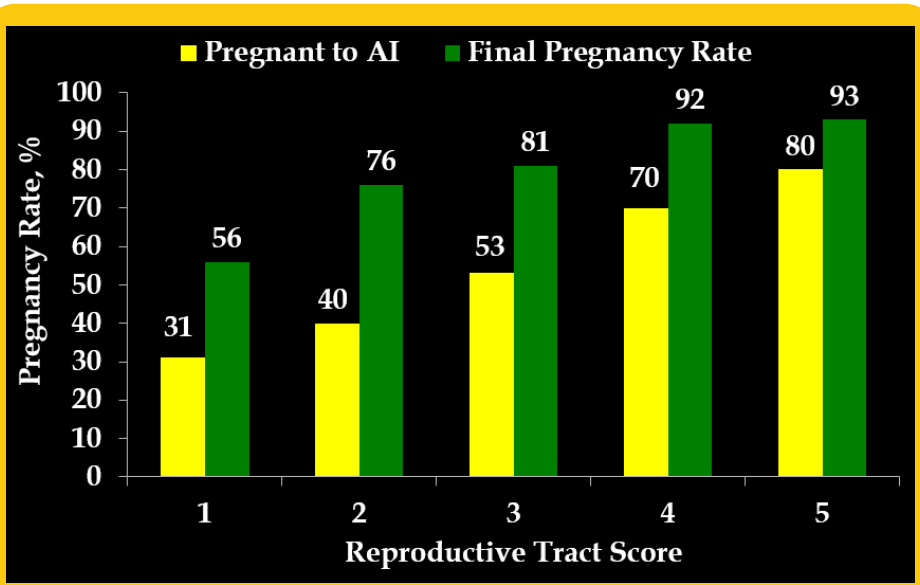


Figure 3. The impact of reproductive tract score on pregnancy rate with AI and season-ending pregnancy rates in beef heifers. (Adapted from Holm et al., 2009. Journal of Animal Science)

Health/Vaccination Status

Prior to the breeding season, females should be in good overall health. Several types of viruses and bacteria can cause reproductive failure. For example, bovine viral diarrhea virus (BVDV), infectious bovine rhinotracheitis (IBR) and a host of Leptospira bacteria all have been associated with poor reproduction through reduced pregnancy rates, abortions or stillbirths.

Prebreeding vaccines help protect cattle against some common sources of embryonic/fetal loss and should be administered according to the manufacturers' label recommendations. In cases where vaccines require a booster, plan ahead to ensure the booster dose is administered in advance of breeding.

Work closely with your herd veterinarian to establish and follow a herd health program that supports reproduction. For more information, see NDSU Extension publication AS1731, "A Preventative Herd Health Program: Checklist for Beef Producers." (https://www.ndsu.edu/agriculture/extension/publications/preventive-herd-health-program-checklist-beef-producers)

Bull Factors that Influence Success

Although utilizing AI takes many of the traditional bull factors (age, stocking rate, libido, etc.) out of the breeding equation, differences in fertility still exist among AI sires.

Differences in fertility among beef sires exist, but large-scale sire fertility tracking in the beef industry is inhibited by two items: 1) the beef industry does not have recordkeeping infrastructure comparable to the dairy industry to track sire fertility, and 2) utilization of AI is much lower in the beef industry, compared with the dairy industry, and good prediction of sire fertility requires pregnancy results from a large number of breedings.

Nevertheless, at the time this publication was created, several AI companies were exploring methods to report fertility of frozen beef semen, and some companies were beginning to publish sire conception rate data on a portion of their beef bull battery. According to one advertisement, selecting a bull with the greatest fertility could yield estimated pregnancy rates that are 10% greater than those of a bull with the least fertility estimates.

Consult with your semen supplier about which bulls consistently have generated superior fertility in the AI scenario you plan to implement (fixed-time AI, heat detection, etc.). Consistently identifying and using bulls that produce semen of high fertility in AI settings is a positive step toward optimizing AI pregnancy rates.

Management Factors That Influence Success

Careful management is directly related to the success of an AI program. Once a clear plan to implement AI has been established, focus on perfecting the necessary tasks required at each step of the process, including working with the weather and managing cattle after breeding.

Perfecting Necessary Tasks

Cattle handling: Synchronization protocols require producers to handle cattle two to four times to accomplish AI breeding. Each person handling cattle should always practice calm, low-stress handling techniques through adequate facilities; otherwise, stress may contribute to poor results. Whenever possible, avoid anything that can stress cattle, including loud noises, aggressive dogs, aggressive people and excessive use of cattle prods or hotshots.

Acclimating cattle allows them to become accustomed to working facilities and handling practices used during the synchronization and AI process. Moving cattle calmly through facilities several times in advance of the breeding season can reduce the stress of subsequent handling events, improve handling efficiency and cattle temperament, and may increase pregnancy rates.

Estrus detection efficiency: If producers are using a protocol that requires heat detection, spending adequate time detecting estrus and being able to correctly identify animals that are in estrus is critical. In general, the more time spent observing, the greater the proportion of animals that will be correctly identified in estrus. Minimum recommendations are to heat detect twice a day for 30 minutes each, typically in the morning and evening. Observing for longer (up to two hours) and more frequent (morning, noon and night) periods of time allows for more accurate results.

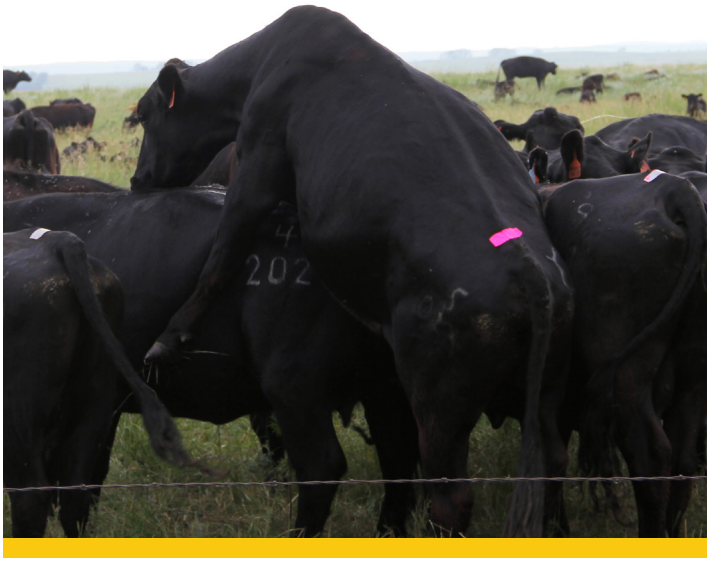
The only primary sign of estrus is standing to be mounted. Females that mount other females are not necessarily in estrus. Only those that stand to be mounted should be considered to be in estrus.

If facilities allow, move cattle in estrus into a pen or pasture away from nonestrus cattle. Estrus detection will be easier in the remaining animals, and once the very active estrus females are removed, females that have more subtle expression of estrus may be observed.

Several types of estrus detection aids are available to assist producers with identifying females in estrus. Estrus detection aids are placed on the tail head of females and are activated by the pressure applied when other cattle mount an estrus female. Producers can observe changes in the estrus detection aid or electronic signals as possible signs of estrus. For estrus detection patches, when more than 50% of the patch is rubbed off, that female is considered to be in estrus.

The timing of insemination must allow for sperm and oocyte (egg cell) lifespans to overlap. Research in this area has found optimal pregnancy rates to AI around 12 hours after the onset of estrus, emphasizing the need for diligent estrus detection. The “a.m./p.m. rule” is used during estrus detection programs, where females detected in estrus in the morning (a.m.) are inseminated the following evening (p.m.), approximately 12 hours later.

Since pregnancy rates to AI are greater for females that have expressed estrus prior to AI, using estrus detection aids can be helpful to use with fixed-time AI protocols as well. In this scenario, females expressing estrus can be easily sorted and may be good candidates for preferred matings or to receive more valuable semen compared with females that have not expressed estrus prior to fixed-time AI.



Compliance to protocols: Estrous synchronization to facilitate fixed-time AI requires precise timings of injections and insemination; therefore, producers need to plan ahead before executing a protocol to avoid missing a critical time point.

First, ensure cleanliness, safety and appropriate administration of all synchronization products according to label directions and Beef Quality Assurance guidelines. Maintain cleanliness of CIDR® inserts and applicators, and ensure cleanliness of the females' vulva/perianal region before CIDR® insertion.

Each task at each working event is required for successful synchronization and impacts of noncompliance (missed cattle, administering wrong product, improper timing, CIDR® left in, etc.) are additive. If every task is completed correctly 90% of the time and a protocol requires three working events, the end result would be 72.9% of females synchronized correctly (.90×.90×.90 = 72.9%). Strive for complete compliance when executing tasks to limit negative additive effects. For help with planning days and times of an AI breeding program, an Estrous Synchronization Planner has been developed and is availible at https://beefrepro.org/resources/.

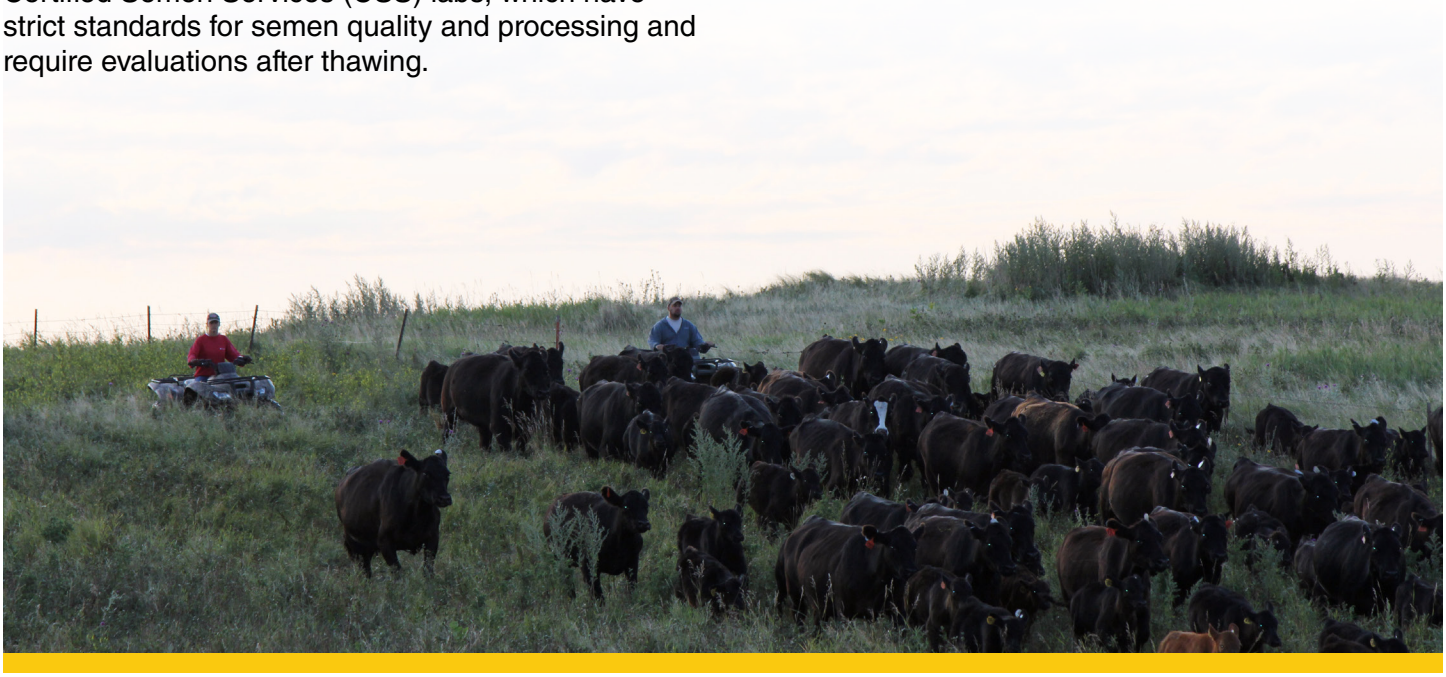
Semen-handling: To ensure the highest possible fertility, utilize high-quality semen that has been handled correctly. Semen quality can be compromised by damage caused at any step of the collection, handling, freezing, storing, thawing or insemination processes.

Purchase semen from a reliable source such as Certified Semen Services (CSS) labs, which have strict standards for semen quality and processing and require evaluations after thawing.

Once semen has arrived to the operation, transfer the semen from dry shipping tanks to storage tanks filled with appropriate liquid nitrogen levels as soon as possible. **Do not** use dry shipping tanks during breeding. As a general rule, keep semen exposure to air temperature to *8 seconds or less* during tank transfer or when taking semen out of the tank to thaw. Impacts of air exposure on semen can affect not only the semen being thawed and used to inseminate, but also the semen that is stored in the same cane and being put back into the tank. Additionally, do not allow semen to be in direct sunlight while transferring or thawing, as UV light is extremely damaging to sperm cells.

- Keep accurate inventory of semen tank
- Keep all equipment clean (tweezers, thaw unit, straw cutter, AI gun, etc.)
- Avoid semen exposure to air temperature and sunlight
- Thaw straws in a 94-98 degrees Fahrenheit water bath for 45 seconds. Do not estimate.
- Once placed into the water bath, a straw should be used within 10 to 15 minutes

Insemination technique: Pregnancy rates can vary greatly by technician, so ensure every technician is proficient in AI and has sufficient experience to breed the number of cattle required within the window of time allowed. Have backup technicians in case of fatigue or injury to a primary technician. Professional AI services are available if AI proficiency, confidence, experience or time limits are a concern.



Working With the Weather

Adverse weather (heat, cold, excess precipitation, etc.) is a stressor that can negatively impact the success of an AI program. Although not controllable, understanding the impacts that weather can have allows proper scheduling in anticipation of these events and their impacts.

An example of the negative impacts of heat and humidity at different times of the day on pregnancy success is found in Table 1. In this example, cattle were gathered after sunrise (about 6 a.m.), and breeding started after all cows were sorted from their calves. Cows that were inseminated earlier in the morning had greater pregnancy rates than those cows that remained in the holding area and were inseminated later.

If working on hot days, handling cattle in the early morning is recommended. Start gathering, sorting and breeding cattle for large AI projects as soon as daylight permits. If labor and facilities allow, consider assigning several people to tasks of sorting cows from calves, and have others designated to begin breeding as soon as the first cows are sorted off.

During hot summer periods, the body temperature of cows in the early morning is the lowest it will be throughout the day. If cattle working is required during peak periods of sunlight and heat, provide shade and water when possible. Also, provide ample space for cattle to spread out in staging areas, and ensure cattle spend as little time as possible in closely confined portions of working facilities.

With herds that are inseminated during cooler times of the year, the focus may shift from concerns of hot temperature to managing freezing conditions, or to optimizing the use of available daylight to complete cattle work.

In all cases, prepare for the damaging effects that precipitation (rain or snow), bright sunlight, wind, etc., can have on semen quality, cattle movements and labor forces, and have a plan to counter each. In a fixed-time AI protocol, the most time-sensitive window is from CIDR® removal to GnRH administration and AI, so pay close attention to forecast models and plan accordingly. If major weather events force changes to protocols, seek technical advice for the best plan of action.

Table 1. Effect of time of day and temperature humidity index on pregnancy success in beef cows

	Breeding Group	
Item	**Early**	**Late**
Start time	7:45	9:52
End time	9:50	noon
Temp. humidity Index*	75.9	78.7
Number pregnant	32 of 52	20 of 52
Pregnancy rate, %	61.5	38.5

* Temperature humidity index at 72 = physical signs of heat stress; at 86 = severe heat stress

Managing Cattle After Breeding

After insemination, additional management factors must be considered to avoid embryonic loss and optimize pregnancy rates. In the first five days after insemination, the developing embryo is in the oviduct of the reproductive tract, where it is less susceptible to stress than in the uterine environment.

From day five to 42 after insemination, the embryo is in the uterus and is more sensitive to changes in that environment resulting from transportation or nutritional stress. After day 42, the placenta has developed, and while a chance for pregnancy loss still exists, it is much less likely. Due to these dramatic changes in embryonic development during this critical window, it is recommended that transportation of cattle occur from day one to four after AI, or be delayed until 45 days after AI to avoid the risks associated with transportation stress.

Heat stress in cattle during this critical window can also impact embryonic loss and pregnancy rates. If forecast models predict pending heat stress, consider taking steps outlined in NDSU Extension publication AS1615, "Dealing With Heat Stress in Beef Cattle Operations" (https://www.ndsu.edu/agriculture/extension/publications/dealing-heat-stress-beef-cattle-operations).

Diet and environmental changes immediately after insemination can also impact AI pregnancy rates. While it is common for heifers to be developed and inseminated in a dry lot environment, research has shown that moving heifers from a dry lot environment to a pasture immediately after breeding can cause a decrease in pregnancy rates. This response is likely due to changes in activity level from dry lot to pasture, grazing behavior, and the resulting change in energy balance. If heifers have only been in a dry lot setting, movement to a grazing system could cause weight loss and decreased pregnancy rates to AI, compared with heifers that have previous grazing experience.

In addition, supplementing cattle on pasture for 45 days after moving them from dry lots to pasture immediately after AI can result in greater pregnancy rates, compared with cattle moved immediately after AI and not supplemented. Take action to maintain a diet that meets nutrient requirements throughout pregnancy, and avoid sudden changes to the diet or stressors to cattle.

Conclusions

Many factors can influence pregnancy rates to AI, including days postpartum, body condition, health, breeding soundness, following protocol specifications, weather, handling, transportation and changes to nutrition. Paying attention to detail in each of these areas when utilizing estrous synchronization and AI is imperative to optimizing pregnancy rates. In addition, a thorough evaluation of what went right, what went wrong and how it can be improved after each AI project will help achieve desired results in the future.

All photos by Carl Dahlen, NDSU.

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For more information on this and other topics, see www.ndsu.edu/extension

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