Proceedings, Applied Reproductive Strategies in Beef Cattle - Northwest
September 30 – October 1, 2011; Boise, ID

STRATEGIES TO OPTIMIZE USE OF AI IN COW/CALF PRODUCTION SYSTEMS

John B. Hall

Department of Animal & Veterinary Sciences
University of Idaho, Nancy M. Cummings REEC, Carmen, ID

Although the focus of this presentation/paper is Strategies to Optimize Use of AI, the entire conference really addresses this topic. Throughout the next two days, the information you receive will not only relate to optimizing the use of AI, but relate to optimizing reproductive management of the cow/calf herd. This paper will focus on where we are today with AI in beef cattle, how we got here, and an overview of the strategies to optimize the use of AI.

The Situation

Artificial insemination in dairy cattle began in the 1930's with the first AI Co-ops appearing in 1937. By 2010, approximately 66% of dairy cows in the US were bred AI with 85% of all Holsteins a product of AI (Blezinger, 2010; Holstein Assoc., 2011). In contrast, only 7.9% of beef operations use estrus synchronization, and 7.6% of operations use AI (NAHMS, 2009). In a study by the National Animal Health Monitoring Service (NAHMS, 2009), only 6.4% of the cows represented in the study were bred AI or bred AI followed by natural service. The percentage of beef heifers bred AI is twice that of beef cows; however, less than 20% of all beef heifers ever receive a straw of semen (Figure 1).

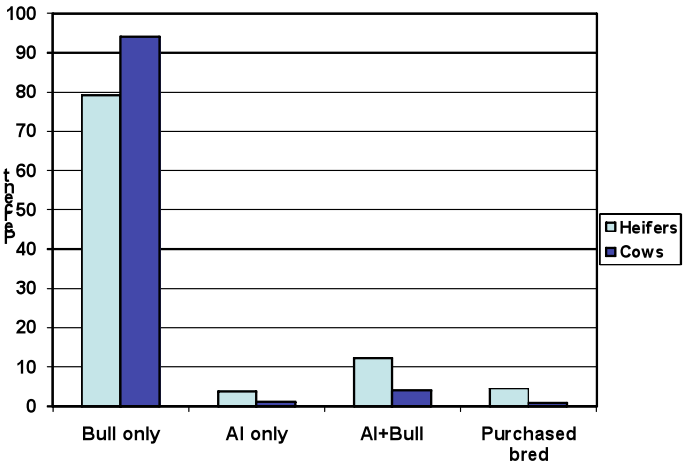

Figure 1. Percentage of beef cows and heifers bred by different methods

Overall use of reproductive technologies is high in the poultry and pork industries, moderate in the dairy sector, and low in beef operations. Beef producers were surveyed on the use of eight major reproductive technologies (Figure 2, NAHMS, 2009). Pregnancy testing (18.0% of operations; range 10.8% to 58.3%) and semen evaluation (19.5% of operations; range 10.9% to 56.8%) were the most frequently used technologies. Larger operations (> 200 head) adopt reproductive technologies more readily than smaller operations (< 100 head). When queried about why reproductive technologies are not used by ranches, the overwhelming answer is time or labor. Cost of the technology, difficulty in implementation and lack of facilities were also cited as barriers to adoption. In contrast, over 97% of operators admit that the common beef reproductive technologies work.

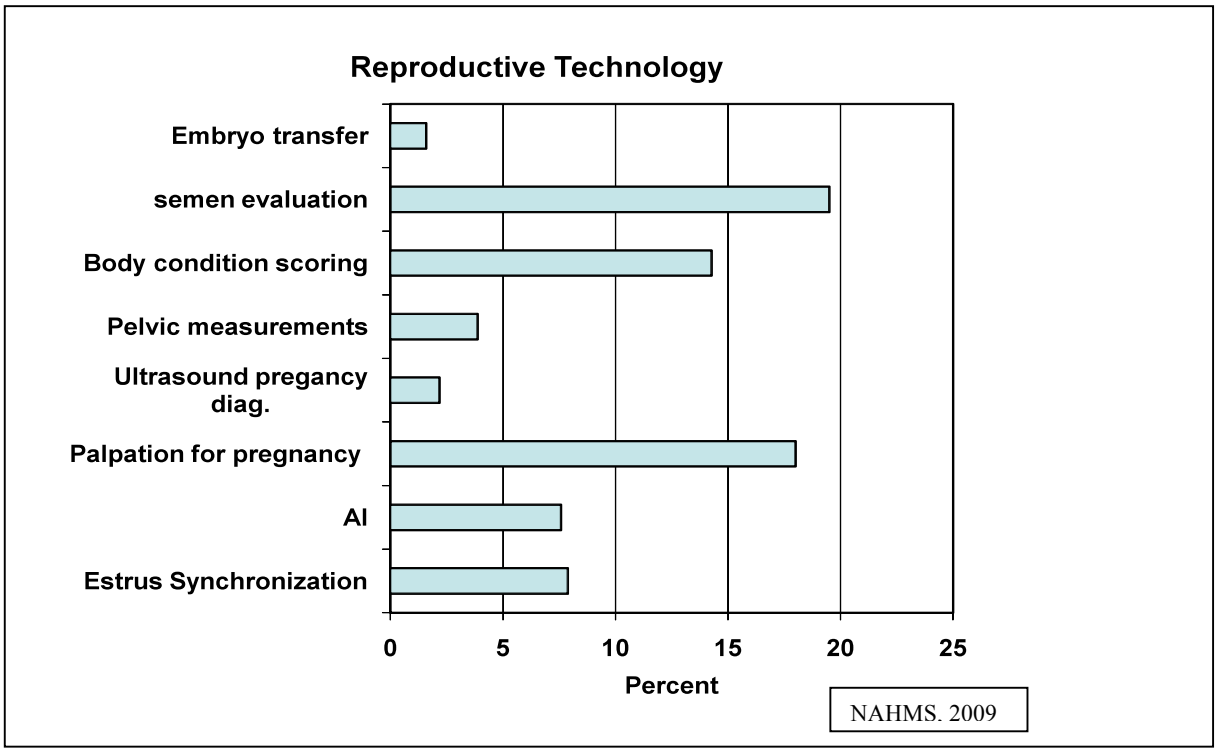

Figure 2. Percentage of beef operations using various reproductive technologies.

In addition to the social challenges to adoption of estrus synchronization and AI, the bovine presents some physiological challenges as well. In females, factors such as delayed puberty, prolonged anestrous, poor estrus expression, under-nutrition, extended calving seasons, failure to synchronize, and stress can compromise AI (and natural service) success. Sperm quality, sperm motility, ability to freeze, and a variety of other factors can impair the usefulness of bulls in an AI program. Add to the cattle factors, the human part of the equation …ability to detect estrus, handle semen, inseminate cows, and manage complex systems…and you end up asking:

"Why are we here?"

"Why even try?"

In my opinion, there are two crucial factors influencing the reason to adopt estrus synchronization and AI in beef cattle at this time.

1. We have the tools and technologies to overcome or at least manage a number of the factors influencing the success of estrus synchronization and AI.

2. The management, production, genetic, and final product benefits are significant.

The Strategies

Management Strategies

High pregnancy rates during a controlled breeding season are dependent on cows and heifers being physiologically ready to breed. Undernourished cows, young cows, underdeveloped heifers, and cows early postpartum have a high probability of being anestrous at the beginning of a controlled breeding season (Short et al., 1990). These non-cycling females create a huge challenge for an AI and natural service programs.

Several speakers today will focus on management strategies such as nutrition and body condition scoring to reduce the number of anestrous females in the herd. Others will focus on minimizing the physiological effects of suckling and presence of the calf. The use of biostimulation to reduce postpartum interval as well as the impacts of prenatal nutrition on subsequent fertility will be discussed. **Therefore, a key strategy is for cows to be physiologically ready by managing to increase the percentage of females cycling at the beginning of the breeding season AND designing synchronization systems that induce cycles in anestrous females.**

In the Northwest, beef producers know all too well the dangers of trichonomiasis or brucellosis on reproductive efficiency as well as profits. Diseases including BVD, IBR, Leptospirosis, and Vibriosis will reduce pregnancy rates. Heavy parasite burdens may also impair reproductive success (Larson et al., 1995; Purvis and Whittier, 1996). Herd health programs that use the proper combination of testing, vaccination, and treatment can help insure the reproductive success of a herd. Improper timing of application of herd health products such as Modified Live vaccines and some anti-parasitics may compromise pregnancy rates (Whittier and Baitis, 2005; Daly, 2006; Volkmann, 2011). **A quality herd health program is an important component to successful reproduction.**

It may seem strange, but a good natural service program is essential to optimizing the use of AI. First, a tight calving season with high pregnancy rates during the breeding season is important before moving adding an AI program. This is a good indicator that cow fertility and herd management are ready for AI. Several Extension programs used estrous synchronization along with natural service as a transition to an AI program (Patterson, 1991; Anderson, 2007). Also, few beef herds use all AI; therefore, a program for bull management and fertility assessment must be in place.

Proper management of bulls along with an annual breeding soundness exam will increase overall herd reproductive efficiency and pregnancy rates (Anderson et al., 1986). Beef producers often worry that clean-up bulls will be overwhelmed when females that did not become pregnant to AI return to estrus following synchronization. In a study from Virginia Tech, heifers were synchronized using CIDR + natural service, CIDR-Select with estrus detection, AI and "clean-up AI"(FTAI of non-responders), or CIDR-PG with estrus detection, AI and clean-up AI (Hall et al., 2006). During the synchronized natural service period the bull to heifer ratio was 1:22. Fourteen days after the synchronized AI and synchronized natural service period, heifers were randomly assigned to single sire mating groups with a bull to heifer ratio of 1:40 for 45 days. All bulls passed a standard breeding soundness exam. Pregnancy rates to AI averaged 60%, but

pregnancy rate to synchronized natural service was only 40% due to poor performance by one bull. As a result, clean-up bulls had an average of 20 heifers to breed. Some of the questions we asked were 1) Does one bull receive a large number of unbred heifers?; 2) What effect does number of unbred heifers presented have on pregnancy rates to clean-up bulls. On average, these young bulls bred 75% of the heifers presented to them (Figure 3). Remember these bulls are receiving the heifers that did not breed to AI so there may be some inherent infertility/subfertility in the heifers presented. The number of unbred heifers presented to each bull is indicated by the denominator of each column in Figure 3. Due to the relatively small sample size, there was no significant effect of number of unbred heifers presented. It should be noted that the two poorest performing bulls (N131 – 62.5%; N041 – 69.2%) had the most and the least unbred heifers, respectively. Two-year old bulls (indicated by M prefix) had slightly better clean-up pregnancy rates than yearling bulls (N prefix) with 81.0% and 69.7%, respectively. This is not too surprising considering the extra breeding experience of older bulls. At NMCREEC, we routinely use a bull to female ratio of 1:50 for clean-up following FTAI and achieve overall pregnancy rates of 88%-95%. **Pregnancy rates of > 90% in a controlled breeding natural service program are a good indicator of readiness for AI. Use of experienced, BSE tested clean-up bulls at a bull to female ratio of 1:40 to 1:50.**

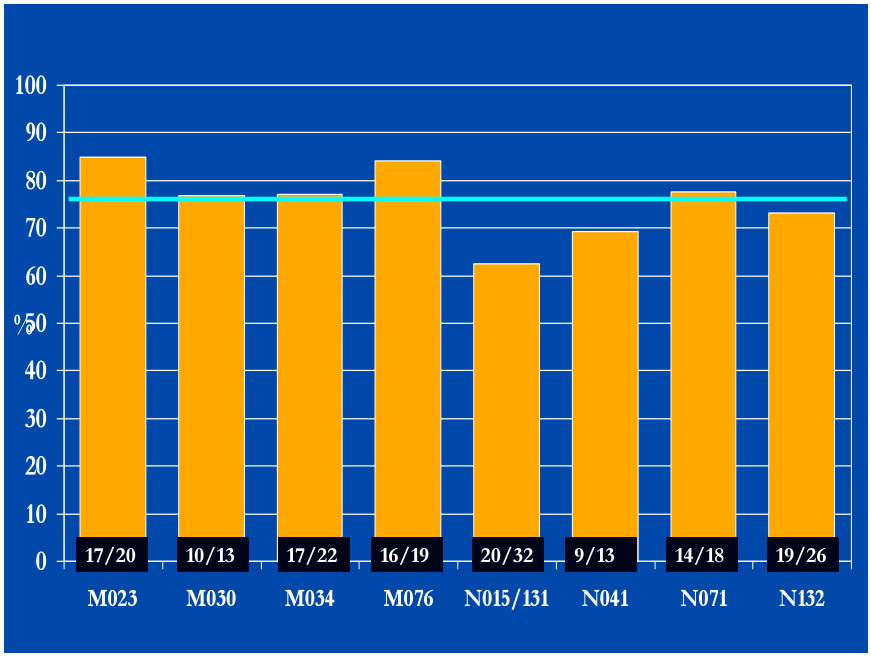

Figure 3. Impact of bull and number of unbred heifers presented after synchronized breeding.

The human variable is an important consideration in optimizing an AI program. Commitment to the program by the ranch leader (if not all involved) is crucial. By taking a "we'll try it and see if it works" attitude, an operation is headed down the road to poor performance. The investment in time, labor, and money is too great not to start with the right attitude and good preparation. All involved should understand the basic procedures, animal handling principles, and benefits of the program. The value of good technical assistance should not be underestimated. Engaging your beef genetics representative and veterinarian at the outset of the planning of an AI program is key. Despite the fact that a majority of the members of my staff, students, and I are all very capable of breeding cows AI, we use professional AI technicians when conducting research to

minimize variation due to technician. This does not mean you can't have a successful AI program if you breed all your cows yourself; simply don't overlook the benefits of someone that breeds 1000's of cows a year. This is one of the benefits of FTAI especially for smaller operations; technicians can be hired to breed cows while producers concentrate on other aspects of the synchronization and AI program. **Don't overlook the human variable.**

Estrus Synchronization and AI

One of the most significant barriers to a successful AI program is effective estrus detection. Both efficiency and accuracy of estrus detection affect the number of cows presented for AI. Estrus detection efficiency is the percentage of cows observed in estrus of cows that are in estrus. In other words, "Did we find the cows that were in heat?" Accuracy is the percentage of cows identified in estrus that actually ovulate. So were the cows we identified as in heat actually in heat and ovulated? Several research projects indicate that in beef cattle visual estrus detection efficiency ranges from 20-80% with accuracies of 88% to 100% (Stevenson et al., 1996; Geary et al., 2000). Therefore, producers do a good job of identifying cows that are really in heat, but fail to find a significant portion of females that are actually in estrus. Both efficiency and accuracy increase with increasing intensity of observation, and the use of estrus detection aids such as Estrotect™ or Kamar®. Use of electronic estrus detection devices, such as HeatWatch®, increases efficiency to 89% to 100% with accuracy similar to excellent visual estrus detection. **Therefore, a principal strategy is to improve the efficiency of estrus detection or to eliminate the need for estrus detection altogether.**

In the 1970's, breakthroughs with the development of commercially available prostaglandin F2a (PGF2a; Lutalyse) and progestins (MGA and Norgestomet) allowed producers to reduce time spent with estrus detection by inducing a high percentage of females to express estrus in a 3 to 7 day period. This synchrony of estrus was a result of either lysing the corpus luteum with PGF2a or extending the cycle with progestins. The protocols using these compounds were generally effective, but suffered from variability in estrus response and/or fertility (Lauderdale et al, 1980; Odde, 1990).

Prostaglandin F2α is only effective in cycling females, and then only from day 7 to 17 of the estrous cycle (Lauderdale et al., 1974). Progestins can induce estrous cycles in anestrous or pre-puberal females, but also can result in persistent follicles (Kinder et al., 1996; See Smith's paper in these proceedings). Despite some of the challenges with these two types of estrus synchronization products, systems that employ these compounds to cyclic females or in combination are often effective for producers willing to detect estrus. Several of these protocols are listed on the Beef Reproduction Task Force estrous synchronization protocol sheets. In fact, the MGA-PG system is still an effective and favorite system for producers willing to check heat in beef heifers.

While estrus synchronization systems that bring a large percentage of females in heat over 3 to 5 days increase estrus detection efficiency, these systems are still high labor systems due to the need to pull groups of estrual females and breed them approximately 12 hours after observed estrus. In addition, animals not observed in heat are not inseminated. Since we miss some of those animals that are in heat, we miss an opportunity for an AI pregnancy. Using a "clean-up" AI of non-responders allow all females to be inseminated, but pregnancy rates to "clean-up" AI

are extremely variable and generally less than 35%. **An important strategy would be to submit all cows/heifers over one or two days and that ovulation would be synchronized, not merely estrus.**

The availability of GnRH (1990's) and the Eazi-Breed® Controlled Drug Release Device (CIDR; 2002) allowed researchers to develop systems (Ov-Synch, CO-Synch, etc) which synchronized ovulation (Pursley et al., 1997; Geary and Whittier, 1998). In addition, when a progestin, especially the CIDR, was added to these protocols the effectiveness in anestrous females was greatly improved (Wheaton and Lamb, 2007). The most effective systems usually use a GnRH-CIDR-PG-GnRH arrangement of treatments. The systems now allow fixed-time AI (FTAI) of a large number of females with acceptable pregnancy rates to AI. Fixed-time AI synchronization systems eliminate the need for estrus detection. As a group, the Beef Reproduction Task Force conducted (and continues to conduct) research on estrus synchronization to optimize AI success, especially with FTAI systems. One of the goals in developing these systems is to keep total trips through the working chute to three including AI. **The final strategy is to use FTAI systems that are effective in anestrous and cyclic animals, and these systems result in AI pregnancy rates of greater than 55%.**

The Impacts

Positive impacts of a successful estrus synchronization and AI program include tighter calving distribution, increasing the percentage of calves born early in the calving season, reduced dystocia, and increase product quality and calf value.

Beef producers are often concerned that estrus synchronization and AI, especially fixed-time AI, could result in an overwhelming number of calves born on a single day. Researchers in Missouri documented calving patterns of cows bred to several different bulls (Schafer, 2005; Bader et al., 2005). They found that at most 20% of calves were born on a given day. For example, at our research station, we routinely use FTAI to inseminate 300 to 350 cows over one or two days. Even with pregnancy rates to AI of 65%, we average 10 to 15 calves born during the busy part of calving with a few days of 20 to 25 calves. Because of our bull selection as well as cow phenotype, dystocia in these cows is extremely low and this number of calves is very manageable even when calving in Idaho in February! Figure 4 illustrates the findings of Schafer (2005) depicting a normal bell-shaped calving distribution curve. Calves as a result of FTAI on a single day are born over a 2-week period. This two week calving period is a result of normal variation in gestation length in beef cattle. As a result of this variation in calving date, synchronized calving is manageable.

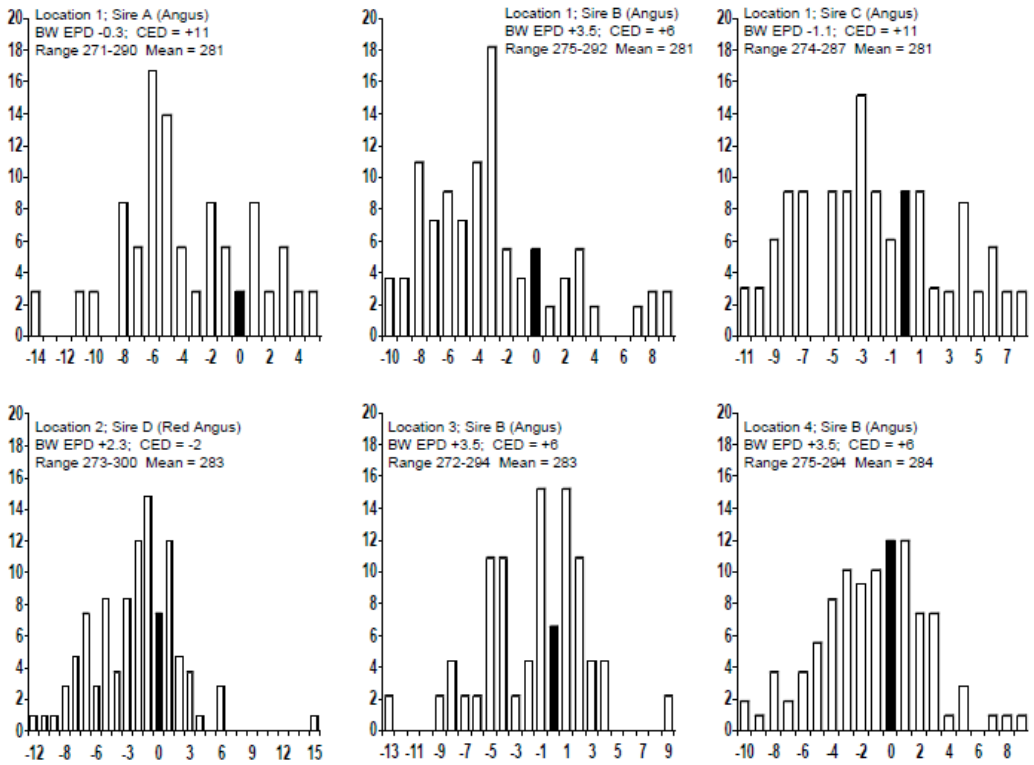

Figure 4. Calving distribution of cows conceiving to fixed-time AI (Schafer, 2005). Dark bar is anticipated due date based on 285 day gestation.

Using estrus synchronization and AI repeatedly over a period of years shifts a greater percentage of calf births to the early portion of the calving season (Patterson et al., 2007; Figure 5). This shift toward more calves born early in the calving season is a result of induction of cyclicity in anestrous individuals as well as an increase in days postpartum at the beginning of the breeding season. In addition, nutritional and health management of the herd is enhanced as cows are more similar in their physiological status.

The advantage of this shift of more calves early in the calving season is increased weaning weights and calf value in commercial operations. In fact, several groups of commercial producers use this shift in calving season along with the genetic benefits of AI to effectively market tractor trailer load lots from multiple small herds. In seedstock operations, the grouping effect of estrus synchronization and FTAI results in more uniform and larger contemporary groups. This improvement in contemporary groups increases accuracy of genetic evaluation.

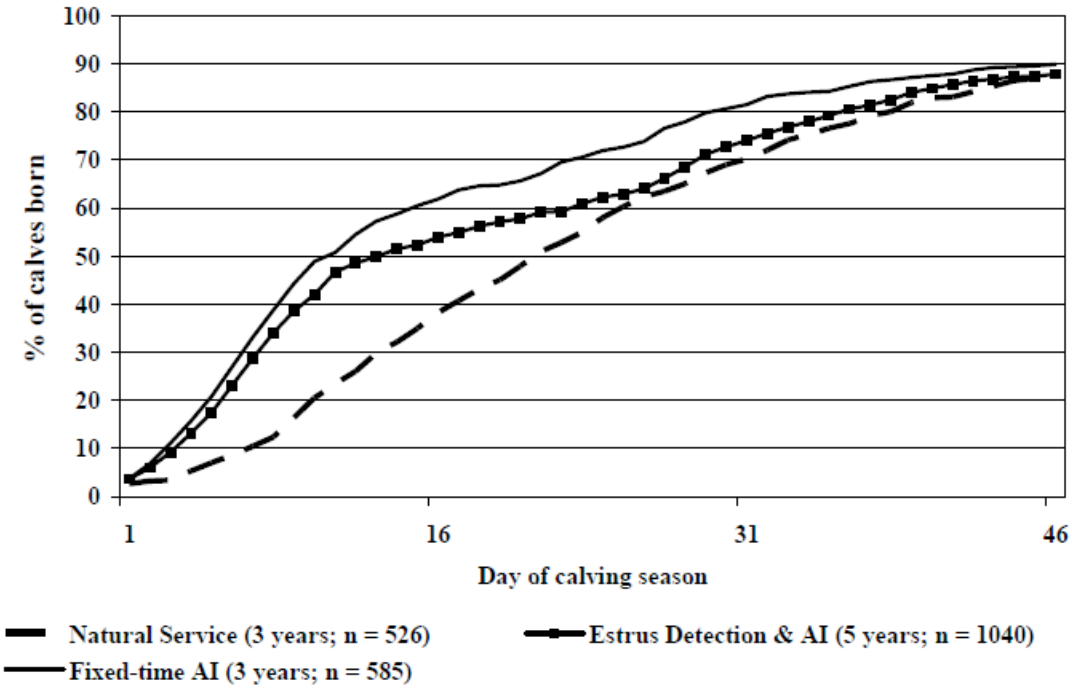

Figure 5. Effect of natural service, estrus synchronization and AI or Fixed-time AI on calving distribution for the first 46 days of the calving season over 11 years at University of Missouri Thompson Farm (From Patterson et al., 2007)

By utilizing superior genetics through AI, beef producers may improve product quality and returns to the ranch. One of the best real world examples of the impact of AI on the ranch was presented by Mr. Tim Sutphin of Hillwinds Farm at the 2007 Beef Improvement Federation meetings. Hillwinds Farm herd consists of 700 commercial Angus crossbred cows. They have used AI long enough to have females sired by AI bulls producing calves in their herd in addition to calves sire by AI and natural service sires. This enabled them to look at the value of AI from both the dam and sire sides. Artificial insemination sired calves born to dams that were products of AI returned 22% more to the ranch in calf value compared to natural service calves from natural service dams (Figure 6). Calves that were sired by natural service bulls born to dams that were from clean-up bulls had the lowest income returned to the ranch. It should be noted that clean-up bulls used had excellent EPDs for growth and carcass traits; however, accuracies were low. The percentage of steers grading choice was increased from 61% for no direct AI influence to 74 to 85% for 1 AI parent to 97% with both parents from AI.

The operators of Hillwinds Farm indicated that capturing the full economic value of AI was dependant on retaining ownership of the calves through the feedlot. The increase in productivity of the replacement females that were products of AI was also extremely valuable. However, they did not estimate the increased value of an AI dam when retained ownership was not used. Overall, the Sutphins attribute their ability to be sustainable and expand their operation is due, in part, to adoption of an AI program.

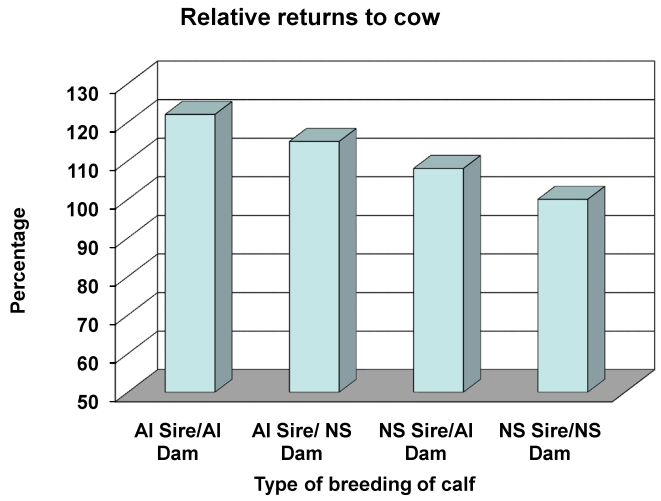

Figure 6. Effect of AI status of dam or sire on relative returns to cow in a Virginia cow herd.

Summary

This is perhaps one of the most exciting and challenging times to be in the beef industry. Current technologies, genetics, and market forces make incorporation of AI in to the beef operation a viable and profitable management decision. Optimizing the use and success of AI in beef cattle relies on 1) using proven management techniques to insure cattle and operator readiness; 2) determining which estrus synchronization system works best for the ranch; 3) managing the human and physical resources of the ranch.

- **Be Ready**…Manage cows for success by increasing percentage of cows physiologically competent at the beginning of the breeding season by using:
    - Sound nutrition
    - A planned herd health
    - Proper facilities and animal handling
    - A controlled and successful natural service/clean-up program

- **Use Proven Reproductive Strategies:**
    - Estrus synchronization systems which are effective in cycling and non-cycling females.
    - Improve estrus detection efficiency or eliminate the need for estrus detection
    - Highly consider fixed-time AI systems
    - Use semen from CSS approved suppliers
    - Experienced, BSE tested clean-up bulls at a bull to female ratio of 1:40 to 1:50.

- **Don't overlook the human variable…**Make sure personnel have**:**
    - Commitment
    - Communication
    - Competency

References

Anderson, L. H. 2007. Begin Planning The Breeding Season. 'Off the Hoof' Kentucky Beef Newsletter – April; University of Kentucky

Anderson, R. S., H. L. Fillmarc and J. N. Wiltbank. 1986. Improving reproductive efficiency in range cattle: An application of the O'Connor Management System.

Bader, J. F., F. N. Kojima, D. J. Schafer, J. E. Stegner, M. R. Ellersieck, M. F. Smith and D. J. Patterson. 2005. A comparison of progestin-based protocols to synchronize ovulation and facilitate fixed-time artificial insemination in postpartum beef cows. J. Anim. Sci. 83:136-143.

Blezinger, Stephen B. 2010. A.I. is beef industry's most underused tool. http://www.cattletoday.com/archive/2010/March/CT2172.php

Daly, R. 2006. Timing of vaccination in beef cattle herds. Proceedings, Applied Reproductive Strategies in Beef Cattle, Rapid City, South Dakota

Geary, T.W. and J.C. Whittier. 1998. Effects of a timed insemination following synchronization of ovulation using the Ovsynch or Co-Synch protocol in beef cows. Prof. Anim. Sci. 14:217-220.

Geary, T. W., E. R. Downing, J. E. Bruemmer, and J. C. Whittier. 2000. Ovarian estrous response of suckled beef cows to the select synch estrous synchronization protocol. Prof. Anim. Sci. 16:1–5.

Holstein Association USA. 2011. History of the Holstein breed http://www.holsteinusa.com/holstein_breed/breedhistory.html

Kinder,J. E., F. N. Kojima, E. G. Bergfeld, M. E. Wehrman and K. E. Fike. 1996. Progestin and estrogen regulation of pulsatile LH release and development of persistent ovarian follicles in cattle. J. Anim. Sci. 74:1424-1440

Larson R. L., L. R. Corah, M. F. Spire, and R. C. Cochran. 1995. Effect of treatment with ivermectin on reproductive performance of yearling beef heifers. Theriogenology 44:189-197.

Lauderdale, J. W., B. E. Seguin, J. N. Stellflug, J. R. Chenault, W. W. Thatcher, C. K. Vincent and A. F. Loyancano 1974. Fertility of Cattle Following PGF2α Injection. J. Anim. Sci. 38:964-967.

Lauderdale. J. W., J. F. McAllister, E. L. Moody and D. D. Kratzer. 1980. Pregnancy rate in beef cattle injected once with PGF2a. J. Anim. Sci. 51(Suppl. 1):296.

NAHMS. 2009. Beef 2007-2008. Part II: Reference of beef cow-calf management practices in the United States, 2007-2008. National Animal Health Monitoring System, USDA-APHIS.

Odde K. G. 1990 A review of synchronization of estrus in postpartum cattle. J. Anim. Sci. 68:817-830

Patterson, D. J. 1991. Using MGA to shorten the beef breeding season. Univ. of KY publication ASC-132

Pursley, J. R., M. C. Wiltbank, J. S. Stevenson, J. S. Ottobre, H. A. Garverick, and L. L. Anderson. 1997. Pregnancy rates per artificial insemination for cows and heifers inseminated at a synchronized ovulation or synchronized estrus. J Dairy Sci 80:295–300

Purvis, H. T., Jr. and J. C. Whittier. 1996. Effects of ionophore feeding and anthelmintic administration on age and weight at puberty in spring-born beef heifers. J. Anim. Sci. 74:736-744.

Schafer, D. J. 2005. Comparison of progestin based protocols to synchronize estrus and ovulation in beef cows. M.S. Thesis. University of Missouri, Columbia.

Short, R. E., R. A. Bellows, R. B. Staigmiller, J. G. Bernardinelli, and E. E. Custer. 1990. Physiological mechanisms controlling anestrus and infertility in postpartum beef cattle. J. Anim. Sci. 68:799-816.

Stevenson, J. S., M. W. Smith, J. R. Jaeger, L. R. Corah, and D. G. LeFever. 1996. Detection of estrus by visual observation and radiotelemetry in peripubertal, estrus-synchronized beef heifers. J. Anim. Sci. 74:729–735.

Volkmann, D. 2011. Bull management for optimum reproductive performance. Proceedings, Applied Reproductive Strategies in Beef Cattle, Joplin, MO pp 297-303.

Wheaton, J.E. and G.C. Lamb. 2007.Induction of cyclicity in postpartum anestrous beef cows using progesterone, GnRH and estradiol cypionate (ECP). Ani. Reprod. Sci. 102: 208-216

Whittier, W. D, H. K. Baitis. 2005. Timing of vaccinations in estrous synchronization programs. Proceedings, Applied Reproductive Strategies in Beef Cattle, Lexington, KY pp147-156