ECONOMICS OF AI VERSUS NATURAL SERVICE: USING DECISION-AID TOOLS

G. Cliff Lamb
North Florida Research and Education Center, Marianna, Florida
University of Florida

Introduction

Estrous synchronization and artificial insemination (AI) are reproductive management tools that have been available to beef producers for over 40 years. Synchronization of the estrous cycle has the potential to shorten the calving season, increase calf uniformity, and enhance the possibilities for utilizing AI. Artificial insemination allows producers the opportunity to infuse superior genetics into their operations at costs far below the cost of purchasing a herd sire of similar standards. These tools remain the most important and widely applicable reproductive biotechnologies available for beef cattle operations (Seidel, 1995). However, beef producers have been slow to utilize or adopt these technologies into their production systems.

Several factors, especially during early development of estrus synchronization programs, may have contributed to the poor adoption rates. Initial programs failed to address the primary obstacle in synchronization of estrus, which was to overcome puberty or postpartum anestrus. Additionally, these programs failed to manage follicular waves, resulting in more days during the synchronized period in which detection of estrus was necessary. This ultimately precluded fixed-time AI with acceptable pregnancy rates. More recent developments focused on both corpus luteum and follicle control in convenient and economical protocols to synchronize ovulation. These developments facilitated fixed-time AI (TAI) use, and should result in increased adoption of these important management practices (Patterson et al., 2003). Current research has focused on the development of methods that effectively synchronize estrous in postpartum beef cows and replacement beef heifers by decreasing the period of time over which estrous detection is required, thus facilitating the use of TAI (Lamb et al., 2001, 2006, Larson et al., 2006). This new generation of estrus synchronization protocols uses two strategies which are key factors for implementation by producers because they: 1) minimize the number and frequency of handling cattle through a cattle-handling facility; and 2) eliminate detection of estrus by employing TAI.

High priority needs to be placed on transferring these current reproductive management tools and technology to producers, veterinarians and industry personnel to ensure they are adopted at the producer level and to provide the necessary technical support to achieve optimum results. Because current management, breed, economic, location, and marketing options are producer specific, it is essential to ensure that transfer of this technology is not presented in blanket recommendations. Producers receiving all the necessary, applicable information packaged to include, but not limited to, protocol administration, economic implications, and genetic improvements to the cowherd are more apt to implement these tools into their management systems and achieve positive outcomes as a result. Without timely transfer of this technology within the United States, our research products and technology will be more effectively utilized in foreign countries competing with the United States to produce and market high quality, uniform beef products. The recent development of estrous synchronization protocols for TAI in beef cows has the potential to alter reproductive performance in numerous herds.

Economics of Estrus Synchronization

Recently we performed an experiment using partial budget analysis to determine the economic outcome of estrus synchronization and TAI in commercial cow/calf production (Rodgers et al., 2012). Suckled beef cows (n = 1,197) from 8 locations were assigned randomly within each location to 1 of 2 treatment groups: 1) cows were inseminated artificially after synchronization of ovulation using the 7-day CO-Synch + CIDR protocol (TAI; n = 582); and 2) cows were exposed to natural service (NS) without estrous synchronization (Control; n = 615). Within each herd, cows from both treatments were maintained together in similar pastures and were exposed to bulls 12 h after the last cow in the TAI treatment was inseminated. Overall, the percentage of cows exposed to treatments that subsequently weaned a calf was greater for TAI (84%) than Control (78%) cows. In addition, survival analysis demonstrated that cumulative calving distribution differed between the TAI and Control treatments (Figure 1). Weaning weights per cow exposed to treatments were greater for cows in the TAI treatment (425 lb) than those cows in the Control treatment (387 lb). Overall, increased returns plus decreased costs ($82.32), minus decreased returns plus increased costs ($33.18) resulted in a $49.14 advantage per exposed cow in the TAI treatment compared to the Control treatment (Table 1). Location greatly influenced weaned calf weights, which may have been a result of differing management, nutrition, genetic selection, production goals, and environment. We concluded that estrus synchronization and TAI had a positive economic impact on subsequent weaning weights of exposed cows.

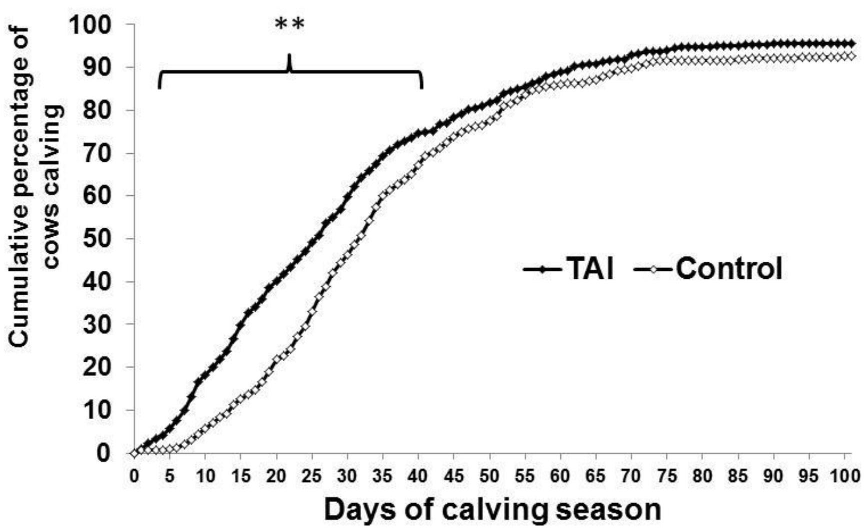

Figure 1. Survival analysis of the percentage of cows calving by day during the calving season. ** Cumulative calving percentage differs ($P < 0.05$) between TAI and Control treatments.

Table 1. Partial budget analysis for cows exposed to estrous synchronization followed by natural service compared to cows exposed only to natural service (expressed in US dollars; Rodgers et al., 2012)[1]

Item	Increased returns[2]	Decreased costs[3]	Decreased returns[4]	Increased costs[5,6]	Gain or loss	Net additional costs[7]	Additional weight, kg[8]	Breakeven price[9]
Herd sensitivity analysis:								
1	45.71	42.81	0	33.18	55.34	-9.63		
2	31.19	21.41	0	33.18	19.42	11.77	4.43	67.26
3	56.74	48.93	0	33.18	72.49	-15.75		
4	123.15	48.93	0	33.18	138.90	-15.75		
5	-10.49	37.46	0	33.18	-6.21	-4.28		
6	44.64	24.79	0	33.18	36.25	8.39	3.15	47.94
7	30.65	32.74	0	33.18	30.21	0.44	0.17	2.51
8	55.12	24.79	0	33.18	46.73	8.39	3.15	47.94
Overall[10]	47.09	35.23	0	33.18	49.14	-2.05		

[1]All returns and costs based on a weaning weight of exposed cows.
[2]Additional weight attributed to estrous synchronization (ES) and fixed-time artificial insemination (TAI) per weaning weight of exposed cows × selling price ($121.00/45.5 kg).
[3]Annual NS bull costs: annual operating costs: grazing and supplemental feed ($365.00), veterinary medicine ($40.00), annual ownership costs: depreciation ($557.00), interest cost ($151.00), death loss ($33.00): purchase price ($3270.00).
[4]Decreased returns attributed to fewer NS bulls to be culled are included as a negative value in the decreased costs calculation.
[5]Labor hours (0.41 h) per ES/TAI cow at $10.00 per hour.
[6] Supplies: Prostaglandin = $2.07/dose, CIDR = $8.76, GnRH = $2.00/dose × 2 doses, Miscellaneous. $0.25, Semen $14.00/unit.
[7]Net additional costs as increased costs minus decreased costs.
[8]Additional weight per exposed cow to cover net additional costs at $121 per 45.5 kg (only in situations where additional costs were noted).
[9]Overall breakeven prices ($ per 45.5 kg) to cover additional costs with additional 17.5 kg pounds weaned per cow exposed to treatment.
[10]Calculated using a bull to cow ratio of 1:17.

Development of the AI Cowculator Smartphone Application

In the process of developing the model in the study above, utilizing a partial budget analysis, we developed a model that may be useful to beef producers to incorporate their own costs and determine the value of estrous synchronization in their own operations. This model has been converted into a smartphone application for Android and iPhone/iPad users and is called the **'AI Cowculator'** (Figures 2-6). The **AI Cowculator** may be downloaded free of charge and is a decision aid tool to assist producers to determine whether they should consider TAI rather than purchasing herd sires for their cow herds. Producers and members of the allied industry are encouraged to download the AI Cowculator and utilize this tool to assist in making bull buying and breeding season decisions.

Figure 2. The AI Cowculator Smartphone Application front page.

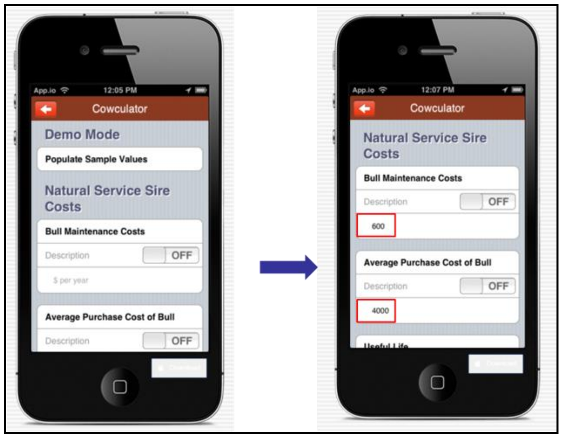

Figure 3. The AI Cowculator allows users to use sample values or enter their own values.

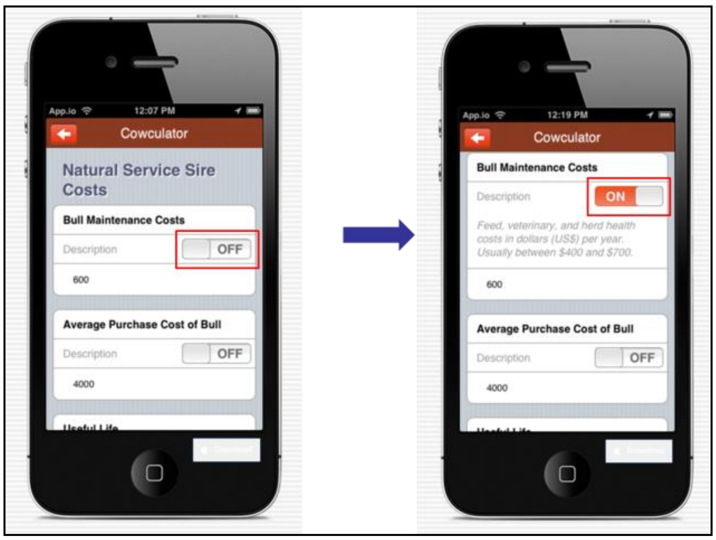

Figure 4. A toggle switch is included that when turned 'ON' defines the input value.

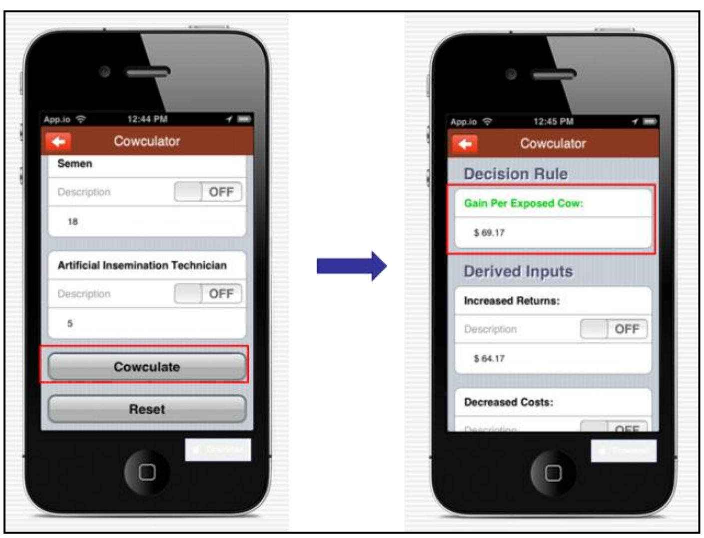

Figure 5. After all inputs are entered users will touch 'Cowculate' resulting in an output screen. A positive value (green) demonstrates that producers should consider TAI and a negative dollar value (red) indicates that producers should not consider TAI.

Figure 6. Other icons allow users to: 1) source AI technicians and suppliers of semen and estrous synchronization products (Locator icon); 2) find resources associated with reproductive management of beef cattle (Resources icon); 3) observe a gallery of pictures (Gallery icon); 4) be directed to the AI Cowculator social media sites, such asFacebook and Twitter (Social Media icon); and 5) access Youtube videos associated with the AI Cowculator including a tutorial (Youtube icon).

In addition, the application contains a locator to determine where products may be purchased and technicians who can provide the service, along with additional resources and a link to the **AI Cowculator** social media. For users who do not have an Android or iPhone/iPad Smartphone device or would prefer to user a personal computer, an Excel-based version (Figure 7) is available and can be downloaded. For more information on the AI Cowculator, including a guide on how to use it, visit the webpage at http://nfrec.ifas.ufl.edu/programs/AICowculator.shtml.

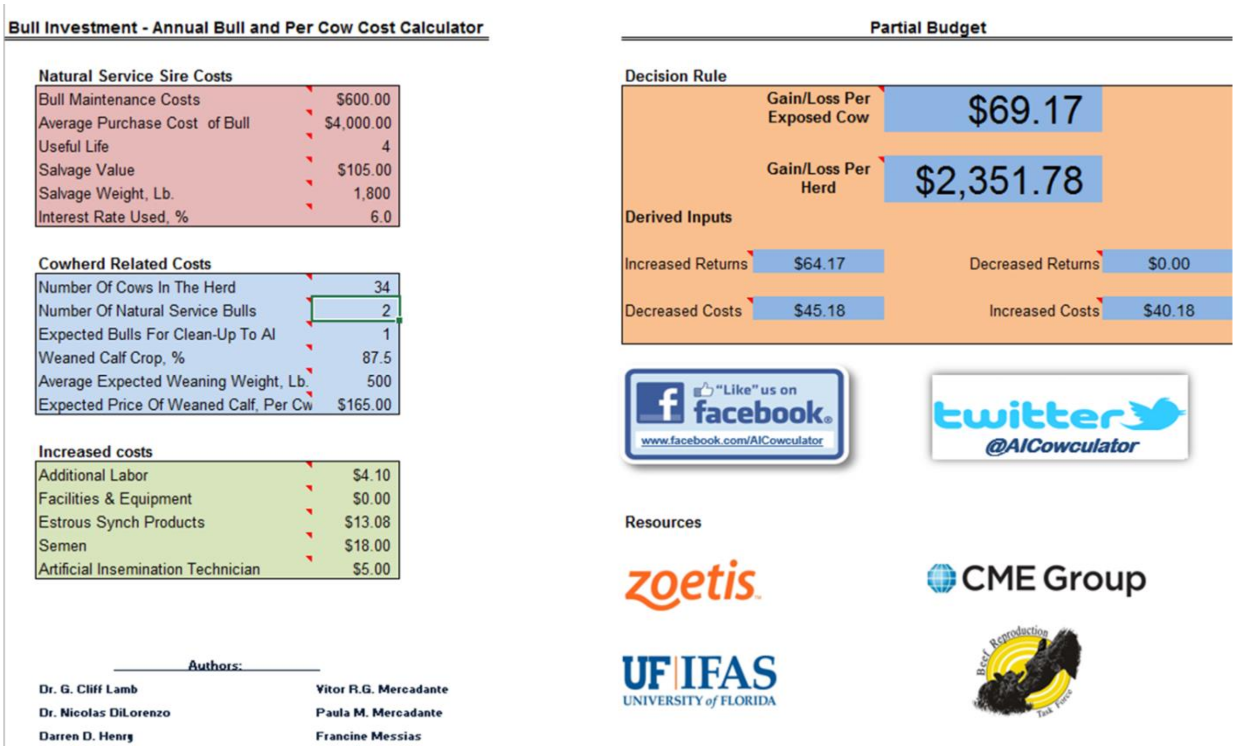

Figure 7. The AI Cowculator Excel version front page.

Starting from Scratch – A Case Study

An example of the influence of utilizing multiple technologies on the subsequent value of the calf crop is reflected in a case study conducted at the University of Florida - North Florida Research and Education Center (NFREC) located in Marianna, FL. This case study was conducted during the spring 2008 to spring 2013 breeding seasons, in a cow/calf operation consisting of 300 cows. Prior to the 2008 the breeding season the herd exposed to a 120 day breeding season. The goal was to reduce the breeding season to 70 days within 4 years (Figure 8). To do this, it was decided, in 2008, that all females in the operation would be exposed to the following criteria: 1) replacement heifer must become pregnant during the first 25 days of the breeding season; 2) every cow will be exposed to ES and TAI; 3) a cow must produce a live calf every year and calve without assistance or she was culled; 4) every cow must provide the resources for the genetic potential of the calves and each calf she produces must be genetically capable of performing; 5) every cow must maintain body condition score without requiring supplemental feeding; and 6) any cow with an undesirable temperament or disposition was culled. As a result of incorporating multiple reproductive management practices, the breeding season was reduced from 120 to 70 days and almost all cows calve prior to initiation of the breeding season and are exposed to a single TAI at the initiation of the breeding season (Figure 9). The net result is a more compact calving season that has increased the value of calves (in current dollars) by $169 per calf or an annual increase in calf value for the 300 head operation of $50,700 per year (Table 2).

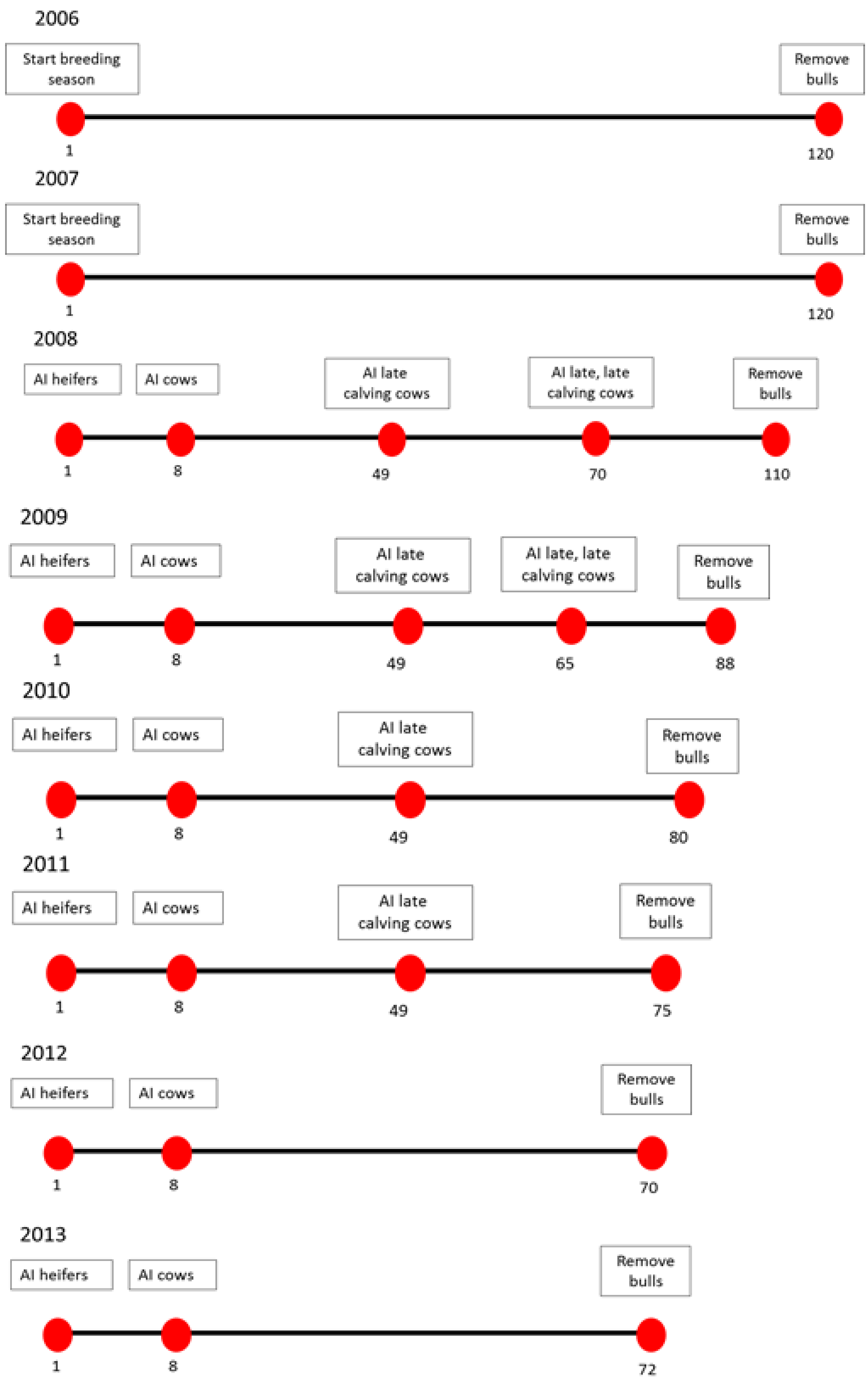

Figure 8. Overview of breeding season length and artificial inseminations schedule from 2006 to 2013

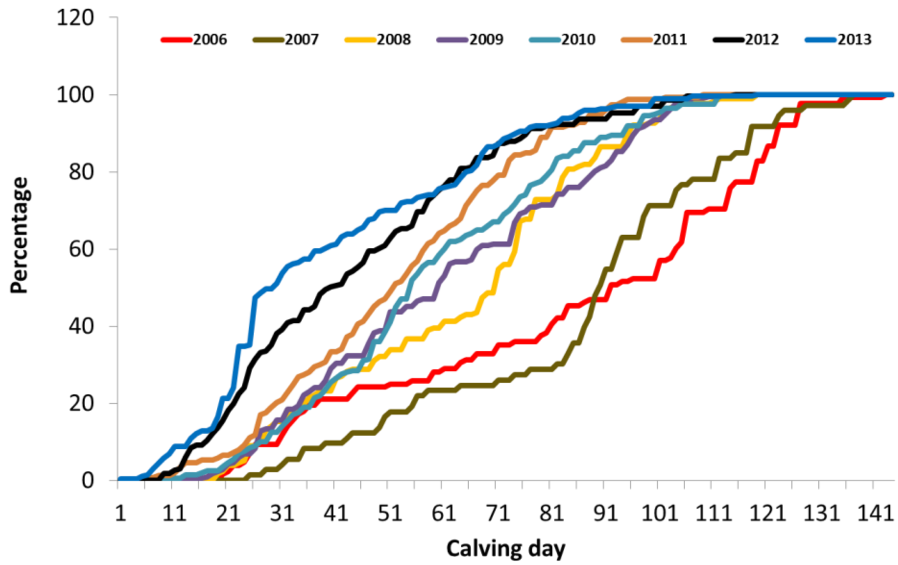

Figure 9. Cumulative calving by year for two years (2006 and 2007) prior to introducing TAI and five years (2008 to 2013) after introducing TAI.

Table 2. Breeding season characteristics and change in calf value by incorporating a TAI program into the NFREC Beef herd

	Year							
Item	2006	2007	2008	2009	2010	2011	2012	2013
Overall PR, %	81	86	84	86	82	94	92	93
Mean calving day[a]	79.2	80.9	59.2	56.2	53.7	47.2	39.5	38.7
Breeding season length, d	120	120	110	88	80	75	70	72
Difference from 2006/2007	0	0	21.7	24.7	27.2	33.7	41.4	42.2
Per calf increase in value[b], $	0	0	$87	$99	$109	$135	$166	$169
Per herd increase in value[c], $1,000	0	0	$26	$30	$33	$40	$50	$51

[a] Mean calving day from initiation of the calving season
[b] Increase calf value based on increased weaning weight compared to 2006/2007 mean calving day with 500 lb calf valued at $2.00/lb
[c] Increase calf value based on 300 head cow herd.

What pregnancy rates should I expect when initially implementing an AI program?

In most cases, using a fixed-time AI program will yield greater pregnancy rates than heat detection systems because every female will have a chance to become pregnant. Producers should consider fixed-time AI as an option, especially if time and labor are potential pitfalls to implementing an AI program. Fixed-time AI will help reduce the time and labor associated with the AI system and all females can be inseminated on the same day. Producers who synchronize and AI for the first time should not expect to obtain similar pregnancy rates to producers who have implemented an AI program for one or more years. Frequently, synchronization and AI is oversold and first-time users have unrealistic expectations of what they should expect for pregnancy rates. From our experience, we know that the advantages of implementing a synchronization and AI program go further than simply obtaining good pregnancy rates.

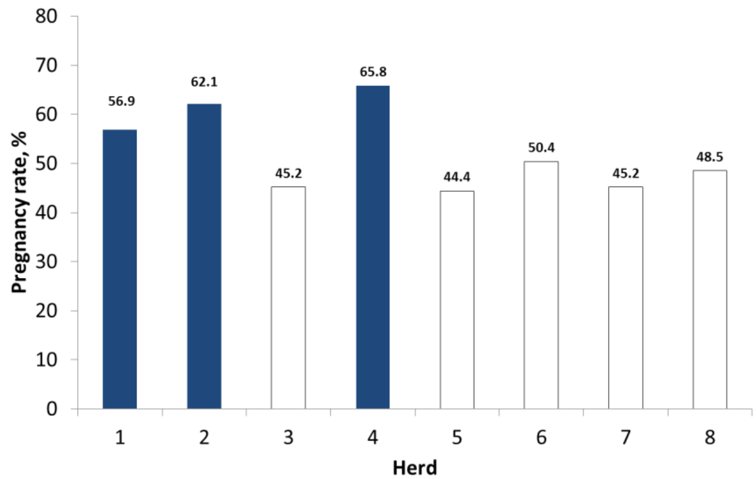

Figure 10. Pregnancy rates among 8 herds synchronized with the same fixed-time AI protocol. Filled bars represent herds that had been previously exposed to estrus synchronization and AI for at least eight years.

In a recent study performed at multiple locations using the same estrus synchronization system the pregnancy rates ranged from 44.4% to 65.8% (Figure 1). After evaluating each of these operations for multiple factors (such as age, body condition score, days postpartum, etc.) that may have affected pregnancy rates, the primary factor that appeared to have the largest impact on success was whether the herd had been previously exposed to estrus synchronization and AI or not. The three herds that had previously been exposed to estrus synchronization and AI for eight or more years had pregnancy rates of 56.9% to 65.8%, whereas those herds that had not previously been exposed to estrus synchronization and AI had pregnancy rates ranging from 44.4% to 50.4%. Therefore, obtaining pregnancy rates that may be deemed good or acceptable may require a long-term commitment rather than expecting excellent results from the start.

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