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Capturing the Value of Artificial Insemination in Commercial Herds

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Artificial insemination (AI) of dairy cattle started in the late 1930's becoming more common place by the 1940's. By the 1950's, frozen semen became available. Today, in the US, over 66% of dairy cows are bred AI and over 85% of registered Holsteins are products of AI. However, only 7.9% of US beef operations use estrous synchronization and 7.6% of operations use AI resulting in less than 10% of US beef females receiving AI (NAHMS, 2009). In addition, a majority of the AI in US beef herds is in the seedstock sector.

So why did AI take off in commercial dairy operations, but still has not gained traction in commercial beef herds? For any technology to be adopted, it must be effective, fit into the management of the operation, and provide sufficient return on investment. For dairies, AI fit into the management system – twice daily milking and heat detection fit together. Removing the hassle and danger of hand mating dairy bulls to lactating dairy cows was a welcome change. Finally, it was easy to see the results of AI. Over the last 50 years, the increase in milk production per cow per year averaged 266 lbs. with 150 lbs. attributed to genetics. It was easy to see the impact of AI in the milk check. For commercial beef herds, capitalizing on the value of AI had been more difficult to obtain and perceive. The impact of AI for commercial operations will be the focus of this presentation.

New Systems Make AI Workable in Commercial Beef Operations

Time and labor are the primary reasons producers indicate as a barrier to adoption of AI in commercial beef cows and heifers (NAHMS, 1998). Advances in fixed-time AI (FTAI) systems for beef cattle resulted in systems that reduce cattle handling and time associated with AI while producing consistent results of AI pregnancy rates from 50% to 65%. For example, Missouri researcher conducted on ranch demonstrations where the inseminated 7028 cows in 73 herds across the state. Average pregnancy rates to AI in cows synchronized with the CO-Synch + CIDR protocol was 62% with only 7 herds having a pregnancy rate below 50%. Pregnancy rates to FTAI for the last 6 years in the UI herd at the Nancy M. Cummings research station are shown in Table 1. These pregnancy rates were achieved during research on modifying estrus synchronization systems; therefore, pregnancy rates were not optimized, but probably reflect what is typical in commercial operations. While not a focus of this paper, information on FTAI and other estrus synchronization systems can be found in beef genetic catalogs or the Beef Reproduction Task Force https://beefrepro.unl.edu/

Table 1. Pregnancy rates to fixed-timed AI from 2014-2019 Nancy M. Cummings REEC Herd

Female	Semen Type	AI Pregnancy rate	Range
Heifers	Conventional	61.9 % (234/378)	57.6% – 70.2%
Heifers	Sexed	48.4 % (200/413)	26.8% – 72.5%
Cows	Conventional	54.6% (976/1789)	38.7% - 62.6%

Bulls are Expensive, but AI isn't Cheap

Although the reduction in the number of bulls needed for clean-up when AI is used is often cited as a cost benefit, it often comes out neutral. It is highly dependent on the cost of the bull, AI success rate and cost of AI. Lately, costs of bulls, like all inputs, are increasing. The impact of the purchase price of a bull on the cost of a natural service pregnancy is illustrated in Table 2. The assumptions are maintenance cost is $700/bull/yr, salvage value is $1600, a bull is used for 3 years, bull to cow ration is 1:25, and pregnancy rate of the herd is 90%. On average, over the 3-year useful life a bull the probability that he will be hurt, or die, is about 20%. Risk of loss = 0.2[(cost of bull + maintenance cost)/2]. Average prices for quality commercial bulls at recent bull sales are between $4000 and $5000 dollars. So, cost per natural service pregnancy averages between $74 and $91.

Table 2. Annual bull cost and cost per natural service pregnancy* based on bull cost and risk.

Purchase price	**$3,000**	**$4,000**	**$5,000**	**$7,000**	**$10,000**
Maintenance cost (3yrs)	$2,100	$2,100	$2,100	$2,100	$2,100
Risk of Loss	$460	$560	$660	$860	$1,160
Salvage value	-$1,600	-$1,600	-$1,600	-$1,600	-$1,600
Total cost (3 yrs)	$3,960	$5,060	$6,160	$8,360	$11,660
Annual cost	$1,320.00	$1,686.67	$2,053.33	$2,786.67	$3,886.67
Cost per pregnancy	$58.24	$74.41	$90.59	$122.94	$171.47

*based on bull to cow ratio of 1:25 and herd pregnancy rate of 90%

To incorporate FTAI into a 300-cow herd, it would cost $14,268.00 including extra labor for working cattle (Table 3). This would make the cost of an AI pregnancy vary from $95.12 for a 50% pregnancy rate to $73.17 for a 65% pregnancy rate (Table 4). Therefore, the cost of an AI pregnancy is about the same as a natural service pregnancy from a $4000 to $5500 bull (See Table 2 v Table 4).

Table 3. Cost of FTAI for a 300-cow herd

Item	**Per cow**	**300 cow herd**
Drug costs	$20	$6,000
Semen cost	$18	$5,400
Technician fee	$7	$2,100
*Additional labor**		$768
Total		$14,268

*labor is based on 4 people @ $8/hr for 8 hr for 3 working days.

Table 4. Impact of AI pregnancy rate on cost per AI pregnancy in a 300-cow herd

AI Pregnancy rate	**45%**	**50%**	**55%**	**65%**
AI calves produced	135	150	165	195
Cost per AI pregnancy	$105.68	$95.12	$86.47	$73.17

To fairly compare the cost of a total natural service program to a combination FTAI plus clean-up bulls, the cost of clean-up bulls needs to be included in the calculation for total breeding costs. Research indicates that incorporating FTAI into a breeding program usually increases final pregnancy rate by 3% to 5% due to "jump starting" anestrous (non-cycling) cows and giving cows more opportunities to become pregnant during the breeding season. Clean-up bull numbers can be significantly reduced. For example at NMCREEC, we routinely run a bull to cow ratio of 1:40 to 1:50 following AI. Using FTAI + Clean-up bulls adds about $3000 to $6000 to the total breeding cost for a 300 cow-herd (Table 5). Therefore, for AI to be incorporated into a commercial cow-calf operation, the results of the FTAI program must bring in additional revenue.

Table 5. Comparison of cost of natural service to fixed time AI (FTAI) plus clean-up bulls

	Bulls only	**FTAI + Clean-up**	**Bulls only**	**FTAI + Clean-up**
Average cost of bull used	$4000	$4000	$5000	$4000
Number of bulls used	12	6	12	7
AI cost	$0	$14,268	$0	14268
Bull cost	$20,240.04	$10,120.02	$24,639.96	11806.69
Total breeding cost	$20,240.04	$24,388.02	$24,639.96	26074.69
Pregnancy rate	90%	95%	90%	95%
Cost per pregnancy	$74.96	$85.57	$91.26	$91.49

Opportunities to Capture AI Value

Most cow-calf operations market feeder calves whereas an increasing number are retaining ownership through harvest. Retention of replacement females is also an important segment of the cow-calf enterprise. Generating replacement heifers for sale is another alternative income stream. There is some potential for reduction in breeding costs. All of these areas offer opportunity for capitalizing on AI. In each case, return to cow exposed is the critical economic indicator.

Increasing Value of the Feeder Calf

The greatest opportunity for most cow-calf operations to capitalize on incorporation of estrus synchronization and AI is by increasing the value of the feeder calf. Research from Missouri and Florida as well as other universities clearly indicates that one of the benefits of FTAI is having a greater percentage of the calves born in the first 21 to 30 days of the calving season. Figure 1. illustrates the change in calving distribution realize when moving from natural service to a combination of FTAI and clean-up natural service. Increased age at weaning of calves, improved pregnancy rates, and the potential for increased growth due to improved genetics results in reported weaning weight increases of 20 to 40 lbs for the entire calf crop (Rodgers et al., 2012).

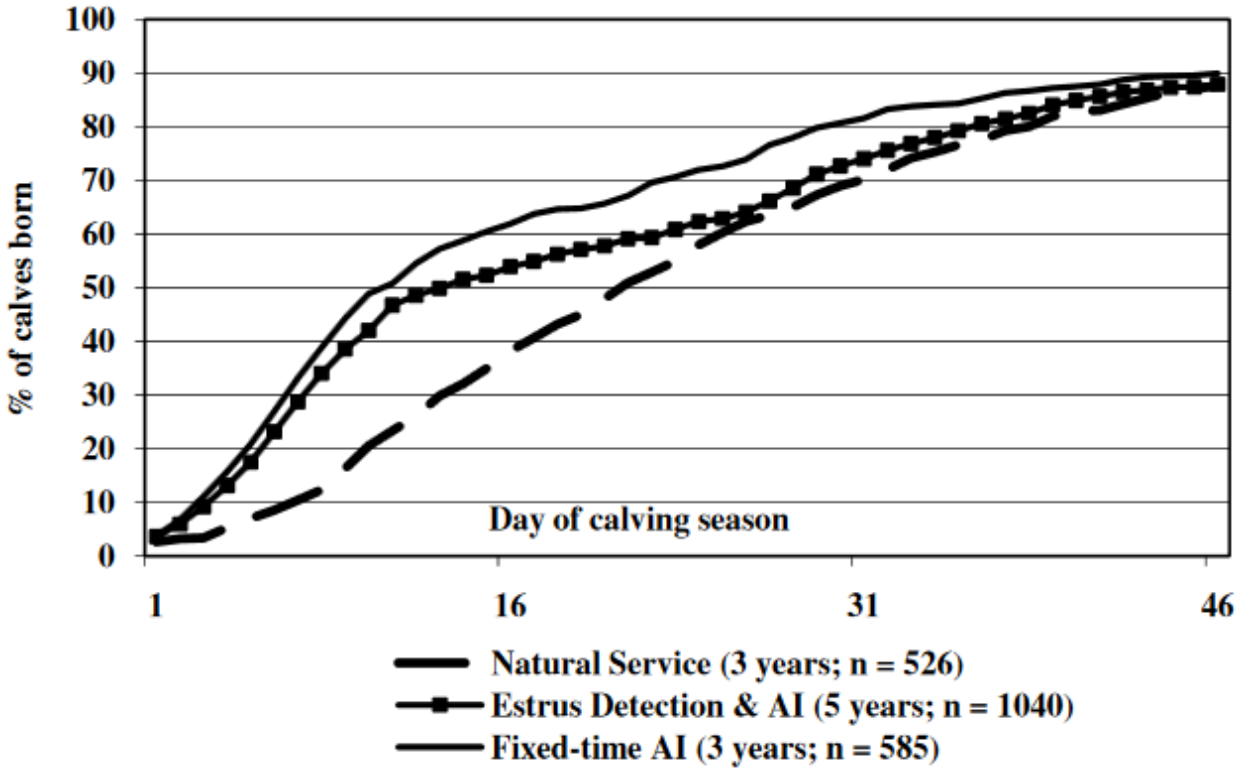


Figure 1. Impact of incorporating fixed-time AI into the Univ. of Missouri cow herd on calving distribution (Patterson et al., 2006)

The value in shifting the percentage of calves born early in the calving season as a result of using FTAI cannot be underemphasized. Researchers at the University of Florida examined the economic benefit of using FTAI to reduce the length of the calving season and alter the distribution of calves born early in the calving season. They compared two years of a 120-day natural service breeding season to transition to a 70-day breeding season including FTAI in their 300 cow Angus herd. Over the five years of transition, they increased returns to the herd by over $40,000 per year (Lamb, 2015).

Another opportunity that FTAI affords is to use more terminal type genetics. Bulls can be selected for terminal traits with the intent to sell all offspring regardless of sex of calf. A portion of the cows could be bred to these terminal type bulls which would increase weaning weights.

The potential value of a FTAI program in a commercial operation is illustrated in Table 6. Costs are taken from Table 5. The first two columns compare the FTAI program which results in 5% more calves and a 30 lb. increase in weaning weight. This results in an over $13,000 benefit to the FTAI system. Comparing column 1 to column 3 assumes that the increase in calves weaned and weaning weight is not as great. Still there is an almost $4,000 advantage to the FTAI system. In both comparisons, the value of replacement heifers as feeder calves are included in the gross value of calves. These examples illustrate that producers need to do their own calculations and have reasonable expectations on returns to FTAI.

Table 6. Examples of calculations and potential returns to a 300-cow herd using fixed-time AI (FTAI).

	FTAI+ Cleanup bulls	Bulls only	Bulls only
Bull purchase cost	$4,000	$4,000	$4,000
Number of bulls	7	12	12
Total breeding cost	$26,074.69	$20,240.04	$20,240.04
Pregnancy rate	95%	90%	93%
% calves weaned	90%	85%	88%
Cows exposed	300	300	300
calves weaned	270	255	264
Weaning weight	580	550	560
Price per cwt	$137.60	$140.00	$139.20
Gross value of calves	$215,481.60	$196,350.00	$205,793.30
Return over breeding cost	$189,406.90	$176,110.00	$185,553.20
Increased return from AI (Column 1 vs Column 2)	$13,296.95		
Increased return from AI (Column 1 vs Column 3)	$3,853.67		

Improving Longevity and Genetic Merit of Replacement Females

Heifers that calve earlier in their first calving season stay in the herd longer and produce more lbs of calf during their lifetime than heifers calving later (Lesmeister et al., 1973). Research from Nebraska clearly demonstrates the value of heifer conceiving in the first 21 days of the breeding season. Figure 2.

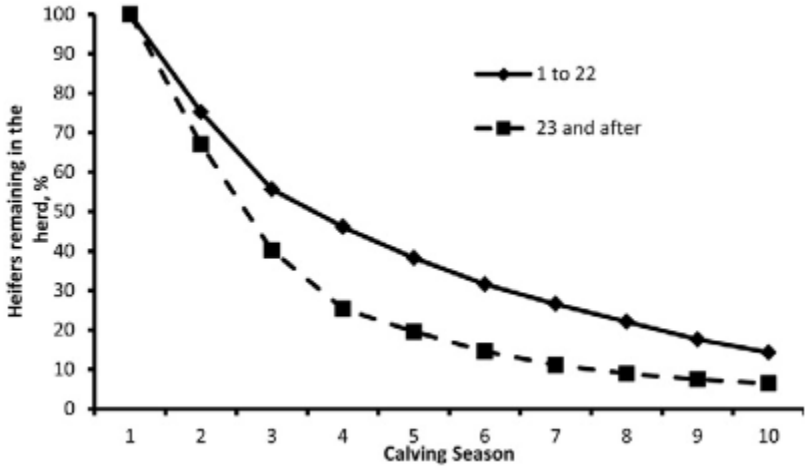


Figure 2. Impact of calving date on longevity of heifers (Cushman et al., 2013)

Estrus synchronization and AI can assist in getting a high percentage of heifers to calve in the first 21 days. It also allows for the use of bulls that are high accuracy for calving ease while still having above average growth genetics. These "curve bender" bulls are often too expensive to buy as natural service sires but can easily be accessed by AI.

As the industry put more emphasis on calving ease and producers improved heifer development, the reduction in calving difficulty by using AI may not be as great as it was 20 years ago. In fact, at our research unit we see no difference in incidence of calving difficulty between AI and natural service bred heifers with dystocia averaging 8.0% in both groups. However, over the last 6 years, heifers bred AI weaned calves that were 73 lbs heavier than heifers bred to natural service. This weigh advantage is a reflection of both age at weaning and greater growth potential.

An advantage to AI, that is somewhat hard to quantify on a monetary basis, is the ability to create crossbred females. Heterosis from crossbreeding increases weaning weight of calves and longevity of dams. At our research station we use AI in an elite group of cows to continue our two-breed rotational cross with Hereford and Angus while breeding the remaining cows to terminal type sires. In addition, this allows us to choose bulls that meet the maternal and frame size characteristics we want in our herd.

Table 7. Impact of maternal heterosis due to crossbred dam on various traits.

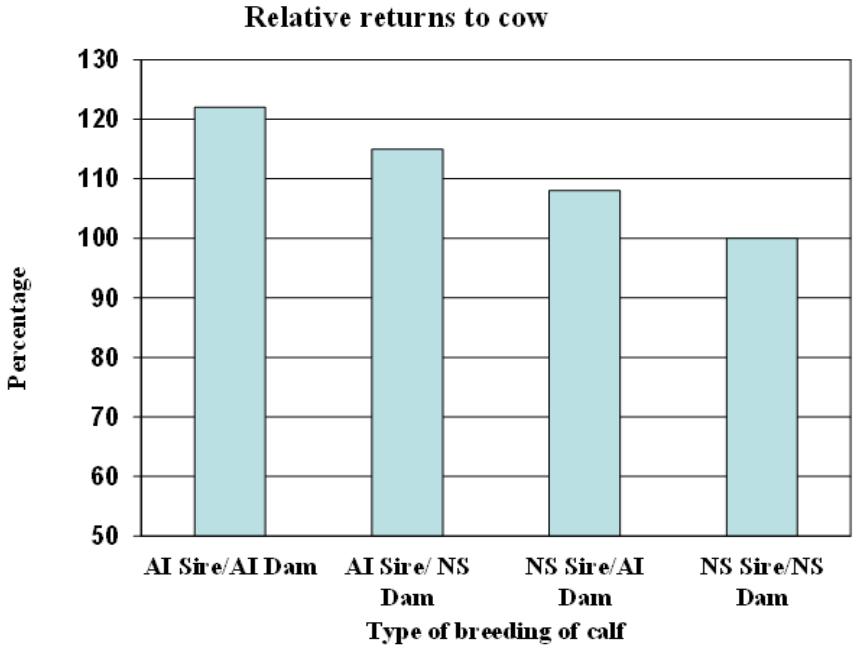
Trait	Units	%
Calving Rate, %	3.5	3.7
Survival to Weaning, %	0.8	1.5
Birth Weight, lb.	1.6	1.8
Weaning Weight, lb	18.0	3.9
Longevity, yr	1.36	16.2

Cundiff and Gregory, 1999 as adapted by Greiner, 2008

Enhanced Final Product Merit

Taking calves all the way to harvest is arguably the best way to realize return on the AI investment. Carcass traits are among the most heritable and high-quality carcasses (upper 2/3 of Choice and Prime) are commanding a premium at present. Dr. Walker and Dr. Glaze will probably address this topic to a greater degree in their presentations. However, the value of AI in a commercial cow-calf program that retains ownership is illustrated in a case-study of Hillwinds Farm in Virginia. The Sutphin family runs 600 cows on multiple farms. Over the years, they marketed their calves through retained ownership and kept track of performance as it

related to the AI breeding in the calf. Having both AI sire and dam increase return to cow by 22% and increase % carcasses grading choice by 38% compared to calves that were a product of a natural service dam and sire.



Percent Choice Carcasses

No AI – 61%

AI Dam – 74%

AI Sire – 85%

Ai Dam & AI Sire – 97%

Figure 3. Impact of AI on carcass quality and returns to cow - Hillwinds Farm (Adapted from Sutphin, 2007).

Calculating AI Cost/Benefit for Individual Operations

In making the decision to incorporate AI into the breeding program, operations should estimate costs and benefits to the operation. There are two programs currently available to assist in this decision analysis. The University of Nebraska's *Breeding Cost Cow-Q-Lator* is an excel spreadsheet that can be downloaded for free. The University of Florida and Zoetis developed an iPad/iPhone app called *AI Cowculator*. Either of these programs can help with the decision to use AI.

Breeding Cost Cow-Q-Lator https://farm.unl.edu/breeding-cost-calculator

AI Cowculator – iPhone/iPad app

The Beef Reproduction Task Force developed the *Estrus Synchronization Planner* http://www.iowabeefcenter.org/estrussynch.html which allows producers to examine different synchronization systems, calculate costs, develop calendars for procedures, and ensure the proper amounts of synchronization products are on hand.

Summary

Fixed-Time AI makes artificial insemination logistically feasible in commercial beef operations. Today, we examined several opportunities to capture value with AI in commercial beef operations. Each operation needs to conduct their own analysis. However, AI can be economically beneficial to the operation if value can be captured in one or more areas.

When will AI Pay in a commercial operation?

First When……

- Management of nutrition and health are already good so the probability of acceptable pregnancy rates to AI is high.
- Estrus synchronization protocols are followed carefully.

Next by capturing AI value (with one or more opportunities) when…..

- Calving distribution is shifted earlier in the calving season and high growth sires are used.
- A portion of the herd is mated to terminal sires.
- Heifers calve earlier in the calving season resulting in greater longevity and lifetime productivity.
- Maternal heterosis is captured through generating crossbred dams.
- Increased carcass value is realized through retained ownership.

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