Economics of Estrus Synchronization and Artificial Insemination

Dr. Les Anderson and Paul Deaton
University of Kentucky

Introduction

Few beef producers would disagree that the genetic potential available for use in their herds via artificial insemination is greater than that of most natural service sires. However, less than 10% of the beef cows in the United States are artificially inseminated each year (NAHMS, 2000). Many reasons exist for the low rate of implementation of estrus synchronization and AI (ESAI) into beef cow-calf operations. One reason is the extensive nature of beef production. Most cows are pastured in large acreages and the labor necessary for handling the cows is too great. Additionally, many producers lack adequate facilities to enable safe and easy cattle handling. Beef production is a minor enterprise on many farms. The income from the beef enterprise in most small and medium-sized operations is secondary to other enterprises or to off-farm income. However, the primary reason for the limited inclusion of ESAI is economics. Little information is available to aid producers in making decisions regarding return on investment and profitability when considering using ESAI. Many producers may incorporate ESAI if it would improve their profitability both short- and long-term. This paper examines the costs of pregnancy for both natural service and AI, the short-term returns on investment of AI and the long-term effects of incorporating AI into a breeding system

Costs per Pregnancy

Few producers understand the costs associated with producing a pregnant female. Sandy Johnson and coworkers (2003) from Kansas State University recently published an excellent article discussing the costs associated with pregnancy using either natural service or a variety of estrus synchronization protocols. Table 1 illustrates the costs per pregnancy for bulls that range in price from $1,500 to $3,000 and bull-to-cow ratios from 1:15 to 1:50. Assumptions of the model included use of the bull for 4 seasons; 10% death loss; 9% interest rate; and a 94% pregnancy rate. Annual bull maintenance costs are variable and increasing the feed costs by $100 increased cost per pregnancy from $2.22 to $7.41 for high and low bull-to-cow ratios, respectively. Costs per pregnancy ranged from $15.98 to $90.51 depending predominantly upon the purchase price and bull-to-cow ratio. Certainly, the ability to identify bulls with a high serving capacity could reduce costs associated with impregnating females.

Use of ESAI will alter cost per pregnancy. Producers can use a partial budget (Table 2) for enterprise analysis of ESAI. Implementation of ESAI can increase returns by increasing the weaning weight of the calves (both age and genetic effects), altering market price by increasing the uniformity of the calf crop, and improving cow productivity by enhancing the number of high-quality

replacement heifers. Alternatively, ESAI can reduce potential income because fewer bulls are available to sell as cull bulls. Estrus synchronization and AI increases costs because of costs for synchronization products and supplies, labor, technician, and perhaps facilities. However, ESAI can reduce costs by lowering the number of bulls needed for natural service and reducing the labor hours at calving due to a more concentrated and predictable calving season.

Several factors affect the cost per pregnancy of an estrus synchronization and AI program. Conception rate to the AI influences the cost per pregnancy (Table 3). As conception rate to AI increases, the cost of pregnancy of the system decreases. Cost per pregnancy is also influenced by total labor hours associated with the ESAI system (Table 4), the cost of labor, and the cost of semen. If pregnancy rate is held constant (Table 4), the cost per pregnancy of ESAI exceeds that of natural service especially for smaller herds. However, if the costs are adjusted for the expected increase in weaning weight of the calves resulting from the ESAI, the cost of pregnancy for Select Synch and MGA-PG is lower to produce a 500 pound equivalent weaned calf (cost per cwt of calf). The cost per pregnancy of CO-Synch to produce a 500 pound equivalent calf was only $.51 per cwt higher than that of natural service. If conception rate to AI increases to 60% (Table 5), then the cost per 500 pound equivalent calf is not different between CO-Synch and natural service.

From these data it seems apparent that the costs of pregnancy are not significantly different between natural service and most ESAI protocols. Of course, if labor is high, if semen costs are excessive, or if conception rate to the AI is low, the cost per pregnancy of ESAI can dramatically increase.

Short-term Return on Investment

Little data can be found in the literature that examines the return on investment of incorporating estrus synchronization and AI. Therefore, the following trial was designed to determine if implementation of estrus synchronization and AI is cost effective and enhances net return. Crossbred postpartum cows (n = 351) were randomly assigned by age and calving date to one of two breeding systems. Approximately two-thirds of the cows (n = 251) were subjected to an estrus synchronization protocol suitable for a fixed-time insemination (SYNC). On Day -9, cows were administered gonadotropin-releasing hormone (GnRH; 100 ug; Cystorelin¤, Merial) and 7 days later were administered 25 mg of prostaglandin $F_{2\_}$ (PG; Lutalyse¤, Pharmacia & UpJohn, Kalamazoo, MI). Cows were administered a second injection of GnRH and were artificially inseminated on Day 0. On Day 10, cows were exposed to natural service for 50 days. Bull-to-cow ratio was 1:50 females in the SYNC group. The remaining cows (n = 100) were exposed to natural service for 60 days (NAT). The bull-to-cow ratio in the NAT treatment was 1:25. The bull-to-cow ratio was different between the SYNC and NAT groups because we anticipated that approximately one-half of the cows in the SYNC group would conceive to AI. To verify date of conception, pregnancy was diagnosed on Day 90 using transrectal ultrasonography.

To determine return on investment, all costs associated with the estrus synchronization and AI were recorded and are summarized in Table 6. Labor was determined by recording amount of time required to bring the cattle to the corral, work the cows and then return them to the breeding pastures. Four laborers were used, three trips through the chute, and an hourly wage of $7.00 per hour. To determine differences in revenue, calves were weighed at weaning and the differences in weight available to market were determined. Calves from both treatments were given a value of $80 cwt.

Differences between treatments were determined using GLM procedures of SAS. Differences between treatments in proportional data were determined using Chi Square analysis.

The results of this trial are shown in Table 7. More ($P > .05$) cows calved in the SYNC group than in the NAT group and more ($P > .05$) cows calved in the first 30 days of the calving season in the SYNC versus the NAT treatment. The average date of calving was earlier ($P > .05$) in the cows in SYNC than in the NAT group. The average weaning weight of calves was heavier ($P > .05$) from cows in the SYNC than from those in the NAT group. The increase in percent calf crop weaned and weaning weight increased the pounds of calf weaned per cow exposed by nearly 110 pounds.

Return on investment is shown in Table 8. Revenue increased by $99.62 in the SYNC group. This increased revenue was achieved by investing $29.88 per cow. Therefore the return on investment for the estrus synchronization and AI was $69.74. This return does not include savings associated with reduced bull costs. One-half the number of bulls was used per cow in SYNC group than in the NAT group. If savings on bull purchases are included, the return on investment increases to $129 per cow. These short-term increases in revenue are quite attractive, but the long-term effects of increasing cow productivity by retaining the heifers sired by proven sires are not apparent.

Long-term Effects of Estrus Synchronization and AI

No data is available that addresses the long-term impact of estrus synchronization and AI in commercial beef cow-calf operations. A trial was designed to examine the long-term effects of incorporating estrus synchronization and AI into a beef cow-calf operation. The data were collected on a single cow-calf operation from 1991 to 2003. Data collected from 1991 to 2000 serve as the baseline or control. During this time period, approximately 45 females (35-40 cows and 5-8 heifers) were exposed to a 60-day natural service season. Two bulls were used each year. The breeding system used was a two-breed rotational system using Angus and Charolais bulls. The average performance of this herd is illustrated in Table 9.

The breeding system was changed to determine the effects of estrus synchronization and AI. All females were subjected to an estrus synchronization protocol suitable for fixed-time insemination (CO-Synch). Females were inseminated to bulls from maternally-

oriented breeds (Angus and Hereford). Charolais-cross cows were inseminated to the Angus sire and Angus-cross cows were inseminated to Hereford bulls. Ten days after AI, cows were exposed to a 50-day natural service season. The natural service sire was from a terminally-oriented breed (Charolais). Replacement heifers with AI-sires were retained. All calves sired by the terminally-oriented sire were marketed. This trial is in the third year of a ten year study. Data reported were analyzed using the Cow Herd Appraisal System (CHAPS) and the Standardized Performance Analysis (SPA) software programs.

The results from the first two years of the trial are shown in Table 9. Incorporation of estrus synchronization and AI increased the percentage of cows that calved, percent calf crop weaned, and the average weaning weight of the steer calves. These increases lead to a marked improvement in pounds of calf weaned per cow exposed. The increases in production efficiency led to increased profitability. Net profit per cow exposed to the bull doubled in the first year and was $20 per cow higher in 2002. We anticipate that productivity and profitability will continue to increase as the AI-sired females enter the breeding herd.

Conclusions

Inclusion of estrus synchronization and AI is a profitable enterprise for commercial beef cow-calf operations. The short-term returns on investment were approximately $70 per cow simply by increasing reproductive efficiency and thus the pounds of marketable calf. Additional short-term increases in revenue exist if the producer retains ownership. Data from the Angus Association demonstrated that the carcass value was $206 per head greater for sires from the top 10% than the bottom 10% for carcass value. Therefore, if the calves produced from the herds used in the above trials were from sires that were only average and the bulls used for AI were in the top 10% and the cattle were marketed on the grid, an additional $100-$125 per calf is profited. The key to capturing the greatest potential profit is to utilize alternative marketing systems. However, even in a commodity market, inclusion of ESAI is a profitable rather than costly venture.

Table 1. Cost per Pregnancy Using Natural Service

Purchase Price	1,500.00	1,700.00	2,000.00	2,300.00	2,500.00	3,000.00
Salvage Value	860.00	860.00	860.00	860.00	860.00	860.00
Summer Pasture	104.13	104.13	104.13	104.13	104.13	104.13
Crop Residue	7.50	7.50	7.50	7.50	7.50	7.50
Hay	90.61	90.61	90.61	90.61	90.61	90.61
Protein, mineral	25.00	25.00	25.00	25.00	25.00	25.00
Labor	50.00	50.00	50.00	50.00	50.00	50.00
Vet	21.00	21.00	21.00	21.00	21.00	21.00
Repairs	31.00	31.00	31.00	31.00	31.00	31.00
Misc.	7.00	7.00	7.00	7.00	7.00	7.00
Interest	15.13	15.13	15.13	15.13	15.13	15.13
Total Variable	351.37	351.37	351.37	351.37	351.37	351.37
Depreciation on Equipment	12.39	12.39	12.39	12.39	12.39	12.39
Depreciation on bull	160.00	210.00	285.00	360.00	410.00	535.00
Interest on bull	212.40	230.40	257.40	284.40	302.40	347.40
Death loss	15.00	17.00	20.00	23.00	25.00	30.00
Total Fixed	399.79	469.79	574.79	679.79	749.79	924.79
Total cost/year	751.16	821.16	926.16	1,013.16	1,101.16	1,276.16
Purchase Price	1,500.00	1,700.00	2,000.00	2,300.00	2,500.00	3,000.00
Cows Exposed Per Year	Cost Per Pregnancy ($)					
15	53.27	58.24	65.69	73.13	78.10	90.51
20	39.96	43.68	49.26	54.85	58.57	67.88
25	31.96	34.94	39.41	43.88	46.86	54.30
30	26.64	29.12	32.84	36.57	39.05	45.25
35	22.83	24.96	28.15	31.34	33.47	38.79
40	19.98	21.84	24.63	27.42	29.29	33.94
50	15.98	17.47	19.71	21.94	23.43	27.15

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Table 2. Partial Budget for Synchronization of Estrus Synchronization Plus AI

Budget Effect	Source	Budget Effect	Source
Increased Returns	Heavier calves (earlier average birth date) Improved genetics (calves and replacement females) Uniformity of calf crop (fewer sires could be used, total breeding season could be shorter)	Decreased Returns	Fewer cull bulls to sell
Decreased costs	Fewer bulls to purchase and maintain Less labor for more concentrated calving season More predictable calving ease	Increased costs	Planning and management for synchronization of estrus and AI Synchronization products and supplies Labor Improved facilities?

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Table 3. Effect of Changing Pregnancy Rate on Breeding Cost per Pregnant Female in a Select Synch Protocol

Calving herd size	AI pregnancy rate (%)	No. of bulls for natural service	Breeding cost ($) per pregnancy	Proportion % of total cost attributed to:			
				Bulls	Semen	Labor	Treatments
100	75	1	42.06	20	37	19	15
100	55	2	46.08	37	24	18	14
100	48	3	53.01	48	19	15	12
300	65	5	40.90	35	33	11	16
300	55	6	41.49	41	27	11	15

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Table 4. Breeding System Costs and 500lb Equivalent Weaned Calf Breeding Cost per cwt

	Days Worked	Preg. Rate (%)	Total Labor Hours			No. of Bulls			Cost ($) per pregnancy			500 lb. equivalent weaned calf breeding cost ($) per cwt.					
			Herd Size			Herd Size			Herd Size			Herd Size					
			30	100	300	30	100	300	30	100	300	30	Diff[a]	100	Diff[a]	300	Diff[a]
System																	
Natural Service						2	4	12	56	34	34	12.91	-	7.79	-	7.79	-
Select Synch	9	50	45	82	142	1	2	6	67	45	40	12.75	0.16	7.74	0.05	6.68	1.11
MGA + PGF	6	50	37	67	116	1	2	6	60	39	35	11.20	1.71	6.47	1.32	5.56	2.23
CO-Synch	3	50	26	47	82	1	2	6	70	51	48	13.41	(0.51)	9.04	(1.25)	8.32	(0.53)

[a] Diff = difference between natural service and breeding system, $/cwt

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Table 5. Breeding System Costs ($) and 500 lb Equivalent Weaned Calf Breeding Cost ($) per Cwt at Various AI Pregnancy Rates

	Days Worked	Preg. Rate (%)	No. of Bulls			Cost ($) per pregnancy			500 lb. equivalent weaned calf breeding cost ($) per cwt.					
			Herd Size			Herd Size			Herd Size					
System			30	100	300	30	100	300	30	Diff[a]	100	Diff[a]	300	Diff[a]
Natural Service			2	4	12	56	34	34	12.91	-	7.79	-	7.79	-
	3	40	1	3	7	70	59	50	13.93	(1.02)	11.50	(3.71)	9.48	1.11
	3	50	1	2	6	70	51	48	13.41	(0.51)	9.04	(1.25)	8.32	(0.53)
CO-Synch	3	60	1	2	5	70	51	45	12.90	0.01	8.53	(0.74)	7.16	0.63
	6	40	1	3	7	58	46	36	11.20	1.71	8.41	(0.63)	6.21	1.58
	6	50	1	2	6	60	39	35	11.20	1.71	6.47	1.32	5.56	2.23
MGA/PGF	6	60	1	2	5	62	42	35	11.20	1.71	6.46	1.33	4.91	2.88
	9	40	1	3	7	65	51	41	12.75	0.16	9.68	(1.90)	7.33	0.45
	9	50	1	2	6	67	45	40	12.75	0.16	7.74	0.05	6.68	1.11
Select Synch	9	60	1	2	5	69	47	40	12.75	0.16	7.73	0.06	6.03	1.76

[a] Diff = difference between natural service and breeding system, $/cwt

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Table 6. Cost of AI

Item	Cost per cow
GnRH	$4.00
Prostaglandin	$4.00
Technician	$5.00
Semen	$10.00
Labor[a]	$2.88
Total	**$29.88**

[a] 8.6 hours X 3 working days X 4 workers X $7.00 per hour for 251 cows

Table 7. Results of Short-Term ESAI Trial

	SYNC	NAT	Diff
Cows	251	100	
Calving Rate	90%	81%	9%
% Calving 1st 30 days	85%	62%	23%
Mean Julian date of calving	74 – .4	84 – .7	10d
% calf crop weaned	88%	79%	9%
Weaning age	210 – 9	200 – 12	10 d
Weaning Weight	576.9 – 18.1	504.8 – 21.2	72.6 lbs
Lbs. calf weaned/cow exposed	507.9	398.4	109.5 lbs

Table 8. Increased Revenues from ESAI

	Revenue	
Weaning Weight	72.6 poundsx $80 cwt =	$58.08
% Calf crop	9% more calves x $80 cwt =	$41.54
Total Revenue		**$99.62**
Return on Investment	**$99.62 — 29.88 =**	**$69.74**

Table 9. Effects of ESAI on Production Efficiency and Profitability in a Medium-Sized Herd

	Avg from 1991 to 2000	2001	2002
No. of females exposed	45	45	44
Calving Rate Percentage (# Cows Calving/# Cows Exposed)	82 %	95%	93%
% Calf Crop Weaned	74.5%	91%	86%
WW Average (pounds)			
Steers	525	542	556
Heifers	484	514	482
Sale Weight[a]			
Steers	554	588	600
Steer Sale Price (per cwt)	$77.00	$88.00	$83.00
Lbs of calf weaned per cow exposed	381.2	481.4	448.2
# Cows Sold	5	9	6
Cash Cow Costs	$235.38	$285.82	$292.26
Net Profit per Cow Exposed (Cash sales per cow- cow cost)	$57.75	$116.62	$76.83

[a]Calves were backgrounded for approximately 25 days prior to marketing