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COSTS AND COMPARISONS OF ESTROUS SYNCHRONIZATION SYSTEMS

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Introduction

Today's producer has an increasing number of options available to use estrous synchronization and artificial insemination (AI) to incorporate the desired genetics into the herd. Low cost production is and will continue to be vital for survival in the beef industry. So understanding the costs of producing pregnancies via various methods and the associated value is important. For some, the fact that you have to do something other than turn a bull out will be enough analysis for them to not consider AI. Others will take a broader view of the issue and may find that AI is a tool that can improve profitability.

This paper will look at costs associated with producing pregnancies via natural service and various synchronization systems. For some parts of the process it will be relatively easy to assign costs and make comparisons, for others assigning economic values will be much more difficult. As always, to make the most informed decisions, producers need to know their own costs of production.

Cost of Natural Service

Understanding the costs associated with natural service breeding is a good place to begin. The original purchase price, bull to cow ratio and years of use are all important factors that affect breeding costs. Table 1 shows annual bull ownership costs and estimated costs per pregnancy for a range of bull purchase prices ($1,500 to $3,000) and bull to cow ratios (1:15 to 1:50). For reference, the American Angus Association reported the average price of Angus bulls sold for fiscal years 2000 and 2001 as $2,292 and $2,267, respectively. Annual bull costs were calculated using Kansas Cow-Calf Enterprise Budget cost estimates (Foglemen and Jones, 2001) and annual bull costs were separated using the method of Kasari et al., 1996. Assumptions include use for four breeding seasons, 10% death loss, 9% interest rate, and a 94% pregnancy rate. Annual feed costs for cows have been shown to vary by as much as $200 per head (Stryker, 2001) among producers, and this same variability would be expected in feed costs for bulls as well. Increasing annual feed costs by $100, increases cost per pregnancy $7.41 for light bull use (15 cows/yr) and $2.22 for heavy use (50 cows/yr) given a $2,000 purchase price.

Producers who use breeding pastures with carrying capacities less than the serving capacity of the bull, will naturally drive up cost per pregnancy. Whereas producers who can correctly identify highly fertile bulls and increase the number of females exposed over more conservative recommendations can greatly reduce their costs per pregnancy.

Table 1. Annual bull costs based on purchase price
and associated cost per pregnancy.

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
Deprec on equipment	$ 12.39	$ 12.39	$ 12.39	$ 12.39	$ 12.39	$ 12.39
Deprec 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/yr	$ 751.16	$ 821.16	$ 926.16	$1,031.16	$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 Per Year		Cost per pregnancy					
Pregnancy Rate	15	$ 53.27	$ 58.24	$ 65.69	$ 73.13	$ 78.10	$ 90.51
94%	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

Cost of AI and Estrous Synchronization

A partial budget is a good tool to gain an overview of potential differences between an AI program and natural service. Compared to natural service, increased costs of an AI program will result from synchronization products, labor to synchronize and inseminate, time for planning, and perhaps improvements in facilities. Costs associated with these items are relatively easily calculated and usually are the first to come to mind in this type of discussion. On the decreased returns side, income from the sale of cull bulls will likely be reduced because fewer bulls will be purchased in most cases. Depending on the size and management of the operation, costs could be decreased by having fewer bulls to purchase, maintain and keep out of trouble, less time and labor for calving in a shorter calving season, and fewer pulled calves from high-accuracy, low-calving-difficulty bulls. Income will increase as a result of more older, heavier calves at weaning. Producers with good marketing skills will also increase returns from a more uniform calf crop and by producing genetics that are in demand. If replacement heifers are generated from within the herd, long-term benefits may accrue from selection for traits such as milk production or longevity. The beneficial items in our budget (i.e. quality genetics, more concentrated calving season) are much more difficult to place a value on, and some might not be captured by producers without additional marketing efforts. Nevertheless, in a marketplace that is increasingly value driven, the opportunity to capture this genetic value will expand in the future.

Table 2. Partial budget for estrous synchronization

Budget Effect	Source	Budget Effect	Source
Increased returns ++$$	Average age of calves is older, producing heavier calves Quality of genetics (calves and replacement females) Uniformity of Calf Crop (shorter calving season)	Decreased returns - $$	Fewer cull bulls to sell
Decreased costs	Fewer bulls to purchase and maintain More concentrated calving season More predictable calving ease	Increased costs	Planning & management for AI & estrous synchronization Synchronization products and supplies Labor Improved facilities?

One way to estimate the value of genetics is to look at the data in Table 3. It summarizes boxed beef values from Angus sires with 10 or more carcass data records into the top 10% and the bottom 10% for carcass value. The difference in carcass value was $206 per head for sires in the two groups. Clearly you could pay a few more dollars in breeding costs to produce a product worth $206 more at harvest. Because the industry has been operating on selling commodity cattle with an average value for so long, it is hard for the average producer to market calves in such a way that he is more nearly paid for the true value of the genetics produced. Currently, these value differences are more readily observed at harvest than weaning, but the trend is toward identifying and rewarding known genetics earlier in the production process. Excellent marketing was cited as one of four key advantages of producers with high returns on assets for cow/calf enterprises in the Northern Great Plains (Dunn, 2000). As the beef industry continues to shift from a commodity market to a value based market, differences in costs and returns for various breeding systems may be more readily calculated. At this point producers may ask themselves: If the cost per pregnancy is higher for a particular method of breeding, what are the chances I can recoup that cost by achieving higher marketing returns on the superior genetics?

Table 2. Average boxed beef values for
Angus sires with 10 or more carcass data records*

Trait	Top 10%	Bottom 10%	Difference
No. Progeny	2728	1751	
No. Sires	109	110	
% Prime	7.7	0.7	+7.0
% CAB	47.4	.7	+46.7
% Choice & above	93.7	48.1	+45.6
% Select	6.1	35.0	-28.9
% Standard	0.2	16.9	-16.7
% YG 1&2	60.0	38.2	+21.8
% YG 4&5	1.4	18.2	-16.8
Carcass Price/cwt	$110.19	$94.15	$16.04
Carcass Value/hd	$822.27	$616.36	**$205.91**

* Angus Beef Bulletin, January 2000.

Whole herd cost of pregnancy

To evaluate the breeding costs under different breeding systems, methods used by Loseke, 1989, were updated to reflect current conditions. Briefly, a survey was taken of beef producers using artificial insemination in Nebraska. From that survey, regression equations were estimated for total labor hours required for various AI programs.

Nonsynchronized program:
$TM = 19 + .036(CD)$ $R^2 = .83$

Lutalyse synchronization program:
$TM = 2.65\ (CD)^{.5}$ $R^2 = .60$

Syncro-Mate-B synchronization program:
$TM = 2.53\ (CD)^{.5}$ $R^2 = .87$

Where TM – Total hours of labor required for AI program
C – Total number of cows and heifers being bred AI
D – Total number of days in AI program

The equation for the Syncro-Mate-B system was used for all the estrous synchronization systems in this report. Breeding systems were evaluated for various size cowherds. Breeding herds of 35, 116, and 348-head allowed for culling of nonpregnant and physically impaired cows to yield 30-, 100-, and 300-head calving herds. For the current model, costs were estimated over a range of AI pregnancy rates. Pregnancy rate was multiplied by number of cows, and the product was divided by an average conception rate of 70% to get the number of cows in estrus. Cows and heifers not pregnant to AI were exposed to bulls for the remainder of the breeding season. Total breeding season pregnancy rate was 94%. The number of bulls required for clean-up was calculated based on the outcome of the AI program. One bull was used per 30 nonpregnant females. Variable and fixed costs for AI are shown in Table 4. The annual interest rate charged for cash costs was 9%. The labor rate used was \$10.77 per hour (Fogleman, 2002). Annual bull costs (\$2,000 purchase price) were \$926 per bull as described in the previous section. Budget items from the partial budget in Table 2 that are not accounted for in this model include value of AI-sired replacement heifers, more concentrated calving season, more predictable calving ease, and any facility improvements.

Table 4. Artificial insemination costs

Item	Cost per unit
Semen	\$13 – straw
Prostaglandin F $_{2"}$	\$2.00 – dose
GnRH	\$3.00 – dose
CIDR	\$8.00 - dose
Supplies	\$.50 – insemination
Fixed costs[a]	176.30

[a] Semen tank, carrying case, pipette gun, thaw box, liquid nitrogen

Cost per pregnant female as calculated in this model reflects both AI and natural service pregnancies. In this case, pregnancy rate to AI impacts the cost per pregnant female in two ways. As AI pregnancy rate is reduced without changing the number of bulls required for natural service, cost per pregnancy actually decreases because of lower costs for semen and interest for a system involving heat detection and AI. While this reduction would mean fewer AI-sired calves, the impact of that reduction would depend on how well the producer capitalizes on the genetic value of the calves and is not reflected in the cost per pregnant female. When pregnancy rate increases to a point where the operation can get along with one less bull, then the reduced bull costs significantly lower cost per pregnancy with little change in the pregnancy rate. As seen in Table 5, an additional bull for natural service adds from \$8.27 per pregnant female for herds of 100 head and only \$2.61 for herds of 300 head. As the AI pregnancy rate increases, the percentage of costs due to semen expense increases and those attributed to the bull decrease. At what might be considered typical AI pregnancy rates, approximately 50%, bull costs easily represent the largest share of costs followed by semen costs. The importance of annual bull costs to the total cost of the breeding system would be further emphasized with bulls with a higher initial purchase price. The percentage of total costs attributed to bulls reflects how bull costs change based on the number of cows pregnant to AI. In reality, a decision on how many bulls to place with the cows after AI has to be made before knowing the AI pregnancy rate. Successfully identifying bulls that can reliably service more than the 30 cows used in this example would be extremely valuable. If four bulls are used rather than 5 bulls for the 300-head herd when the pregnancy rate is 65%, the cost per pregnant female is reduced \$2.83.

A better evaluation of breeding systems would be to account for the proportion of pregnancies from AI or natural service in each system. To do this, calves with AI sires were assigned a value of \$25 per head greater than those born to natural service. The AI sired calves would be on average 10 days older and 20 pounds heavier at weaning thus increasing the return at weaning by $20 if the additional weight is worth $1/cwt. An extra $5 per head was assigned for "genetic" value. This is a fairly conservative estimate compared to the $25 per head bonus for calves that fit the Laura's Lean specifications (genetic and management requirements) and an average of $10-15 per head bonus on carcass performance (Charlie Peters, personal communication). So for this model, calves sired by AI were valued at $525 per head, and natural service sired calves were valued at $500 per head. To compare breeding system costs and returns, a standardized production scale was generated. Breeding system cost per exposed female was reduced for any increased revenue from AI sired calves and expressed as a 500 lb equivalent weaned calf breeding cost per hundred (cwt). A weaned calf crop of 82% was assumed.

Table 5. 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 pregnant female	% of total cost attributed to:			
				Bulls	Semen	Labor	Treatments
100 hd	75%	1	$40.90	21%	38%	20%	13%
	74%	2	$48.28	35%	30%	17%	11%
	55%	2	$44.92	38%	25%	18%	12%
	49%	2	$43.58	39%	23%	19%	12%
	48%	3	$51.85	49%	19%	16%	10%
300 hd	66%	4	$37.13	30%	36%	13%	14%
	65%	5	$39.74	36%	34%	12%	13%
	57%	5	$37.95	37%	31%	12%	14%
	56%	6	$40.56	42%	28%	11%	13%
	55%	6	$40.33	42%	28%	12%	13%
	49%	6	$38.99	44%	26%	12%	14%
	48%	7	$41.60	48%	24%	11%	13%

Breeding system costs and the standardized cost per hundred for various breeding systems assuming equivalent AI pregnancy rates (50%) are in Table 6. Looking at the breeding system cost per pregnant female, natural service followed by MGA/PGF and MGA-Select or Select Synch were the least expensive depending on herd size; CO-Synch+CIDR was most expensive. On a standardized production scale, 500 lb equivalent weaned calf breeding cost per hundred, many systems have costs nearly equal to or less than natural service. These include MGA/PGF, MGA Select, and Select Synch for all herd sizes and include 7-11 Synch and CIDR+PGF for a herd size of 300. So, decisions based strictly on cost and not the returns generated by those costs, may be erroneous. Systems with the highest standardized cost per hundred involve CIDRs and or timed AI. The difference in cost per hundred between MGA/PGF and natural service was $2.23/cwt and $1.71/cwt for herd sizes of 300 and 30, respectively. The difference in cost per hundred between natural service and MGA/PGF indicates the amount the breakeven price for weaned calves would need to change to account for differences in breeding system costs and number of AI pregnancies. Therefore, the weaning breakeven price would need to be $2.23/cwt higher for a natural service breeding system than one using

MGA/PGF to generate equal returns given all else was equal. The CO-Synch+CIDR system standardized cost per hundred was $2.10 and $2.13 more than natural service for herd sizes of 30 and 100, respectively. The common factors among those systems with the lowest standardized costs seem to be low treatment costs, heat detection and estrus AI, and relatively higher labor costs. A comparison in this manor assumes that additional labor to facilitate the heat detection and AI is either readily available or can be hired. If competent help can be hired to complete the task, then that would seem to be the most economical method to use. Some cannot or will not hire outside help, in which case the opportunity cost of the time spent on AI may be perceived to be too great compared to other farming or ranching activities.

In comparing a timed insemination system such as CO-Synch to Select Synch where cows are inseminated after an observed estrus, the standardized costs per hundred are lower with the Select Synch system, and the difference is greatest for the largest herd size. So, while in most cases estrus AI may produce more pregnancies with less overall expense, the additional cost for timed AI may allow a producer to use AI who would not have considered AI if heat detection was necessary because of herd size or a pasture too large for efficient heat detection, or if labor was unavailable. This type of producer may have greater ability to recover the additional cost of timed AI in the value received for the genetics produced.

A further examination of the Select Synch and CO-Synch systems at varying labor and semen costs is shown in Table 7. Combinations of semen and labor costs do exist where standardized costs for the CO-Synch system are less than the Select Synch system. Costs per hundred for CO-Synch at a 60% pregnancy rate are $.22/cwt less than Select Synch when semen cost is $3 per unit and labor is $15.77 per hour in the 100 head herd size (Table 7). For a herd size of 30, the breeding costs per hundred are less for CO-Synch than Select Synch at low semen costs and medium to high labor costs and at the highest semen and labor costs and at an AI pregnancy rate of 60%. For a herd size of 300, at equal pregnancy rates, there are no combinations where the costs are less for CO-Synch. Averaged across all herd sizes and AI pregnancy rates, and at the highest labor cost, the standardized cost for Select Synch is $0.53/cwt less than CO-Synch and this increases to $1.35/cwt at low labor costs. At the lowest semen cost, averaged across all herd sizes and AI pregnancy rates, the advantage of Select Synch over CO-Synch is only $0.18 and increases to $1.70/cwt at high semen costs.

Table 7. 500 lb equivalent weaned calf breeding costs per cwt for a herd size of 100 at various labor and semen costs

System	Preg Rate	Semen Cost								
		$3/unit			$13/unit			$23/unit		
		Labor Cost ($/hour)								
		$5.77	$10.77	$15.77	$5.77	$10.77	$15.77	$5.77	$10.77	$15.77
CO-Synch	40%	$7.82	$8.31	$8.81	$10.48	$10.97	$11.47	$13.13	$13.63	$14.13
CO-Synch	50%	$5.36	$5.85	$6.35	$8.01	$8.51	$9.01	$10.67	$11.17	$11.67
CO-Synch	60%	$4.84	$5.34	$5.83	$7.50	$8.00	$8.49	$10.16	$10.65	$11.15
Select Synch	40%	$7.04	$7.90	$8.76	$8.56	$9.42	$10.28	$10.08	$10.94	$11.80
Select Synch	50%	$4.71	$5.57	$6.43	$6.61	$7.47	$8.33	$8.51	$9.37	$10.23
Select Synch	60%	$4.33	$5.19	$6.05	$6.61	$7.47	$8.33	$8.89	$9.75	$10.61

Pregnancy rates to AI will vary based on a variety of factors and the effect of changing pregnancy rate on the standardized cost per hundred was calculated within each system (Table 8). Notice that for a herd size of 30 using CO-Synch, the cost per exposed female remains the same despite differences in AI pregnancy rates. This is because all animals are treated and inseminated, one bull is still needed for clean up and total number of cows pregnant at the end of the entire breeding season is the same. The benefit of more AI pregnancies is reflected in the standardized production scale.

Table 8 allows a comparison of systems at different AI pregnancy rate outcomes. For example, this allows us to see that if heat detection is a problem and reduces the pregnancy rate to 40% in a Select Synch system, that the pregnancy rate to timed AI in the CO-Synch system would need to be somewhere between 50-60% to yield similar costs per hundred for a herd size of 300. In larger herds where heat detection may really present a challenge, this could easily be true.

Comparing Select Synch to Select Synch+CIDR, the CIDR allows for 2 fewer days of heat detection and should increase pregnancy rates over Select Synch, particularly in anestrous cows. However, even at a 60% pregnancy rate for the Select Synch+CIDR, the cost per hundred is still less for a Select Synch system yielding a 40% pregnancy rate. MGA-Select requires one additional injection of GnRH and one more day of labor than MGA/PGF. Costs per hundred for MGA/PGF at a 40% pregnancy rate are slightly less than a 50% pregnancy rate with MGA/Select (300 head). CO-Synch and MGA-CO-Synch have very similar costs and returns, because there is little added cost with the MGA-CO-Synch in this model. This is based on the assumption that there is no additional labor cost to deliver the MGA, and the MGA carrier is part of the normal ration. A comparison of giving PGF on the day before CIDR removal or at CIDR removal (CIDR+PGFd7) indicates that the CIDR+PGFd7 system reduces cost from $0.84 to $0.27 per exposed female for herd sizes of 30 to 300, respectively and reduces cost per hundred $0.21 to $0.07.

Economies of scale are evident in these results, however breeding costs are just part of the picture. Both Kansas SPA and Farm Management databases indicate that small producers are just as likely to be profitable as large producers.

Pregnancy rates to AI

The costs and returns based on various AI pregnancy rates and synchronization systems have been shown. The question then becomes, what pregnancy rate can be expected from various systems in my herd? The differential response of postpartum cows based on factors such as age, body condition, and days postpartum is thoroughly described in the paper of Stevenson et al., found earlier in these proceedings. Table 9 depicts a summary of recent published data in beef cows of which only one study has less than 75 cows per treatment; most represent large herds and multiple locations. Where available, information on body condition score, days postpartum and proportion cycling has been provided. Most of the herds used in these trials represent average or above average management. This table may serve as a guide to the level and variability of published results.

Excluding the *Bos Indicus* data, the average pregnancy rate reported for Select Synch is 48% and for CO-Synch, 46%. Other systems have fewer reported values, so averages across studies have not been made. Where those limited observations would fall within a normal distribution of pregnancy rates for that system is hard to know. Very limited data is available providing head-to-head comparisons of various systems with large numbers of animals at multiple locations. Without this type of data it is hard to sell any one system as so much better than another.

In most cases the pregnancy rates reported in these studies represent an accurate assessment of AI pregnancies because authors reported waiting at least 10 days after AI to turn in bulls for clean-up and an early pregnancy diagnosis ensured clear distinction between AI and natural service pregnancies. Caution must be used when evaluating field reports of pregnancy rates from various systems when they are reported in conditions other than those described above because the results can be distorted. This caution should also be noted for individuals purchasing animals that are supposedly pregnant to AI or have AI-sired calves because the conditions used to assure and identify those pregnancies vary. Another possible distortion is that in some cases only part of the herd (mature cows or early calvers) is synchronized. This may be a wise and practical way to implement an AI program, but the results will likely be different than when the entire herd is synchronized.

One thing is clear, there are now reliable systems to generate AI pregnancy rates near 50% or better, and that result can be achieved with a single timed insemination. Producers who refine their synchronization preparation and procedures, identify highly fertile bulls for both AI and natural service, and have a gradually increasing percentage of cows calving early will find even better results over time.

Conclusions

While costs of a breeding system are important, a system that can be implemented correctly and efficiently within a given production environment may be equally important. The length or complexity of a system may make it a bad choice for certain situations even though it looks good on paper. The model described here does not account for such things as the likelihood that the right treatment will be given on the right day or that the facilities are adequate to allow estrous detection and sorting.

Results indicate that synchronization systems that involve considerable animal handling and heat detection can generate a return greater than natural service. Given all the demands on the CEO's of today's beef business, hiring highly skilled, specialized people to perform AI and estrous synchronization seems to make good sense. Particularly for someone just starting an estrous synchronization program, experienced help may be worth a lot to the success of a program. The planning required to schedule help is a problem for some, but should be a priority.

Researchers have been working hard to improve responses to timed AI because of the unwillingness of producers to commit time to heat detection. If labor is available and heat detection is feasible, cost analysis would indicate that AI after estrus rather than timed AI would produce greater returns. Some timed insemination systems have standardized costs similar to natural service at a 50% pregnancy rate and lower costs at 60% depending on herd size. For producers who can further increase returns for AI-sired calves, this benefit would be even greater.

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Table 6. Breeding system costs and 500 lb equivalent weaned calf breeding cost per hundred.

	Days worked	Preg rate	Total labor hours			No. of Bulls			Cost per pregnant female			500 lb equivalent weaned calf breeding cost per hundred					
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	$66	$44	$39	$12.48	$ 0.42	$ 7.47	$ 0.32	$ 6.42	$ 1.37
7-11 Synch	8	50%	42	77	133	1	2	6	$67	$46	$42	$12.89	$ 0.02	$ 7.96	$ (0.17)	$ 6.96	$ 0.83
CIDR+PGFd6	8	50%	42	77	133	1	2	6	$71	$49	$45	$13.62	$(0.71)	$ 8.69	$ (0.90)	$ 7.69	$ 0.10
CIDR+PGFd7	7	50%	40	72	125	1	2	6	$70	$49	$44	$13.41	$(0.51)	$ 8.58	$ (0.79)	$ 7.62	$ 0.17
Hybrid Synch**	7	50%	40	72	125	1	2	6	$70	$49	$45	$13.59	$(0.68)	$ 8.76	$ (0.97)	$ 7.80	$ (0.01)
MGA Select	7	50%	40	72	125	1	2	6	$65	$43	$39	$12.22	$ 0.69	$ 7.38	$ 0.41	$ 6.42	$ 1.36
Select Synch+CIDR	7	50%	40	72	125	1	2	6	$73	$52	$48	$14.21	$ (1.30)	$ 9.38	$ (1.59)	$ 8.42	$ (0.63)
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	$67	$48	$45	$12.88	$ 0.03	$ 8.51	$ (0.72)	$ 7.79	$ (0.00)
CO-Synch + CIDR	3	50%	26	47	82	1	2	6	$77	$58	$54	$15.01	$ (2.10)	$10.64	$ (2.85)	$ 9.92	$ (2.13)
MGA-CO-Synch	3	50%	26	47	82	1	2	6	$68	$49	$46	$13.01	$ (0.11)	$ 8.64	$ (0.85)	$ 7.92	$ (0.13)

*Descriptions of these systems can be found elsewhere in these proceedings

**Assumes 40% of cows bred based on observed estrus (no GnRH at AI)

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

Table 8. Breeding system costs and 500 lb equivalent weaned calf breeding cost per hundred at various AI pregnancy rates.

	Days Worked	Preg Rate	No. of bulls			Cost per pregnant female			500 lb equivalent weaned calf breeding cost per hundred					
Herd Size			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**	**$ -**
CO-Synch	3	40%	1	3	7	$67	$57	$48	$13.40	$ (0.49)	$10.97	$ (3.18)	$ 8.95	$ (1.16)
	3	50%	1	2	6	$67	$48	$45	$12.88	$ 0.03	$ 8.51	$ (0.72)	$ 7.79	$ (0.00)
	3	60%	1	2	5	$67	$48	$42	$12.37	$ 0.54	$ 8.00	$ (0.21)	$ 6.63	$ 1.16
MGA-CO-Synch	3	40%	1	3	7	$68	$57	$49	$13.53	$ (0.62)	$11.11	$ (3.32)	$ 9.09	$ (1.30)
	3	50%	1	2	6	$68	$49	$46	$13.01	$ (0.11)	$ 8.64	$ (0.85)	$ 7.92	$ (0.13)
	3	60%	1	2	5	$68	$49	$43	$12.50	$ 0.41	$11.22	$ (3.43)	$ 6.76	$ 1.03
CO-Synch+ CIDR	3	40%	1	3	7	$77	$66	$57	$15.52	$ (2.62)	$13.10	$ (5.31)	$11.08	$ (3.29)
	3	50%	1	2	6	$77	$58	$54	$15.01	$ (2.10)	$10.64	$ (2.85)	$ 9.92	$ (2.13)
	3	60%	1	2	5	$77	$58	$52	$14.49	$ (1.59)	$13.19	$ (5.40)	$ 8.75	$ (0.96)
MGA/PGF	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
	6	60%	1	2	5	$62	$42	$35	$11.20	$ 1.71	$ 9.53	$ (1.74)	$ 4.91	$ 2.88
MGA Select	7	40%	1	3	7	$62	$50	$40	$12.22	$ 0.69	$ 9.33	$ (1.54)	$ 7.08	$ 0.71
	7	50%	1	2	6	$65	$43	$39	$12.22	$ 0.69	$ 7.38	$ 0.41	$ 6.42	$ 1.36
	7	60%	1	2	5	$67	$46	$39	$12.22	$ 0.69	$10.45	$ (2.66)	$ 5.77	$ 2.02
CIDR+PGF d7	7	40%	1	3	7	$67	$55	$45	$13.42	$ (0.51)	$10.53	$ (2.74)	$ 8.27	$ (0.48)
	7	50%	1	2	6	$70	$49	$44	$13.41	$ (0.51)	$ 8.58	$ (0.79)	$ 7.62	$ 0.17
	7	60%	1	2	5	$72	$51	$44	$13.41	$ (0.50)	$11.65	$ (3.86)	$ 6.97	$ 0.82
Select Synch+CIDR	7	40%	1	3	7	$71	$58	$49	$14.21	$ (1.31)	$11.33	$ (3.54)	$ 9.07	$ (1.28)
	7	50%	1	2	6	$73	$52	$48	$14.21	$ (1.30)	$ 9.38	$ (1.59)	$ 8.42	$ (0.63)
	7	60%	1	2	5	$75	$54	$47	$14.21	$ (1.30)	$12.46	$ (4.67)	$ 7.77	$ 0.02
Hybrid Synch	7	40%	1	3	7	$70	$58	$48	$14.10	$ (1.20)	$11.22	$ (3.43)	$ 8.96	$ (1.17)
	7	50%	1	2	6	$70	$49	$45	$13.59	$ (0.68)	$ 8.76	$ (0.97)	$ 7.80	$ (0.01)
	7	60%	1	2	5	$70	$49	$42	$13.07	$ (0.17)	$11.30	$ (3.51)	$ 6.63	$ 1.16
7-11 Synch	8	40%	1	3	7	$65	$52	$42	$12.89	$ 0.02	$ 9.91	$ (2.12)	$ 7.61	$ 0.18
	8	50%	1	2	6	$67	$46	$42	$12.89	$ 0.02	$ 7.96	$ (0.17)	$ 6.96	$ 0.83
	8	60%	1	2	5	$70	$48	$41	$12.89	$ 0.02	$11.02	$ (3.23)	$ 6.30	$ 1.49
CIDR+PGFd6	8	40%	1	3	7	$68	$55	$45	$13.62	$ (0.71)	$10.64	$ (2.85)	$ 8.34	$ (0.55)
	8	50%	1	2	6	$71	$49	$45	$13.62	$ (0.71)	$ 8.69	$ (0.90)	$ 7.69	$ 0.10
	8	60%	1	2	5	$73	$51	$44	$13.62	$ (0.71)	$11.75	$ (3.96)	$ 7.04	$ 0.75
Select Synch	9	40%	1	3	7	$63	$50	$40	$12.49	$ 0.42	$ 9.42	$ (1.63)	$ 7.07	$ 0.72
	9	50%	1	2	6	$66	$44	$39	$12.48	$ 0.42	$ 7.47	$ 0.32	$ 6.42	$ 1.37
	9	60%	1	2	5	$68	$46	$39	$12.48	$ 0.43	$10.53	$ (2.75)	$ 5.77	$ 2.02

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

Table 9. Summary of cow studies

Reference

	1	2	2	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Number	150	872	164	536	1266	593	460	436	467	473	771	1035	560	183	596	209	227	110	201	230	389
Days postpartum††	71	72	74	71	79			89	76		74	71	66.6	77	75	78	80	74	76		70
BCS	5.1	4.5	4.8	4.9	5.7	4.4		4.8	4.9				5	4.7	5.1	5		5.1	5.3		5.7
% Cycling		42%	78%	43%		48%		47%	32%*	39%				60%	71%	36%†	33%†	46%†	26%†		
Age (years) or parity†††	M,P	M,P			4.9			M	M,P	M,P	5.9	M,P	M,P	M,P	M,P	M,P	M	M	M,P		M,P
No. of Locations	1	4	1	3	8	3	2	1	2	2	3	8	4	1	4		2		1		3
Treatments																					
Select Synch	52%	38%	54%	44%		21%^{a}	39%^{a}											59%			
Select Synch + progestin	60%	42%																			
Select Synch + horn bred							40%^{a}														
Hybrid Synch			59%	34%	47%^{a}	36%^{b}															
GnRH + Hybrid Synch					53%^{b}																
2XPGF		28%																		58%	
SMB+CR								42%^{a}													
CO-Synch				33%		31%^{b}	53%^{b}		49%	54%	49%^{a}	47%^{a}	48%^{a}	31%			47%^{a}				
CO-Synch+progestin												45%^{a}	59%^{b}	51%	55%^{a}						
CO-Synch + Calf Removal									46%	63%											
CO-Synch (hCG)									34%												
CO-Synch (hCG) + Calf Removal									35%												
CO-Synch + horn bred							42%^{a}														
GnRH +CO-Synch												50%^{a}									
Ovsynch										52%	57%^{b}										
Ovsynch+Calf Removal								54%^{b}		61%											
MGA+CO-Synch															46%^{b}		61%^{b}				
MGA (14d) /PGF(19d)																68%			58%		
MGA-Select																65%		70%	66%		
CIDR-PGF												39%^{b}									
7-11 Synch																				62%	
7-11 Synch +GnRH & 48-60 h TAI																				73%	53%
7-11 Synch, 60 h TAI																					58%
P Value	NS	TxC	ns	TxC	0.06	0.05	0.01	0.03	ns	ns	0.02	0.05	0.05		0.05	ns	0.05	ns	ns	ns	ns
Note	MGA	Norg				*Bos Indicus*						CIDR	CIDR	Norg	CIDR		72 hr TAI				

1 DeJarnette et al., 2001b
2 Stevenson et al., 2000b
3 DeJarnette et al., 2001a
4 Lemaster et al., 2001
5 Grieger et al., 1998
6 Geary et al., 1998
7 Geary et al., 2001a
8 Geary et al., 2001b
9 Geary & Whittier, 1998
10 Johnson et al., 2000
11 Lamb et al., 2001
12 Stevenson et al., 2000a
13 Medina-Britos et al., 2001
14 Patterson et al., 2001
15 Perry et al., 2001
16 Patterson et al., 2000
17 Paterson et al., 2002
18 Hixon et al., 2001
19 Kojima et al., 2002

†at start of MGA, ††At start of breeding season, †††M=Multiparous, P=primiparous, * one location only

NOTES