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Abstract

Breeding system costs were estimated for natural service and various estrous synchronization plus artificial insemination (AI) systems. Cost per pregnancy was lower for natural service than AI; however, for the large herd size the difference was small for some synchronization systems examined. When the value of an AI-sired calf at weaning was included as $25 greater than a natural service sired calf, several synchronization systems had lower breakeven prices than natural service. Assuming skilled labor could be obtained, systems that involved more heat detection time were more profitable than strict timed insemination systems. Producers that can obtain greater returns from AI-sired calves will find synchronization of estrus and AI valuable tools to increase profitability of their operation.

Keywords

Cattlemen's Day, 2003; Kansas Agricultural Experiment Station contribution; no. 03-272-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 908; Beef; estrus-synchronization protocols; Artificial insemination versus natural service

COMPARISON OF BREEDING SYSTEM COSTS FOR ESTRUS-SYNCHRONIZATION PROTOCOLS PLUS ARTIFICIAL INSEMINATION VERSUS NATURAL SERVICE

S. K. Johnson, S. L. Fogleman, and R. Jones

Summary

Breeding system costs were estimated for natural service and various estrous synchronization plus artificial insemination (AI) systems. Cost per pregnancy was lower for natural service than AI; however, for the large herd size the difference was small for some synchronization systems examined. When the value of an AI-sired calf at weaning was included as $25 greater than a natural service sired calf, several synchronization systems had lower breakeven prices than natural service. Assuming skilled labor could be obtained, systems that involved more heat detection time were more profitable than strict timed insemination systems. Producers that can obtain greater returns from AI-sired calves will find synchronization of estrus and AI valuable tools to increase profitability of their operation.

Introduction

To incorporate desired genetics into cattle breeding programs, producers have an increasing number of options available for synchronization of estrus or ovulation and artificial insemination (AI). Low-cost production continues to be essential for survival in the beef industry. Understanding the costs of producing pregnancies via various methods and their associated value is very important. For some, the need to do more than turn a bull out with the cows is sufficient analysis for them not to 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 examines the costs associated with producing pregnancies via natural service and various estrous synchronization systems. Some parts of the process are relatively easy to assign costs and make comparisons; whereas, for others, assigning economic values is much more difficult. As always, to make the most informed decisions, each producer must know costs of production for their own operation.

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 were $2,292 and $2,267, respectively. Annual bull costs were calculated using Kansas Cow-Calf Enterprise Budget cost estimates made by Fogleman and Jones in 2001. Additional assumptions included the use of each bull for four breeding seasons; 10% death loss; 9% interest rate; and a 94% pregnancy rate. Annual feed costs for cow herds vary by as much as $200 per cow and this same variability is expected in feed costs for bulls. Increasing annual feed costs by $100 increased cost per pregnancy by $7.41 for a low bull to cow ratio (15 cows/year) and $2.22 for heavy bull use (50 cows/year).

Producers who use breeding pastures with carrying capacities less than the serving capacity of the bull (bull to cow ratio), will increase cost per pregnancy. Conversely, cost per pregnancy will be reduced if highly fertile bulls are identified and exposed to more females compared to more conservative recommendations.

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
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	1,031.16	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 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

Cost of Synchronization of Estrus Plus AI

The partial budget in Table 2 gives an overview of cost differences between an AI program and natural service. Compared to natural service, increased costs of an AI program included synchronization products, labor for synchronization of estrus and AI, time for planning, and perhaps improvements in facilities. Decreased returns include income from the sale of cull bulls because fewer bulls will be needed. 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 less calving assistance 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 also will increase returns from a more uniform calf crop and by producing offspring with 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., improved genetics, more concentrated calving season) are much more difficult to value, 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.

An example of the potential value of improved genetics is in Table 3. Boxed beef values from Angus sires with 10 or more carcass data records are illustrated. The carcass value was $206 per head greater for sires grouped in the top 10% than the bottom 10% for carcass value. It is clear that a few more dollars could be invested in breeding costs to produce a product worth $206 more at harvest. Because the industry has been selling commodity cattle based on average values for so long, it is difficult for many producers to market calves so that they are 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 is one of four keys for high returns on assets for cow/calf enterprises in the Northern Great Plains. 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. If the cost per pregnancy is higher for a particular method of breeding, what are the chances those costs can be recouped achieving higher marketing returns on the superior genetics?

Table 2. Partial Budget for Synchronization of Estrus 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?

Table 3. Average Boxed Beef Values For Angus Sires With 10 Or More Carcass Data Records*

Trait	Top 10%	Bottom 10%	Difference
No. of progeny	2728	1751	
No. of sires	109	110	
% Prime	7.7	0.7	+7.0
% CAB	47.4	0.7	+46.7
% Choice & above	93.7	48.1	+45.6
% Select	6.1	35.0	-28.9
% Standard	0.2	16.9	-16.7
% Yield grades 1 and 2	60.0	38.2	+21.8
% Yield grades 4 and 5	1.4	18.2	-16.8
Carcass price/cwt	$110.19	$94.15	$16.04
Carcass value	$822.27	$616.36	**$205.91**

*Source: Angus Beef Bulletin, January 2000.

Whole herd cost of pregnancy

To evaluate breeding costs under different breeding systems, estimates of the hours of labor required for various synchronization systems were obtained from a survey of beef producers using AI in Nebraska in 1988. From that survey, regression equations were estimated for total labor hours required for various AI programs.

Nonsynchronized program:
$TM = 19 + 0.036(CD)$ $R^2 = 0.83$

Lutalyse synchronization program:
$TM = 2.65\ (CD)^{0.5}$ $R^2 = 0.60$

SyncroMate-B synchronization program:
$TM = 2.53\ (CD)^{0.5}$ $R^2 = 0.87$

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 SyncroMate-B system was used for all the estrous synchronization systems in this report. Breeding systems were evaluated for various herd sizes. 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. Pregnancy rate for the total breeding season 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. Annual bull costs ($2,000 purchase price) were $926 per bull as illustrated in the Table 1. 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	$13.00/straw
Prostaglandin $F_{2\alpha}$	$2.00/dose
GnRH	$4.00/dose
CIDR	$8.00/dose
Supplies	%0.50/insemination
Fixed costs[a]	$176.30

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

Costs per pregnant female calculated in this model reflect 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. Although this reduction means fewer AI-sired calves, the impact of that reduction depends 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 costs 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 is 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 must be made before knowing the AI pregnancy rate. Successfully identifying bulls that can reliably service more than the 30 cows would be extremely valuable. If four rather than five bulls are used for the 300-cow 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 lb heavier at weaning, thus increasing the return at weaning by $20, if the additional weight is worth $1/lb. An extra $5 per calf 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 to 15 per head bonus on carcass performance. For this model, calves sired by AI sires 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 costs per exposed female were reduced for any increased revenue from AI-sired calves and expressed as a 500-lb equivalent, weaned-calf, breeding cost per hundred pounds (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 pregnancy	Proportion (%) of total cost attributed to:			
				Bulls	Semen	Labor	Treatments
100	75	1	42.06	20	37	19	15
100	74	2	50.33	34	30	16	13
100	55	2	46.08	37	24	18	14
100	49	2	44.74	36	22	18	14
100	48	3	53.01	48	19	15	12
300	66	4	38.29	30	35	12	17
300	65	5	40.90	35	33	11	16
300	57	5	39.11	36	30	12	16
300	56	6	41.72	41	28	11	15
300	55	6	41.49	41	27	11	15
300	49	6	40.15	42	25	12	16
300	48	7	42.76	46	23	11	15

Breeding system costs and the standardized cost per cwt for various breeding systems assuming equivalent AI pregnancy rates (50%) are in Table 6. Breeding system costs per pregnant female were least for natural service followed by MGA + PGF and MGA-Select or Select Synch (depending on herd size); CO-Synch + CIDR was most expensive. On a standardized production scale, 500-lb equivalent weaned-calf breeding cost per cwt, several 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, CIDR + PGF7, and CIDR + PGF8 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 cwt involve CIDRs and/or timed AI. The difference in cost per cwt 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 cwt 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 must be $2.23/cwt greater for a natural service breeding system than one using MGA + PGF to generate equal returns with all else being equal. The CO-Synch+CIDR system standardized cost per cwt was $2.63 and $2.66 more than natural service for herd sizes of 30 and 300, 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 manner 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 AI system such as CO-Synch to Select Synch where cows are inseminated after an observed estrus, the standardized costs per cwt are less with the Select Synch system, and the difference is greatest for the largest herd size. Therefore, although in most cases estrus-AI may produce more pregnancies with less cost, timed AI may allow a producer who would not have considered AI if heat detection was necessary to use AI. This situation may occur because of herd size, a pasture too large for efficient heat detection, or unavailability of labor. This type of producer may have a 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. At low semen costs and high labor costs, the differences in cost per cwt between CO-Synch and Select Synch are rather small and range from $0.32 to $0.05 per cwt. For a herd size of 30, the breeding costs per cwt 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 at an AI pregnancy rate of 60%. For a herd size of 300, 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 $0.79/cwt less than CO-Synch, and this increases to $1.61/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 $0.45 and increases to $1.96/cwt at high semen costs.

Pregnancy rates to AI will vary based on a variety of factors and the effect of changing pregnancy rate on the standardized cost per cwt was calculated within each system (Table 8). Notice that for a herd size of 30 using CO-Synch, the cost per pregnant 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 similar. 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, if heat detection is problematic and reduces the pregnancy rate to 40% in a Select Synch system, then the pregnancy rate to timed AI in the CO-Synch system must be between 50 and 60% to yield similar costs per cwt 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 two 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 cwt 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 cwt 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 (CIDR + PGF7) or at CIDR removal (CIDR + PGF8) indicates that the CIDR + PGF8 system reduces cost from $0.90 to $0.28 per pregnant female for herd sizes of 30 to 300, respectively, and reduces cost per cwt $0.21 to $0.07.

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

Pregnancy rates to AI

The costs and returns based on various AI pregnancy rates and estrous synchronization systems have been shown. The question then becomes, what pregnancy rate can be expected from various systems? Age, body condition, and days postpartum will all impact the proportion of cows cycling at the onset of the breeding season and thus the pregnancy rate to AI. AI-pregnancy rates will vary widely for the same synchronization system. Table 9 depicts ranges in pregnancy rates that might be expected during a 5-day AI period or a single timed AI (CO-Synch and Ovsynch). The value under the "typical" column is a conservative estimate that might be used for planning in well-managed herds with optimal conditions.

Exercise caution when evaluating field reports of pregnancy rates from various systems. In some cases, only part of the herd (mature or early calving cows) was studied. This may be a wise and practical way to implement an AI program, but the results will likely be better than when the entire herd is synchronized. The method of determining AI pregnancies also may be misleading. To ensure clear distinction between AI and natural service pregnancies, a common research practice is to wait at least 10 days after AI before turning out bulls for clean-up in order to make an accurate early pregnancy diagnosis (30 to 40 days after first AI).

It is clear that reliable estrous synchronization systems exist that generate AI pregnancy rates of 50% or more with a single timed AI. Producers who refine their management in preparation for the breeding season, 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

Although 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 duration 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 proper treatment will be given on the correct day or that the facilities are adequate to allow detection of estrus and sorting of breeding females and their calves.

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 operators of today's cow-calf herds, hiring highly skilled, specialized people to apply estrous synchronization systems and AI makes 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.

Much research has been done to improve pregnancy rates to timed AI. If labor is available and heat detection is feasible, cost analyses indicate that AI after estrus rather than timed AI should produce greater returns per cwt. Some timed AI 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 capitalize on increased returns for AI-sired calves, this benefit should be even greater.

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	8.35	8.85	9.34	11.01	11.50	12.00	13.67	14.16	14.66
CO-Synch	50	5.89	6.38	6.88	8.55	9.04	9.54	11.20	11.70	12.20
CO-Synch	60	5.37	5.87	6.37	8.03	8.53	9.02	10.69	11.19	11.68
Select Synch	40	7.31	8.17	9.03	8.83	9.68	10.54	10.34	11.20	12.06
Select Synch	50	4.98	5.84	6.70	6.88	7.74	8.60	8.78	9.63	10.49
Select Synch	60	4.60	5.46	6.31	6.87	7.73	8.59	9.15	10.01	10.87

Table 9. Pregnancy Rates (%) to a 5-Day AI Period or a Single Timed Insemination*

	Heifers		Cows	
	Range	Typical	Range	Typical
MGA + PGF	40-70	60	40-60	55
MGA Select	40-65	60	40-65	60
MGA CO-Synch*			45-65	60
Select Synch	40-65	50	25-55	45
CO-Synch*	-		30-55	50
CO-Synch+CIDR*	-		+ 0 –15	
Ovsynch*	-		50-57	50
CIDR + PGF	35-60		35-60	45
7-11 Synch	30-55		35-65	
2 × PGF	30-65	50	20-45	40

Table 6. Breeding System Costs and 500 lb 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														
			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
7-11 Synch	8	50	42	77	133	1	2	6	69	47	43	13.15	(0.25)	8.23	(0.44)	7.22	0.57
CIDR+PGF7	8	50	42	77	133	1	2	6	71	49	45	13.62	(0.71)	8.69	(0.90)	7.69	0.10
CIDR+PGF8	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	72	51	47	14.01	(1.11)	9.18	(1.39)	8.22	(0.43)
MGA Select	7	50	40	72	125	1	2	6	66	45	40	12.48	0.42	7.65	0.14	6.69	1.10
Select Synch+CIDR	7	50	40	72	125	1	2	6	74	53	49	14.48	(1.57)	9.64	(1.85)	8.68	(0.90)
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)
CO-Synch + CIDR	3	50	26	47	82	1	2	6	79	60	57	15.54	(2.63)	11.17	(3.38)	10.45	(2.66)
MGA-CO-Synch	3	50	26	47	82	1	2	6	70	51	48	13.55	(0.64)	9.18	(1.39)	8.45	(0.66)

*Descriptions of these systems are shown in Figure 1.
**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 Cwt at Various AI Pregnancy Rates

	Days worked	Preg. rate (%)	No. of bulls			Cost ($) per pregnancy			500 lb equivalent weaned calf breeding cost ($) per hundred					
			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**	**-**
CO-Synch	3	40	1	3	7	70	59	50	13.93	(1.02)	11.50	(3.71)	9.48	(1.70)
	3	50	1	2	6	70	51	48	13.41	(0.51)	9.04	(1.25)	8.32	(0.53)
	3	60	1	2	5	70	51	45	12.90	0.01	8.53	(0.74)	7.16	0.63
MGA-CO-Synch	3	40	1	3	7	70	60	51	14.06	(1.15)	11.64	(3.85)	9.62	(1.83)
	3	50	1	2	6	70	51	48	13.55	(0.64)	9.18	(1.39)	8.45	(0.66)
	3	60	1	2	5	70	51	45	13.03	(0.12)	8.66	(0.87)	7.29	0.50
CO-Synch+ CIDR	3	40	1	3	7	79	68	60	16.06	(3.15)	13.63	(5.84)	11.61	(3.82)
	3	50	1	2	6	79	60	57	15.54	(2.63)	11.17	(3.38)	10.45	(2.66)
	3	60	1	2	5	79	60	54	15.03	(2.12)	10.65	(2.87)	9.28	(1.49)
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	6.46	1.33	4.91	2.88
MGA Select	7	40	1	3	7	63	51	41	12.49	0.42	9.60	(1.81)	7.34	0.45
	7	50	1	2	6	66	45	40	12.48	0.42	7.65	0.14	6.69	1.10
	7	60	1	2	5	68	47	40	12.48	0.43	7.65	0.14	6.04	1.75
CIDR+PGF8	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)	8.58	(0.79)	6.97	0.82
Select Synch+CIDR	7	40	1	3	7	72	60	50	14.48	(1.57)	11.59	(3.80)	9.34	(1.55)
	7	50	1	2	6	74	53	49	14.48	(1.57)	9.64	(1.85)	8.68	(0.90)
	7	60	1	2	5	77	56	49	14.48	(1.57)	9.64	(1.85)	8.03	(0.24)
Hybrid Synch	7	40	1	3	7	72	60	50	14.53	(1.62)	11.64	(3.85)	9.38	(1.60)
	7	50	1	2	6	72	51	47	14.01	(1.11)	9.18	(1.39)	8.22	(0.43)
	7	60	1	2	5	72	51	44	13.50	(0.59)	8.67	(0.88)	7.06	0.73
7-11 Synch	8	40	1	3	7	66	53	43	13.16	(0.25)	10.18	(2.39)	7.87	(0.08)
	8	50	1	2	6	69	47	43	13.15	(0.25)	8.23	(0.44)	7.22	0.57
	8	60	1	2	5	71	49	42	13.15	(0.24)	8.23	(0.44)	6.57	1.22
CIDR+PGF7	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)	8.69	(0.90)	7.04	0.75
Select Synch	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
	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

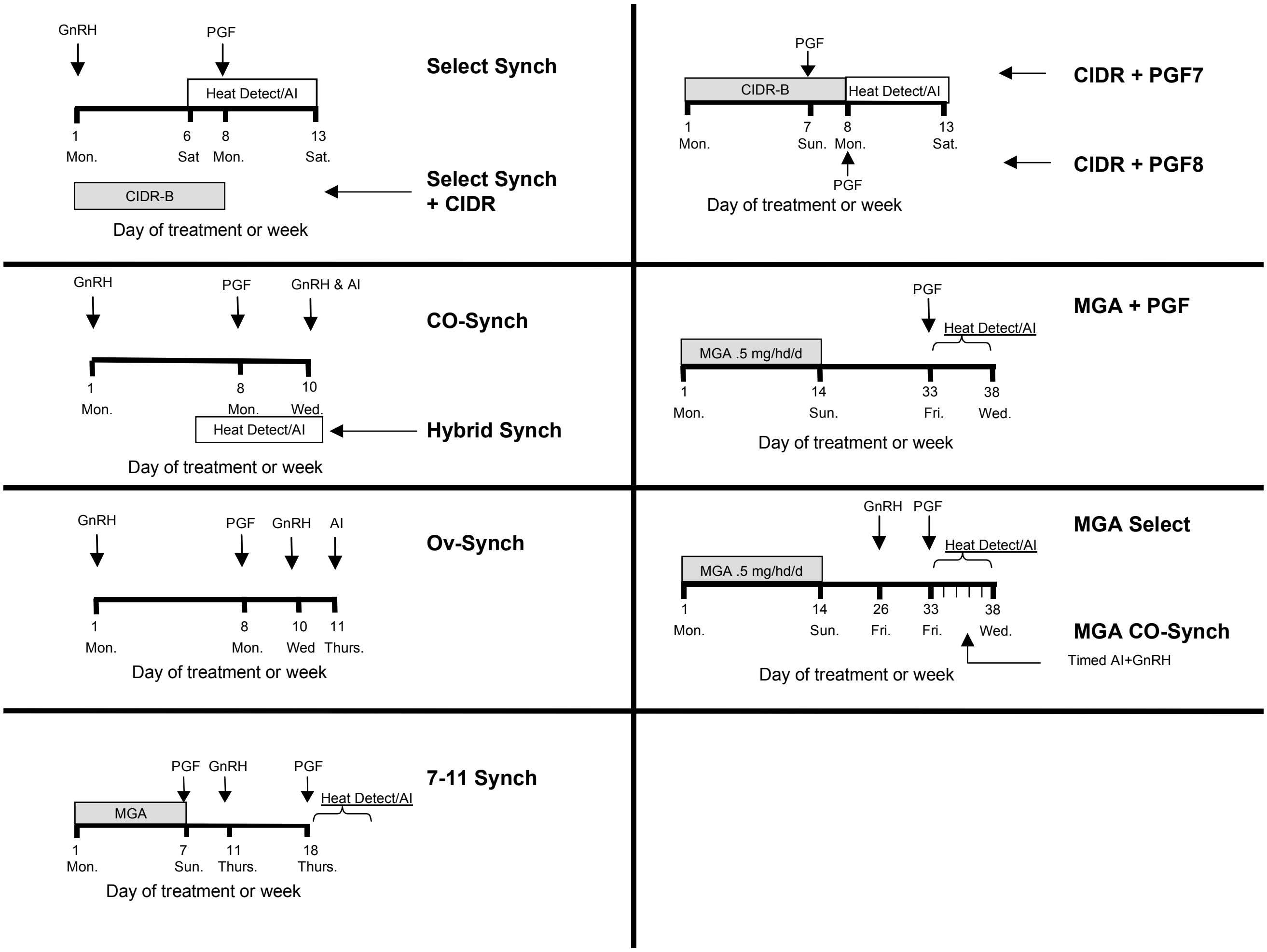

Figure 1. Diagram of Systems For Synchronization of Estrus Included in Cost Analysis.