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NEW TOOLS FOR ESTROUS SYNCHRONIZATION – COSTS AND BENEFITS

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INTRODUCTION

Estrous synchronization has become a powerful tool in managing breeding seasons to compliment niche markets. Synchronization of estrus, along with the use of AI, has become a popular technology that can introduce new sire genetics along with control of the breeding and calving season. Cattle producers have long searched for methods to efficiently and effectively synchronize females for artificial insemination without compromising conception or pregnancy rates versus conventional natural service breeding. Over the past 40 years, research scientists have developed and tested many synchronization protocols to synchronize estrus and ovulation in beef and dairy cattle with a goal to consistently produce acceptable pregnancy rates. Success in meeting these goals has been limited. Current approaches to synchronization have included the use of progestins (MGA & CIDR-B), prostaglandins (PGF_2_), and gonadotropin-releasing hormones (GnRH; Table 1).

Table 1: Summary of past and current estrous synchronization protocols.

Method	**Protocol**	**References**
PGF_2_ (PG)	(1-shot PG) – breed off heats for 4 d, PG inject d 5	Lauderdale et al., 1980 Moody, 1979
	(2-shot PG) – 1st PG injection d 0, 2nd PG injection d 10 - 12	Lauderdale, 1979
Melengestrol Acetate (MGA + PG)	(MGA + PG) - MGA fed at .5 mg/hd/d for 14 d w/ PG 17 - 19 d after MGA removal	Heersche et al., 1974 Wishart, 1974 Patterson et al., 1995
GnRH + PG	(Select Synch) - GnRH inject d 0, PG d 7	Grieger et al., 1998
	(Co-Synch) – Select Synch w/ timed AI 48 hrs post PG, & 2nd GnRH at timed AI	Geary & Whittier, 199 Stevenson et al., 2000
	(Ov Synch) – Select Synch protocol w/ 2nd GnRH injection 48 hrs post PG and timed AI 72 hrs post PG	Pursley et al., 1995 Pursley et al., 1998 Geary et al., 1998
MGA + GnRH + PG	(MGA® Select) – MGA fed 14 d, Select Synch begins 10-12 d post MGA removal	Patterson et al., 2000 Wood et al., 2001
	(7-11 Synch) – MGA fed 7 d w/ PG given at MGA removal, Select Synch begins 4 d post PG injection	Kojima et al., 2000 Hixon et al., 2001
Controlled-Intravaginal Drug Release (CIDR-B + PG)	(CIDR-PG) – CIDR insert d 0, PG inject d 6, CIDR removal d 7	Lucy et al., 2001 FDA, 2002

PROSTAGLANDINS, PROGESTINS, AND GONADOTROPINS

Over the years, scientist and pharmaceutical companies have worked together to evaluate different products that would induce an animal to come into heat and ovulate. Researchers have taken these products and developed an extensive program for timing and use of these products capable of being producer friendly. Prostaglandin F_{2}_ (PG) and analogues were developed to induce luteolysis, demise of the corpus luteum, for synchronizing estrus in cattle. Acceptable pregnancy results have been reported, yet the use of PG alone could not cause luteolysis in cattle during certain stages of the estrous cycle or cause non-cyclic animals to become cyclic (Tables 2 & 4). Progestins became popular, in collaboration with PG's, to alter the estrous cycle and induce cyclicity in non-cycling cattle in order to have more control over synchronizing standing estrus. Progestins, such as MGA, have been used to suppress estrus in cycling cattle to allow for a narrow window for AI (Table 3). Gonadotropins (GnRH) were later introduced to control the effects of PG on the estrous cycle during any stage and create a tighter synchrony for ovulation (Tables 2 & 3). The use of timed-inseminations increased with incorporation of GnRH into synchronization protocols (Table 2), yet early heats were not controlled.

Table 2:

Stevenson et al., 2000				**Geary and Whittier, 1998**		
Beef Cows				Beef Cows		
Treatment	Number	ER (0-144 hr), %	CR, %	Number	ER, %	PR, %
2 X PG	294	47.2	60.6			
Select Synch	289	59.2	65.7			
Co-Synch				369		49
Ovsynch				402		57

Table 3:

Wood et al., 2001				**Kojima et al., 2000**		
Beef Heifers				Beef Cows		
Treatment	Number	ER (48-72 hr), %	CR. %	Number	ER (42-66 hr), %	CR, %
Select Synch				45	91	68
MGA+PG	17	63				
MGA Select®	17	76				
7-11 Synch				44	69	47

Table 4:

Lucy et al., 2001						
	Beef Cows			Beef Heifers		
Treatment	Number	ER (3 day), %	CR, %	Number	ER (3 day), %	CR, %
Control	285	15	50	251	13	58
PG	283	45	66	252	27	52
CIDR+PG	283	59	61	221	65	60

ER (Estrous Response) = number of animals synchronized / number of animals exhibiting estrus.
CR (Conception Rate) = number of animals artificially inseminated / number of animals determined pregnant.
PR (Pregnancy Rate) = number of animals synchronized / number of animals determined pregnant to AI.

Some of the more recent synchronization protocols combine PG's, GnRH, and progestins to reduce the amount of time needed for detecting estrus and eliminate early heats (Table 3). Although the use of MGA in many synchronization protocols has dramatically improved estrous synchrony and pregnancy rates, a smaller variance in ovulation time within a group of animals has been reported by incorporating a controlled intravaginal drug release (CIDR-B). One of the first studies using CIDR inserts for initiation of FDA approval was done by Lucy et al (2001). CIDR inserts were left in for 7 days with PG given on day 6. They reported an increase in estrous synchrony within the first 3 days after CIDR removal for beef cows [CIDR (59 %) vs PG (45 %) vs control (15 %)] and beef heifers [CIDR (65 %) vs PG (27 %) vs control (13 %)]. It appeared that using CIDR inserts improved estrous synchrony, creating a tighter window of standing heats. This improved synchrony may provide opportunities to incorporate timed-insemination programs into herds to try and benefit from the advantages offered from synchronization and artificial insemination. The use of CIDR inserts was approved by the Food and Drug Administration for beef cows and beef & dairy heifers in the summer of 2002, and dairy cows in July of 2003.

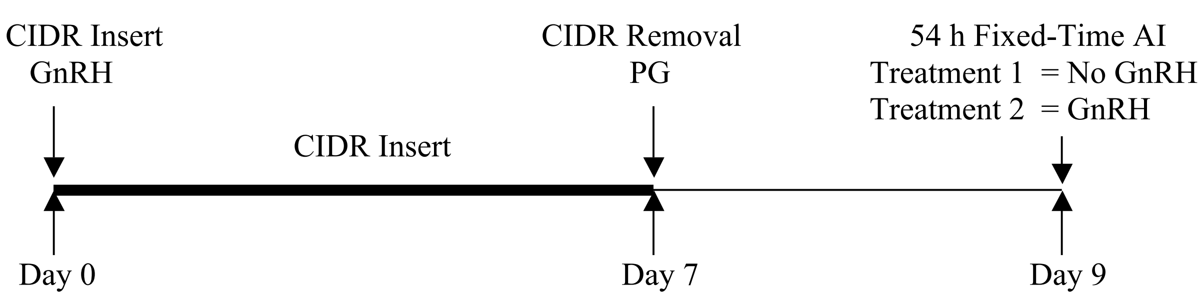
Richardson et al., (2002) reported a higher and tighter estrous response and higher conception rate, in dairy and beef heifers combined, when GnRH was given or not given at day 1 of a 7 day CIDR insertion protocol with PG on day 6 (ER = 84.1 & 87.1 %; CR = 58.2 & 58.6 %) vs a Select Synch protocol (ER = 77.7 %; CR = 53 %). By moving the PG injection from day 6 to day 7 (at CIDR removal), Lamb et al., (2001) showed that pregnancy rates were higher in suckled beef cows that received a CIDR + CO-Synch protocol (58 %) vs a Co-Synch protocol (48 %) alone. Estrous response and pregnancy rates in beef heifers were higher in a modified CIDR + Co-Synch protocol (using GnRH with PG given at day 7; ER = 65.0 % and PR = 65.0 %) vs a 6 d MGA feeding on top of a Co-Synch protocol using GnRH (ER = 35.6 % and PR = 52.5 %) with peak estrous response for both MGA and CIDR groups ranging from 36 to 48 h post CIDR removal (Martinez et al., 2002). If estrous response is highest within 36 – 48 h post CIDR removal, possibly due to incorporation of GnRH at CIDR insertion and PG can be given at CIDR removal, then delaying timed-insemination may also result in higher pregnancy rates.

COLORADO STATE UNIVERSITY CIDR STUDY

Heifer Study:

A study conducted by Colorado State University involved timing ovulation for delayed fixed-time AI in beef heifers using a modified Co-Synch + CIDR protocol (Figure 1) with two research herds in Colorado and Wyoming and one cooperator herd in South Dakota.

Figure 1: Modified Co-Synch + CIDR



A total of 375 nulliparous crossbred beef heifers were synchronized and blocked by BCS, weight, and AI technician and randomly assigned to one of two treatment groups. Treatment 1 heifers were timed-inseminated at 54 h post CIDR removal and treatment 2 heifers were timed-inseminated at 54 h post CIDR removal with a second injection of GnRH at breeding. All heifers were diagnosed for pregnancy to AI via transrectal ultrasonography 45 d post insemination.

Results from the modified Co-Synch + CIDR protocol with delayed fixed-time AI are depicted in Table 5.

Table 5: CSU CIDR Heifer Results

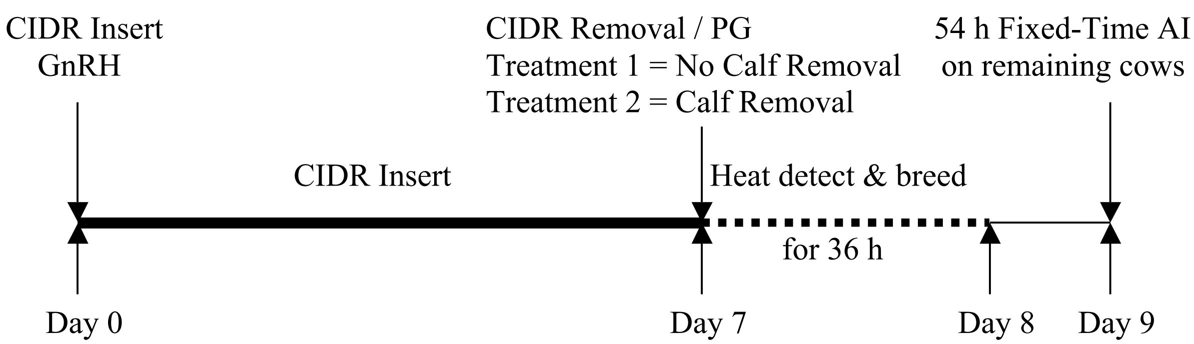
Location	Number	Trtmt 1 PR, %	Trtmt 2 PR, %	Overall PR, %
South Dakota	211	40.4	54.2	47.4
SW Colorado	39	52.6	55	53.9
Wyoming	125	54	56.5	55.2
Pooled Herds	375	46.2	55	50.6

Trtmt 1 = heifers did not receive a second injection of GnRH at timed-insemination 54 h post PG.
Trtmt 2 = heifers did receive a second injection of GnRH at timed-insemination 54 h post PG.
PR (Pregnancy Rate) = number of animals synchronized / number of animals determined pregnant to AI.

Calf Removal Study:

A second study at Colorado State University involved the effects of calf removal on estrous response and pregnancy to AI in suckling multiparous beef cows at two research herds in Colorado and Wyoming. Angus and Red Angus crossbred beef cows (n = 583) were all synchronized for estrus using a modified Hybrid Synch + CIDR protocol (Figure 2) and blocked by BCS, weight, and cyclicity status and randomly assigned to one of two treatments groups. Treatment 1 consisted of no calf removal and treatment 2 consisted of a 54 h calf removal beginning at PG injection.

Figure 2: Modified Hybrid Synch + CIDR w/ calf removal



Calves remained separated until their dams were inseminated. Cows were visually observed for estrus 1 hour at dawn, noon, and dusk for signs of standing heat beginning at time of PG injection and continuing for 36 h. Cows that were detected in standing estrus were artificially inseminated 12 h later, and cows not detected for standing estrus were timed-inseminated 54 h post PG injection. All cows were diagnosed for pregnancy to AI via transrectal ultrasonography 45 d post insemination.

Results from the modified Hybrid Synch + CIDR protocol with calf removal are depicted in Table 6.

Table 6: CSU CIDR w/ Calf Removal Results

	Locations									
	SW Colorado									
	Group 1		Group 2		Pooled Groups		Wyoming		Pooled Herds	
Item	#	PR, %	#	PR, %	#	PR, %	#	PR, %	#	PR, %
Heats										
Trtmt 1	11	54.5	5	80.0	16	62.5	29	62.1	45	62.2
Trtmt 2	14	85.7	13	69.2	27	77.8	52	67.3	79	70.9
Overall	25	72.0	18	72.2	43	72.1	81	65.4	124	67.7
TAI										
Trtmt 1	38	42.1	47	38.3	85	40.0	160	42.5	245	41.6
Trtmt 2	40	37.5	37	18.9	77	28.6	137	36.5	214	33.6
Overall	78	39.7	84	29.8	162	34.6	297	39.7	459	37.9
Total										
Trtmt 1	49	44.9	52	42.3	101	43.6	189	45.5	290	44.8
Trtmt 2	54	50.0	50	32.0	104	41.3	189	45.0	293	43.7
Overall	103	47.6	102	37.3	205	42.4	378	45.2	583	44.3

Trtmt 1 = no calf removal.
Trtmt 2 = 54 hr calf removal beginning at CIDR removal.
TAI = timed artificial insemination.
# (Number) = number of animals in a group.
PR (Pregnancy Rate) = number of animals synchronized / number of animals determined pregnant to AI.

DISCUSSION

As the diversity of genetics broaden and the interest in estrous synchronization and use of artificial insemination remains constant within beef herds across the US, producers will continue to practice and preach low cost production as a management strategy. Due to the increasing number of synchronization protocols available for use today, understanding cost of producing a pregnancy while using some of these different breeding systems and estimating an expected outcome can become very valuable. Years ago, natural service was the only means of synchronizing a herd of cattle, but with today's technology, one can manipulate the cycle of an animal and control what and when that animal produces. Because there are so many synchronization protocols available today, understanding what system can be implemented correctly and efficiently within a given production environment, when considering AI, and which system would fit your low cost management strategy can be very important. Listed below in Table 7 is projected cost for some commonly used breeding systems today and reported responses in pregnancy rates to these systems. This table will give you an idea of the cost per head on each one of these breeding systems, but take into account that the number of animals in each of these reports is not the same (some with small numbers and some with large numbers). These costs only account for cost of the drugs used in those systems and not extra expenses such as semen, AI supplies, labor, time, and clean up bulls.

Table 7: Estrous Synchronization Protocol Costs

Drug Costs: PG = $1.57 GnRH = $2.50 MGA = $0.02/hd/day CIDR = $8.00

Synchronization System Costs

Protocol	Cost	Type	CR, %	PR, %	Reference
2 X PG	$ 3.14	Cows	60.6		Stevenson et al., 2000
Select Synch	$ 4.07	Cows	65.7		Stevenson et al., 2000
		Cows	68.0		Kojima et al., 2000
Co-Synch	$ 6.57	Cows		49.0	Geary & Whittier, 1998
Ovsynch	$ 6.57	Cows		57.0	Geary & Whittier, 1998
MGA + PG (19)	$ 1.85	Cows	63.0		Patterson et al., 2002
MGA Select	$ 4.35	Cows	66.0		Patterson et al., 2002
7-11 Synch	$ 5.78	Cows	47.0		Kojima et al., 2000
CIDR + PG	$ 9.57	Cows	61.0		Lucy et al., 2001
Study Protocol	$12.07	Cows		44.3	Unpublished Data
	$14.57	Heifers		50.6	Unpublished Data

CR (Conception Rate) = number of animals artificially inseminated / number of animals determined pregnant.
PR (Pregnancy Rate) = number of animals synchronized / number of animals determined pregnant to AI.

These system costs vary depending upon the system you use, drugs involved and the status of your herd. Some of these protocols, for different reasons, work better on heifers vs cows and some work well on cows vs heifers. Understanding endpoints from your management strategies and evaluating the condition your animals and the conditions around you, producers can implement some of these breeding systems to accomplish their management goals.

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REFERENCES

Food and Drug Administration. 2002. Certain other dosage form new animal drugs; progesterone intravaginal inserts. Federal Register 67:41,823.

Geary, T. W., J. C. Whittier, E. R. Downing, D. G. LeFever, M. D. Holland, T. M. Nett, and G. D. Niswender. 1998. Pregnancy rates of postpartum beef cows that were synchronized with the Syncro-Mate B or Ovsynch protocol. J. Anim. Sci. 76:1523.

Geary, T. W., and J. C. Whittier. 1998. Effects of a timed insemination following synchronization of ovulation using the Ovsynch or Co-Synch protocol in beef cows. Prof. Anim. Sci. 14:217-220.

Grieger, D. M., G. C. Lamb, T. G. Rozell, K. E. Thompson, and J. S. Stevenson. 1998. Site of semen deposition and fertility in beef cows inseminated according to estrus or at a fixed time after synchronization with GnRH-PGF$_{2}$_. J. Anim. Sci. 76(Suppl. 1):279.

Heersche, G., Jr., G. H. Kiracofe, R. M. McKee, D. L. Davis, and G. R. Brower. 1974. Control of estrus in heifers with PGF$_{2}$_ and Syncro-Mate B. J. Anim. Sci. 38:225 (Abstr.).

Hixon, D. L., R. D. Landis, B. M. Alexander, D. W. Moore, D. D. Carr, and G. E. Moss. 2001. A MGA-prostaglandin-GnRH synchronization protocol suitable for timed artificial insemination. Proc. West. Sec. Am. Soc. Anim. Sci. 52:372-373.

Kojima, F. N., B. E. Salfen, J. F. Bader, W. A. Ricke, M. C. Lucy, M. F. Smith, and D. J. Patterson. 2000. Development of an estrus synchronization protocol for beef cattle with short-term feeding of melengestrol acetate: 7-11 Synch. J. Anim. Sci. 78:2186.

Lamb, G. C., J. S. Stevenson, D. J. Kesler, H. A. Garverick, D. R. Brown, and B. E. Salfen. 2001. Inclusion of an intravaginal progesterone insert plus GnRH and prostaglandin F$_{2}$_ for ovulation control in postpartum suckled beef cows. J. Anim. Sci. 79:2253-2259.

Lauderdale, J. W. 1979. Efficacy of Lutalyse sterile solution. In: J. W. Lauderdale and J. H. Sokolowski (Ed.) Proceedings of the Lutalyse Symposium. pp 17-32. Upjohn Co., Kalamazoo, MI.

Lauderdale. J. W., J. F. McAllister, E. L. Moody, and D. D. Kratzer. 1980. Pregnancy rate in beef cattle injected once with PGF$_{2}$_. J. Anim. Sci. 51(Suppl. 1):296 (Abstr.).

Lucy, M. C., H. J. Billings, W. R. Butler, L. R. Ehnis, M. J. Fields, D. J. Kesler, J. E. Kinder, R. C. Mattos, R. E. Short, W. W. Thatcher, R. P. Wettemann, J. V. Yelich, and H. D. Hafs. 2001. Efficacy of an intravaginal progesterone insert and an injection of PGF$_{2}$_ for synchronizing estrus and shortening the interval to pregnancy in postpartum beef cows, peripubertal beef heifers, and dairy heifers. J. Anim Sci. 79:982.

Martinez, M. F., J. P. Kastelic, G. P. Adams, and R. J. Mapletoft. 2002. The use of a progesterone-releasing device (CIDR-B) or melengestrol acetate with GnRH, LH, or estradiol benzoate for fixed-time AI in beef heifers. J. Anim. Sci. 80:1746-1751.

Moody, E. L. 1979. Studies on Lutalyse use programs for estrus control. In: J. W. Lauderdale and J. H. Sokolowski (Ed.) Proceedings of the Lutalyse Symposium. pp 33-52. Upjohn Co., Kalamazoo, MI.

Patterson, D. J., J. B. Hall, N. W. Bradely, K. K. Schillo, B. L. Woods, and J. M. Kearnan. 1995. Improved synchrony, conception rate, and fecundity in postpartum suckled beef cows fed melengestrol acetate prior to prostaglandin F$_{2}$_. J. Anim. Sci. 73:954-959.

Patterson, D. J., S. L. Wood, F. N. Kojima, and M. F. Smith. 2000. Current and emerging methods to synchronize estrus with melengestrol acetate. In: 49th Annual Beef Cattle Short Course Proceedings "Biotechnologies of Reproductive Biology". Pp. 45-66. University of Florida, Gainsville.

Patterson, D. J., J. E. Stegner, G. A. Perry, F. N. Kojima, and M. F. Smith. 2002. Review of estrous synchronization systems: MGA. Proc. Applied Reprod. Strat. in Beef Cattle Workshop. pp. 34-45. Manhattan, KS.

Pursley, J. R., M. O. Mee, and M. C. Wiltbank. 1995. Synchronization of ovulation in dairy cows using PGF_2_ and GnRH. Theriogenology 44:915-923.

Pursley, R. J., R. W. Silcox, and M. C. Wiltbank. 1998. Effect of time of artificial insemination on pregnancy rates, calving rates, pregnancy loss, and gender ratio after synchronization of ovulation in lactating dairy cows. J. Dairy Sci. 81:2139-2144.

Richardson, A. M., B. A. Hensley, T. J. Marple, S. K. Johnson, and J. S. Stevenson. 2002. Characteristics of estrus before and after first insemination and fertility of heifers after synchronized estrus using GnRH, PGF_2_, and progesterone. J. Anim. Sci. 80:2782-2800.

Stevenson, J. S., K. E. Thompson, W. L. Forbes, G. C. Lamb, D. M. Grieger, and L. R. Corah. 2000. Synchronizing estrus and(or) ovulation in beef cows after combinations of GnRH, norgestomet, and prostaglandin F_2_ with or without timed insemination. J. Anim. Sci. 78:1747-1758.

Wishart, D. F. 1974. Synchronisation of oestrus in cattle using a potent progestin (SC21009) and PGF_2_. Theriogenology 1:87.

Wood, S. L., M. C. Lucy, M. F. Smith, and D. J. Patterson. 2001. Improved synchrony of estrus and ovulation with addition of GnRH to a melengestrol acetate-prostaglandin F_2_ estrous synchronization treatment in beef heifers. J. Anim. Sci. 79:2210.