Animal Sciences

EXPERT REVIEWED

Timed-Artificial Insemination in Beef Cows:
What are the Options?

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Overview

As research on the reproductive physiology and endocrinology surrounding the estrous cycle in beef cattle has been compiled, several estrous synchronization programs have been developed for use with beef heifers and cows. These include several programs that facilitate the mass breeding of all animals at a predetermined time (timed-AI) rather than the detection of estrus.

Timed artificial insemination (timed-AI) programs are often advantageous to the beef producer because they reduce the time and labor required for the detection of estrus and allow all animals to be managed in groups rather than individually. Given these advantages of timed-AI, a wide variety of effective timed-AI programs have been developed for beef cows. No one program is "perfect" for every beef producer, thus the goal is to find the right program for your operation.

Numerous factors such as the proportion of animals that are anestrus prior to breeding, the amount of time and labor available, and various management practices can dictate which timed-AI program is best suited for a given beef operation.

This publication will summarize most of the timed-AI programs available, provide advantages and disadvantages of each, and give some insight into expected outcomes when these programs are used in reproductively competent and properly managed beef cows.

Basics to a Timed-AI Program

Unlike programs designed to synchronize the expression of behavioral estrus into a three to seven day period, timed-AI programs are designed to synchronize ovulation among a group of animals that are often in various stages of the estrous cycle at the initiation of the program. Therefore, timed-AI programs were designed to: 1) control follicular wave dynamics, 2) induce regression of the corpus luteum (CL), and 3) induce the ovulation of a dominant follicle. To accomplish this, most timed-AI programs utilize the sequential administration of gonadotropin-releasing hormone (GnRH-1), prostaglandin $F_{2\alpha}$ (PGF), and a second administration of GnRH (GnRH-2). Administration of GnRH-1 induces ovulation or luteinization of the dominant follicle that standardizes follicular wave emergence and follicular growth patterns in the majority of animals treated thus resulting in a dominant follicle to be present on the ovary at the time of GnRH-2 administration.

In a proportion of anestrous cows, the resultant CL following GnRH-induced ovulation provides progesterone exposure that can cause a proportion of anestrous cows to initiate estrous cycles. It must be noted, however, that the day of the estrous cycle when GnRH is administered impacts its effectiveness and hence GnRH is not 100 percent effective in standardizing follicular growth in all cows. Five to seven days following GnRH-1 administration, PGF is given to induce regression of the CL and eliminate circulating concentration of progesterone. Following CL regression, the GnRH-2 is administered to induce ovulation of the dominant follicle. In some programs, AI is performed at GnRH-2 administration, while in others AI is postponed for 8 to 16 hours following GnRH administration.

Many timed-AI programs have been adapted to include the use of a progestin (progesterone) source, such as melengestrol acetate (MGA®; synthetic progesterone) or an intravaginal progesterone-releasing insert (CIDR; natural progesterone), either prior to the initial GnRH administration or between the initial GnRH administration and PGF. Given that GnRH administration is not 100 percent effective in all animals, the inclusion of a progestin source in a timed-AI program ensures that the cattle will be exposed to a progestin during the synchronization program.

Exogenous progestin exposure has been demonstrated to induce estrous cycles in previously anestrous cattle and to ensure that the estrous cycle following ovulation and AI will be of normal duration (~21 days) and not a short-cycle (~10 days). The inclusion of a progestin between GnRH and PGF also prevents premature expression of estrus and ovulation prior to, or immediately following (24 hours) PGF administration.

Table 1 lists hormones, including their commercial names, available for use in estrous synchronization and timed-AI programs.

Table 1. Commonly used hormones in estrous synchronization and their trade names[a].

Hormone (Abbreviation)		Commercial Products[b]
Gonadotropin Hormone Releasing Hormone (GnRH)		Cystorelin®, Factrel®, Fertagyl®, OvaCyst®
Progestins		
Progesterone		CIDR®, Intravaginal progesterone-releasing insert
Synthetic progestin		Melengestrol acetate (MGA®), Orally-active feed additive
Prostaglandin $F_{2\alpha}$ (PGF)		Lutalyse®, Estrumate®, ProstaMate®, estroPLAN™, In-Synch™

[a] Table adapted from M.L. Day and D.E. Grum, The Ohio State University

[b] The commercial products often do not have the same chemical composition as the hormone produced by the animal's body. In many cases, these compounds have similar effects on the reproductive system as the native hormone. Please read and follow label instructions when using these products.

Timed-AI Programs for Beef Cows

There are several timed-AI programs available for beef producers, each with advantages and disadvantages depending upon the management scenario. This section will outline the most commonly used timed-AI programs and provide recommendations regarding their use.

Table 2 summarizes timed-AI pregnancy rates achieved with each program from numerous cited publications to provide some insight into the expected outcomes for each program.

Table 2. Common timed-AI programs and pregnancy rates obtained in various cited reports[a].

Program		Time (h) of AI after PGF[b]	# Cows[c]	AI Preg Rate (%)[d]	Reference
7 day CO-Synch[e]		**48 h**			
		48	91	31	Stevenson et al., 2003
		48	178	44	Stevenson et al., 2003
		48	71	45	Martínez et al., 2002
		48	287	48	Lamb et al., 2001
		48	50	52	Martínez et al., 2002
		48	117	54	Geary et al., 2001
		48	92	61	Stevenson et al., 2003
	Total	**48 h**	**886**	**48%**	
		60–66 h			
		60	548	43	Larson et al., 2006
		66	323	66	Schafer et al., 2007
	Total	**60 – 66 h**	**871**	**52%**	
		72 h			
	Total	**72**	**112**	**47%**	Perry et al., 2002
7 day CO-Synch + CIDR[f]		**48 h**			
		48	77	43	Martínez et al., 2002
		48	136	44	Dobbins et al., 2006
		48	291	55	Stevenson et al., 2003
		48	273	59	Lamb et al., 2001
		48	95	66	Stevenson et al., 2003
	Total	**48 h**	**872**	**55%**	
		54–66 h			
		54	215	59	Busch et al., 2007
		56	157	63	Dobbins et al., 2006
		60	365	45	Kasimanickam et al., 2006
		60	181	48	Stevenson et al., 2003
		60	599	52	Kasimanickam et al., 2008
		60	111	53	Bridges et al., 2007
		60	539	54	Larson et al., 2006
		60	201	56	Bridges et al., 2007
		60	111	68	Bridges et al., 2007
		64	170	55	Dobbins et al., 2006
		66	219	64	Busch et al., 2007
	Total	**60-66 h**	**2868**	**54%**	
		72 h			
	Total	**72**	**142**	**51%**	Dobbins et al., 2006

Table 2. Common timed-AI programs and pregnancy rates obtained in various cited reports[a] *cont.*

Program	Time (h) of AI after PGF[b]	# Cows[c]	AI Preg Rate (%)[d]	Reference
7 day OvSynch + CIDR[g]	**64***			
	64*	369	49	Kasimanickam et al., 2006
	64*	1269	54	Kasimanickam et al., 2008
	64*	279	56	Kasimanickam et al., 2006
Total	**64***	**1917**	**53%**	
5 day CO-Synch + CIDR[h]	**60 h**			
Total	**60**	**112**	**57%**	Bridges et al., 2007
	72 h			
	72	199	65	Bridges et al., 2007
	72	128	69	Unpublished Results[§]
	72	282	70	Unpublished Results[£]
	72	105	80	Bridges et al., 2007
Total	**72 h**	**714**	**70%**	
MGA-Select[i]	**72 h**			
	72	327	61	Schafer et al., 2007
	72	115	61	Perry et al., 2002
	72	213	67	Bader et al., 2005
	72	108	69	Stegner et al., 2004
Total	**72 h**	**763**	**64%**	
7-11 Synch[j]	**60 h**			
	60	122	59	Kojima et al., 2003a
	60	209	61	Bader et al., 2005
	60	103	63	Kojima et al., 2003b
Total	**60 h**	**434**	**61%**	

[a] Studies reported were conducted in mature *Bos Taurus* cows of various ages, BCS, and cyclic status.

[b] Interval from PGF administration until GnRH and timed-AI, reported in hours (h).

[c] Number of cows in the experiment.

[d] Percentage (%) of cows that conceived to timed-AI.

[e] A schematic illustration of the 7 day CO-Synch program is provided in Figure 1.

[f] A schematic illustration of the 7 day CO-Synch + CIDR program is provided in Figure 2.

[g] A schematic illustration of the 7 day Ovsynch + CIDR program is provided in Figure 3.

* GnRH was administered 48 hours following PGF and AI occurred 16 hours following GnRH administration.

[h] A schematic illustration of the 5 day CO-Synch + CIDR program is provided in Figure 4.

[§] Data from the laboratory of M.L. Day, The Ohio State University
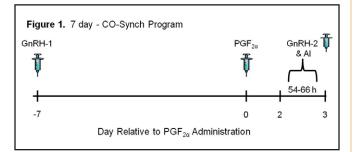
[£] Data from the laboratory of J.B. Hall, R. Kasimanickam, and W.D. Whittier, Virginia Polytechnic Institute and State University.

[i] A schematic illustration of the MGA-Select program is provided in Figure 5.

[j] A schematic illustration of the 7-11 Synch program is provided in Figure 6.

7 day CO-Synch

The 7 day CO-Synch program (Figure 1) is one of the simplest timed-AI programs to implement since it only requires animals to be handled three times. The 7 day CO-Synch program involves giving GnRH-1 on day -7, PGF on day 0, and GnRH-2 between days 2 and 3 concurrent with AI (Figure 1). This program was originally designed for timed-AI to occur 48 hours following PGF; however, as indicated in Table 2, subsequent research has demonstrated that conception rates are improved if timed-AI is performed between 54 and 66 hours following PGF administration. Timed-AI pregnancy rates (Table 2; 31 – 66%) with the CO-Synch program can vary considerably from herd to herd depending upon the proportion of cows that have resumed normal estrous cycles (cyclic cows) by the time of program initiation.
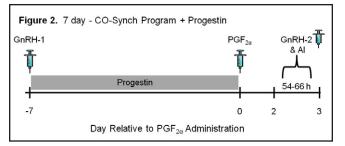

Figure 1. 7 day - CO-Synch Program

Due to the lack of an exogenous progestin source in this program, this program is most effective in cyclic cows rather than in cows that have not resumed normal estrous cycles following calving (anestrous cows). This program is recommended in herds where a high percentage of cows are cyclic, such as herds with a high proportion of mature cows ($\geq$ 3 years old) that are > 60 days postpartum (dpp) at the initiation of the synchronization program. It is not recommended for use in herds where cows are thin, or where a majority of the cows are less than 60 dpp at program initiation, since there is a higher probability that these females will be anestrus.

An additional disadvantage of the CO-Synch program is that a proportion (~10%) of cows will exhibit estrus and ovulate between days -1 and 1 and these animals will not conceive if strictly timed-AI is used. Producers who have the labor and facilities to accommodate estrus detection between days -2 and 1 can AI these cows that exhibit premature estrus.

7 day CO-Synch + Progestin

The 7 day CO-Synch + Progestin timed-AI program (Figure 2) is similar to the 7 day CO-Synch program, but includes the use of a progestin source

Figure 2. 7 day - CO-Synch Program + Progestin

between GnRH-1 administration (day -7) and PGF administration (day 0). Either MGA or a CIDR can be utilized as a progestin source, however it has been demonstrated that a CIDR is more effective than MGA. Furthermore, ensuring that every cow receives the appropriate dosage of MGA each day is often difficult. Hence, a CIDR is most commonly utilized and is recommended as the preferred progestin source for this timed-AI program.
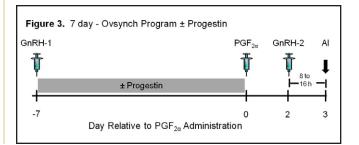
Inclusion of the CIDR ensures that all animals are exposed to progesterone prior to insemination and improves timed-AI pregnancy rates in anestrous cows compared to the 7 day CO-Synch program without a CIDR. The inclusion of a CIDR prevents the premature expression of estrus on days -1 to 1 which eliminates the need for estrus detection during that period.

Timed-AI pregnancy rates with the 7 day CO-Synch + CIDR program have ranged from 45 to 68 percent across the studies summarized in Table 2. The 7 day CO-Synch + CIDR program is recommended for use when the proportion of cyclic cows in the herd is not known, or expected to be low such as when the herd has numerous two-year-old cows, thin cows (BCS < 5), or cows that are less than 60 dpp.

7 day Ovsynch ± Progestin

A minor variation to the 7 day CO-Synch program is the 7 day Ovsynch ± Progestin (Figure 3) timed-AI program. In the Ovsynch program cattle are not inseminated at GnRH-2 administration on day two, but rather inseminated 8 to 16 hours following GnRH-2 administration.

Most commonly used in dairy herds, the Ovsynch program has been investigated in beef cattle and has
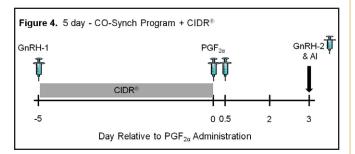

Figure 3. 7 day - Ovsynch Program ± Progestin

been demonstrated to increase timed-AI pregnancy rates by 2 to 8 percent compared to the 7 day CO-Synch program. One drawback of the Ovsynch program is that it requires handling cows an additional time between 8 and 16 hours following GnRH-2, which increases labor requirements and can increase handling stress on the cows.

For producers that have adequate labor and facilities to easily accommodate the additional animal handling, the Ovsynch program may be a practical alternative. As with the CO-Synch program, if cows are thin and/or being bred following a short postpartum interval, producers should consider including a progestin source, such as a CIDR between GnRH-1 and PGF injections.

5 day CO-Synch + CIDR

Modifications to the 7 day CO-Synch + CIDR program have been recently investigated to determine if timed-AI pregnancy rates could be improved. Although similar in design to the 7 day program, the 5 day CO-Synch + CIDR program (Figure 4) was demonstrated to be a more effective program for timed-AI in postpartum beef cows than the 7 day CO-Synch + CIDR program.

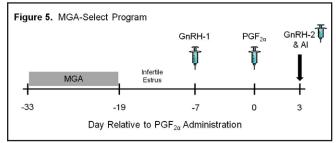Figure 4. 5 day - CO-Synch Program + CIDR®

In a comparison study, the 5 day CO-Synch + CIDR program increased timed-AI pregnancy rates in two-year-old and mature cows, as well as in anestrous and cyclic cows. The 5 day CO-Synch + CIDR involves administering GnRH-1 and a CIDR on day -5, removing the CIDR and giving PGF on day 0, administering a second injection of PGF approximately 12 hours after CIDR removal to ensure CL regression, and AI concurrent with GnRH-2 administration on day 3 (72 hours following the initial PGF injection).

In four studies conducted with the 5 day CO-Synch + CIDR program (Table 2) in beef cows, timed-AI pregnancy rates ranged from 65 percent to as high as 80 percent. One disadvantage of the 5 day CO-Synch + CIDR program is the necessity to administer two doses of PGF twelve hours apart. This requires an additional handling of the cows and the additional cost of a second dose of PGF.

Studies have demonstrated that the improvement in timed-AI pregnancy rates obtained with the 5 day CO-Synch + CIDR program compared to the 7 day CO-Synch + CIDR program are lost if only a single dose of PGF is administered at the time of CIDR removal. The 5 day CO-Synch + CIDR program is recommended for producers that have the capabilities to easily handle the cows an additional time. Moreover, the 5 day CO-Synch + CIDR program is effective in both young and mature cows, as well as anestrous and cyclic females. Studies are currently being conducted to investigate the efficacy of the 5 day CO-Synch program without the inclusion of a CIDR.

MGA- Select Program

The MGA-Select program utilizes a CO-Synch program proceeded by a period of progestin treatment (Figure 5). Beginning on day -33, MGA is fed for 14 days followed by GnRH-1 administration on day -7, PGF on day 0, and GnRH-2 concurrent with AI on day 3.
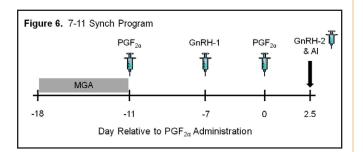

Figure 5. MGA-Select Program

Studies demonstrate that a 14 day CIDR treatment (CIDR-Select) is just as effective as feeding MGA during this period. With the CIDR-Select program, the interval from CIDR removal and GnRH-1 is reduced from 12 days (MGA-Select) to 9 days (CIDR-Select). However, the CIDR-Select program requires the cattle to be handled two additional times, for CIDR insertion and CIDR removal. The MGA-Select program has been demonstrated as an effective timed-AI protocol (Table 2, 61-69 percent timed-AI pregnancy rates); however, a disadvantage of this program is the duration of the protocol.

Given the limited time available between calving and the beginning of the breeding season in late calving cows, implementation of the MGA-Select program may not be practical. In early calving cows and first calf heifers that calved prior to the cow herd, the MGA-Select program is an effective system. Anestrous cows will benefit from the MGA-Select or

CIDR-Select program given that it utilizes a progestin source. In addition, the 14-day progestin feeding serves to "pre-synchronize" follicular growth patterns and can potentially improve the response to the initial GnRH on day -7.

7-11 Synch Program

Similar in design and advantages to the MGA-Select program, but shorter in duration, the 7-11 Synch program (Figure 6) is also an effective (Table 2; 59-63 percent timed-AI pregnancy rates) timed-AI program for beef producers. The 7-11 Synch program utilizes a seven-day progestin exposure period (MGA; fed from days -18 to -11) with PGF administration at the conclusion of the MGA feeding (day -11). GnRH-1 is then administered on day -7, PGF on day 0, and AI is concurrent with GnRH-2 on day 2.5 (60 hours following PGF).

Figure 6. 7-11 Synch Program

Although the 7-11 Synch program requires an additional working of cattle through the chute compared to the MGA-Select program, the reduced duration of the 7-11 Synch program allows for easier implementation in most herds. As with any program that utilizes MGA, ensuring that all cows receive the proper dosage each day can be challenging, especially in cattle not accustom to being fed a supplement.

Summary

There are several timed-AI programs available to beef producers who want to incorporate estrous synchronization and AI into their management practices, but do not have the time or labor required for estrus detection. No single timed-AI program is perfect for every producer and each program has both advantages and disadvantages. When selecting the best timed-AI program for your operation, consider the cost and availability of labor, as well as the animal feeding and handling facilities required to accomplish the program. Cow age, body condition, and the interval from calving to initiation of the timed-AI protocol should also be considered when selecting the appropriate timed-AI program since these parameters provide valuable insight into the proportion of

anestrous cows at the initiation of the synchronization program. If a large proportion of cows are expected to be anestrous prior to breeding, choosing a program that utilizes a progestin is recommended.

The best pregnancy rates occur in cattle that are properly managed. At the initiation of the synchronization program, cows should be in good body condition (BCS 5-6; 1 = thin, 9 = obese) and calved at least 30 days prior to starting the synchronization protocol. Cattle should be handled appropriately during the timed-AI program to reduce stress. The variety of timed-AI programs available allows producers the flexibility to incorporate estrous synchronization and AI into their herds, as well as the opportunity to take advantage of both the genetic improvements and economic benefits that can be realized from estrous synchronization and AI.

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