

Optimizing Reproductive Performance through Fixed-Time Artificial Insemination

Saurabh Nistane^{1*}, Dipan Rudra Paul¹, Sagnik Das²,
Diksha Upreti¹, Pratyanshu Srivastava¹

¹Division of Animal Reproduction, ICAR-Indian Veterinary
Research Institute Izatnagar, Bareilly-243122, Uttar Pradesh, India

²Central Avian Research Institute, Izatnagar, Bareilly-243122,
Uttar Pradesh, India

*Corresponding author Email: saurabhni99@rediffmail.com
doi.org/10.5281/VeterinaryToday.22819558

Abstract

Fixed-Time Artificial Insemination (FTAI) is an effective reproductive management technique that facilitates scheduled insemination without relying on accurate estrus detection. It uses hormonal synchronization protocols involving prostaglandin (PGF₂α), progesterone, gonadotropin-releasing hormone (GnRH), or their combinations to synchronize follicular development, luteolysis, estrus, and ovulation. Common protocols include prostaglandin-based, progesterone/CIDR-based, Ovsynch, Cosynch, Presynch, and CIDR-PGF₂α protocols. The success of FTAI depends on appropriate protocol selection, insemination timing, semen quality, reproductive health, body condition, nutrition, environmental conditions, and skilled AI technique. Seasonal variation and heat stress may also influence conception rates. Properly adapted FTAI programs can improve reproductive efficiency, reduce dependence on estrus detection, and facilitate better herd management. Protocol selection should consider breed, season, health, nutrition, and economic conditions.

Keywords: Fixed time AI, Ovsynch, Cosynch, Presynch, Estrous

Introduction

Fixed-Time Artificial Insemination (FTAI) has emerged as an important reproductive management strategy that has significantly improved the efficiency of herd breeding programs. Unlike conventional artificial insemination, which depends heavily on accurate detection of estrus or heat, FTAI uses a predetermined hormonal synchronization protocol to control the reproductive cycle of animals and facilitate insemination at a scheduled time (Monteiro et al., 2023). The technique enables the synchronization of estrus in a large number of cows, allowing farmers to determine both the number of animals to be inseminated and the most appropriate time for insemination, including the desired season, month, and day (Gutiérrez-

Añez et al., 2022). Estrus synchronization has now become a standard component of reproductive management in dairy cattle.

Detecting estrus within a herd remains a major challenge for farmers. Increasing herd size, mechanization, high milk production, prolonged postpartum anestrus, and reproductive disorders are major factors reducing estrus detection efficiency in dairy cattle. Additional challenges include silent heat, lameness, heat stress, poor nutrition, and inadequate housing conditions. Consequently, missed or inaccurately detected estrus can lead to delayed insemination, increased calving intervals, reduced reproductive efficiency, and significant economic losses. By inducing estrus and ovulation at a

predetermined time, the technique facilitates the efficient scheduling of artificial insemination (AI) and improves the overall management of herd reproduction.

FTAI-Based Estrus Synchronization Protocols:

1. By shortening Luteal phase duration using PGF_{2α}: Luteolytic agents, particularly PGF_{2α} and its analogues, promote regression of the corpus luteum (CL), thereby synchronizing estrus and ovulation. This method shortens the lifespan of the CL and promotes its timely regression. Their efficacy varies with the developmental stage of the CL. Combining progesterone with luteolytic agents further enhances synchronization by suppressing estrus until progesterone withdrawal.

2. By extending Luteal phase duration using progesterone: Progesterone treatment suppresses the release of luteinizing hormone (LH) and follicle-stimulating hormone (FSH), which play crucial roles in follicular growth and ovulation and supports natural regression of the corpus luteum. Following progesterone withdrawal, follicular development, estrus, and ovulation generally occur within 2–8 days. The duration of treatment is typically 10 days or more, depending on the species and protocol.

Prostaglandin-based protocols: Prostaglandin can be administered either as a single injection or as two injections given 11–14 days apart (Barile, 2012; Colazo & Mapletoft, 2014). In the single-shot method, PGF_{2α} is administered only once to cows with an active CL (5–17 days of estrous cycle), inducing estrus within 2–3 days (Pal & Dar, 2020; Jeyakumar et al., 2022). In the two-shot method, two PGF_{2α} injections are given 11 days apart. The first induces luteolysis, while the second ensures complete CL regression. AI is generally performed 48–72 hours after the second injection (Drugociu et al., 2019).

Progesterone-based protocols: Here, controlled intravaginal drug releasing

(CIDR) device inserted intravaginally for 10–12 days to mimic corpus luteum function. On removal of the CIDR promotes estrus, while concurrent PGF_{2α} administration induces luteolysis and accelerates onset of estrus. Following synchronization, AI is carried out at a predetermined time.

GnRH based protocols:

Ovysynch: The Ovysynch protocol starts with first GnRH injection randomly during estrous cycle, followed by PGF_{2α} seven days later and a second GnRH after two days (Fig. 1). Fixed-time AI is performed at 16–24 hours later. The first GnRH injection stimulates the development of a new follicle, induces ovulation and CL formation. PGF_{2α} on 7th day cause luteolysis and terminates the current estrous cycle. On day 9, GnRH induces ovulation of new follicle.

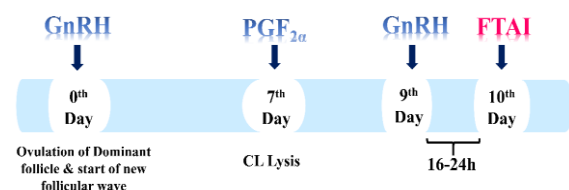


Figure 1: Ovysynch protocol

Cosynch: The protocol involves administering GnRH on Day 0, prostaglandin on Day 7, and a second GnRH injection on Day 9 (Fig. 2), followed by timed artificial insemination on same day which reduces the time required for heat detection.

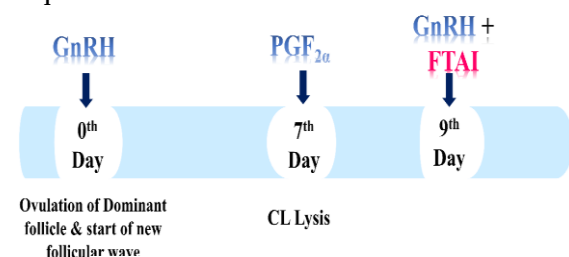


Figure 2: Cosynch protocol

Presynch: Here, there is combination of two PGF_{2α} injections with a GnRH-based protocol. 2 PGF_{2α} injections are administered 14 days apart, followed 12–14 days later by Ovysynch, Co-Synch, or

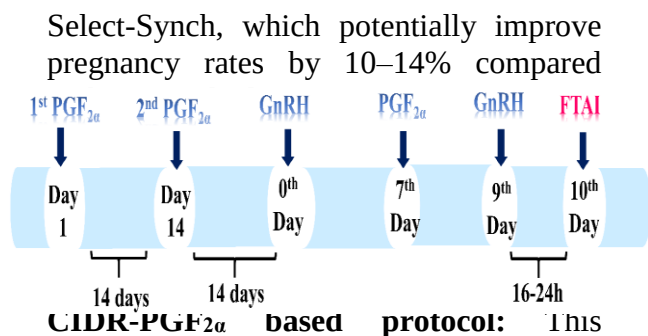


Figure 3: Presynch protocol

protocol reduces reliance on heat detection, regulates follicular development, and enables efficient fixed-time AI, particularly in anestrus or irregularly cycling cows.

Day 0: Insert a CIDR intravaginally containing 1.38 g of progesterone.

Day 5: Administer 25 mg of PGF_{2α} (dinoprost) intramuscularly.

Day 14: Removal of CIDR and administration of another 25 mg dose of PGF_{2α} intramuscularly.

Day 30: Administer the final 25 mg dose of PGF_{2α} intramuscularly.

Days 30–33: Monitor for heat (estrus) within 72 hours of the final PGF_{2α} injection.

Days 33–34: Perform timed artificial insemination (TAI) at the scheduled time.

management. Important factors include the effectiveness of hormonal protocols, the expertise of the inseminator, the animal's reproductive health, adequate nutrition, favorable environmental conditions, and minimizing stress during the breeding period.

Reproductive management: Effective reproductive management, including balanced nutrition, proper health care, and regular observation of estrus signs, plays an important role in improving the success of FTAI (Cardoso Consentini et al., 2021). Maintaining an appropriate body condition score (BCS) is also closely associated with better reproductive performance and higher pregnancy rates.

Semen quality, AI technique, and

genetic factors: High-quality semen from genetically superior, fertile bulls enhances AI success, while genetic factors related to fertility and reproductive traits influence conception rates and the overall effectiveness of FTAI (Anzar et al., 2003).

Estrous synchronization protocols: The effectiveness of synchronization largely depends on selecting an appropriate hormonal protocol and ensuring accurate dosage, timing, and proper administration of the hormones.

Timing in FTAI: Insemination is generally performed 48–72 hours after progesterone withdrawal or prostaglandin administration, coinciding with expected ovulation. This timing ensures sperm availability during the fertile window

insemination (FTAI) offers considerable potential for improving reproductive efficiency; however, its effectiveness varies among breeds and across different seasons. Before implementing FTAI, the synchronization protocol and management practices should be adjusted according to the **season, nutritional and health status, breed, and economic conditions** of the herd to achieve better reproductive and financial outcomes.

References:

Anzar, M., Farooq, U., Mirza, M. A., Shahab, M., & Ahmad, N. (2003). Factors affecting the efficiency of artificial insemination in cattle and buffalo in Punjab, Pakistan. Pakistan Veterinary

- Journal, 23(3), 106-113.
- Barile, V. L. (2012). Technologies related with the artificial insemination in buffalo. *Journal of Buffalo Science*, 1(2).
- Baruselli, P. S., Carvalho, N. A. T., Gimenes, L. U., & Crepaldi, G. A. (2010). Fixed-time artificial insemination in buffalo. *Italian Journal of Animal Science*, 6(2s), 107-118.
- Bhakat, M., Maiti, S., Mohanty, T., Mondal, G., & Baithalu, R. (2021). Impact of climate change on dairy production. *Clim Resil Anim Husb*, 104, 104-23.
- Cardoso Consentini, C. E., Wiltbank, M. C., & Sartori, R. (2021). Factors that optimize reproductive efficiency in dairy herds with an emphasis on timed artificial insemination programs. *Animals*, 11(2), 301.
- Colazo, M. G., & Mapletoft, R. J. (2014). A review of current timed-AI (TAI) programs for beef and dairy cattle. *The Canadian Veterinary Journal*, 55(8), 772.
- DRUGOCIU, D., ROȘCA, P., & CIORNEI, Ș. (2019). Induction of estrus in buffalo by luteolysis management (single PGF and dual administration). *Lucrari Stiintifice: Seria Medicina Veterinara*, 62(4), 442.
- Gutiérrez-Añez, J. C., Camacho de Gutiérrez, A., & Nava-Trujillo, H. (2022). Application of fixed-time artificial insemination in water buffaloes. In *Biotechnological applications in buffalo research* (pp. 295-318). Singapore: Springer Singapore.
- Haider, M. S., Hassan, M., Khan, A. S., Husnain, A., Bilal, M., Pursley, J. R., & Ahmad, N. (2015). Effect of timing of insemination after CIDR removal with or without GnRH on pregnancy rates in Nili-Ravi buffalo. *Animal reproduction science*, 163, 24-29.
- Jeyakumar, S., Balasubramanian, S., Vedamurthy, G. V., Lavanya, M., Chethan, H. S., Kumaresan, A., & Ramesha, K. P. (2022). Advances in estrous synchronization and timed breeding programs for fertility enhancement in cattle and buffaloes. In *Current concepts in bovine reproduction* (pp. 119-167). Singapore: Springer Nature Singapore.
- Monteiro, P. L., Consentini, C. E. C., Andrade, J. P. N., Beard, A. D., Garcia-Guerra, A., Sartori, R., & Wiltbank, M. C. (2023). Research on timed AI in beef cattle: Past, present and future, a 27-year perspective. *Theriogenology*, 211, 161-171.
- Pal, P., & Dar, M. R. (2020). Induction and synchronization of estrus. In *Animal Reproduction in Veterinary Medicine*. IntechOpen.