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Economic significance of fixed-timed artificial insemination in buffalo

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Abstract

This review examines the economic significance of Fixed-Time Artificial Insemination (FTAI) in buffalo, highlighting its role in enhancing reproductive efficiency, genetic improvement, and overall farm profitability. FTAI enables synchronized breeding, resulting in increased calving rates and shorter intervals between calvings, which optimizes herd productivity. The use of superior genetics through high-quality semen contributes to improved traits such as milk production and disease resistance, fostering faster genetic progress and greater genetic diversity within herds. Additionally, FTAI offers cost-effective solutions by reducing the need for bull maintenance and labor associated with natural breeding methods. The adoption of FTAI enhances market competitiveness by producing higher quality livestock that meet consumer demands. Furthermore, it mitigates risks related to disease transmission and provides predictability in breeding outcomes. Despite challenges such as initial investment costs and variability in conception rates, the long-term economic benefits of FTAI are significant. This review underscores the importance of education and continuous improvement in FTAI practices to maximize its economic impact on buffalo farming and contribute to sustainable livestock production systems.

Keywords: Fix-timed artificial insemination, estrus, buffalo economic significancy

Introduction

Fixed-Timed Artificial Insemination (FTAI) has emerged as a pivotal reproductive technology in the livestock industry, particularly in buffalo farming. This method allows for the synchronization of estrus cycles, enabling farmers to breed their animals at a predetermined time without the need for heat detection. The economic significance of FTAI in buffalo is multifaceted, impacting productivity, profitability, and genetic improvement.

Nowadays, the fixed time artificial insemination may be utilized throughout the year, in order to schedule efficiently the conception and the calving period. Improvement of the FTAI protocol by incorporating ultrasound scanning and intracornual AI was performed to reduce waste and maximize the effectiveness of the OvSynch hormone therapy. The efficiency of the ovarian response was achieved through a careful gynecological selection of female heifers and bio-stimulation with bulls (Stefan Gregore, 2023) ^[17].

Buffalo has a significant role in the agricultural economy of many developing countries by providing milk, meat and draught power. The buffalos can utilize poorer quality roughages, adapt to harsher environments and are more resistant to several bovine tropical diseases. Despite these merits, buffalo have relatively poor reproductive efficiency irrespective of their location throughout the world. Buffalo exhibit many of the known reproductive disorders including delayed onset of puberty, poor oestrus expression, longer postpartum ovarian quiescence, and most importantly lowered conception rates particularly when bred artificially (Warriach *et al.*, 2015) ^[18].

Assisted reproduction can be considered an enabling technology that allows the livestock industries to achieve faster rates of genetic gain by making greater use of individual males and females with commercially important traits.

Buffalo is a multipurpose domestic animal has extraordinary capacity utilization of less digestible feeds (straw, sugar cane wastes, crop residues etc.) helps the livelihood of people by providing excellent quality food milk and meat. Buffaloes are economically and culturally important livestock species especially in developing countries (Hagos and Mokhtar, 2015) ^[19].

The water buffalo is the second most important species in the world in terms of milk production, after dairy cows (Coroian *et al.*, 2013) ^[20] and good source of milk and meat in all over the world. Comparing to cow, buffalo milk is higher in protein, fat, lactose and energy.

The Ovsynch protocol effectively synchronized estrus in indigenous river type buffaloes with a reasonable conception rates after FTAI. Estrus synchronization and FTAI could be applied for effective breeding program of buffalo in Bangladesh, though further studies are needed to increase the conception rate. (Rabidas, Susanto and Gofur, Md (2017) ^[24].

Hormonal Protocols

Hormonal synchronization of estrus and AI technologies are crucial reproductive technologies for buffalo propagation. The reproductive biotechnology- AI has had such a massive and significant impact on herds' genetic progress and technological transformation. But its widespread use in the dairy industry and water buffalo industry remains limited due to unique characteristics and differences in buffalo reproductive biology.

Study of different hormonal treatments (GnRH, PGF2 α , progesterone) used to synchronize estrus in buffalo. Synchronizing estrus and ovulation in buffalo using timed inseminations (TAI) protocols circumvents the limitations associated with estrus detection. Spontaneous estrus in buffalo may achieve more conception rate on insemination than those subjected to synchronization of estrus and timed insemination (TAI). The advantages of insemination following synchronization programs include higher detection rates combined with decreased embryonic losses and reduction in days open. A synchronization programme should ensure control of estrus cycle which entirely depends on ovarian status of animals before starting any protocol.

Estrus induction protocols using various hormones such as gonadotropin-releasing hormone (GnRH), progesterone (CIDR, Crestar), estradiol, pregnant mare serum gonadotropin (PMSG), and prostaglandins associated with fixed-time artificial insemination (FTAI) have been tried for the treatment of anestrus with variable success rates. (L Kumar, 2016) ^[12]

Estrus synchronization in buffaloes

Satisfactory results have been achieved when estrus cycles were synchronised on the basis of manipulation of ovarian activity and prediction of time of ovulation in cattle. Such manipulation and prediction could be possible by controlling the estrus cycle in buffaloes which has already been reviewed by previous studies (Perera, 2011) ^[14]. The estrus cycle may be controlled by either controlling the luteal phase or follicular phase such as follicular development and ovulation

The cycle duration of estrus ranges from 16 to 33 days, with the highest concentration between 21 and 24 days. Water buffalo have a shorter duration of heat only 8 to 32 hours compared to cattle, with less pronounced heat symptoms (Drost, 2007) ^[7]. The buffalo even exhibit nocturnal sexual behavior, with little or rare homosexual activity and slight mucus discharge, making it difficult to identify females in heat. This results in a high silent ovulation rate (Perera, 2008) ^[13]. A secondary estrus sign, tail curling when exerting pressure on the pelvic area, is present in this species, which could be used in heat detection programs.

Buffaloes are short-daylight seasonal polyestrous animals, but can reproduce throughout the year under certain conditions (Perera, 2011) ^[14]. Factors such as rainfall and availability of forage influence the cyclical reproductive pattern

Economic Benefits

Increased Reproductive Efficiency: FTAI enhances the reproductive efficiency of buffalo by reducing the time and labor associated with estrus detection. Studies have shown that FTAI can lead to higher conception rates and shorter calving intervals. This efficiency translates into more calves produced per breeding season, directly influencing milk and meat production (Praveen *et al.*, 2024) ^[23].

The Fixed-Time Artificial Insemination (FTAI) is advantages to the buffalo breeders because it reduces the time and labor for detection of estrus and can introduce the superior genes from bull. This technique was introduced in Philippines in 2017 (Atabay *et al.*, 2017) ^[1], which greatly improve the artificial insemination efficiency and conception in buffalo.

Cost-Effectiveness: By streamlining the breeding process, FTAI reduces costs related to labor and management. Farmers can allocate resources more effectively, leading to overall cost savings. According to Singh *et al.* (2019) ^[6], the implementation of FTAI in buffalo herds resulted in a significant reduction in breeding costs compared to traditional methods.

Genetic Improvement: FTAI facilitates the use of superior genetics by allowing the introduction of high-quality semen from genetically elite bulls. This practice can enhance milk yield and disease resistance in subsequent generations, providing long-term economic benefits (Kumar *et al.*, 2019) ^[6]. The ability to access a wider genetic pool contributes to overall herd improvement.

Market Competitiveness: As global demand for dairy products increases, farmers utilizing FTAI can improve their competitiveness in the market. Enhanced productivity leads to higher output, enabling farmers to meet market demands more effectively (Ranjan *et al.*, 2021) ^[25]. This is particularly important in regions where buffalo farming is a significant economic activity.

Risk Mitigation: FTAI can help mitigate risks associated with reproductive failures and seasonal breeding challenges. By ensuring more predictable breeding outcomes, farmers can stabilize their production cycles and financial planning (Patel *et al.*, 2022) ^[26].

Challenges and Considerations While FTAI presents numerous economic advantages, challenges remain. The initial investment in training, technology, and veterinary services can be significant. Additionally, successful implementation requires careful management of nutrition and health to ensure optimal reproductive performance (Singh *et al.*, 2019) ^[6]

Discussion of the Review

The economic significance of Fixed-Time Artificial Insemination (FTAI) in buffalo is a multifaceted topic that

encompasses various aspects of livestock production, reproductive efficiency, and economic viability.

- 1. Increased Reproductive Efficiency:** FTAI allows for the synchronization of estrus in buffalo, enabling multiple animals to be inseminated within a short time frame. This increases the efficiency of breeding programs by reducing the time between calving intervals, which can lead to Higher Calving Rates.
- 2. Genetic Improvement:** FTAI facilitates the use of superior genetics through the introduction of high-quality semen from selected bulls. This can lead to: Enhanced Genetic Diversity: Access to a broader genetic pool, which is particularly beneficial in improving traits such as milk production, growth rates, and disease resistance and Faster Genetic Progress: The ability to rapidly disseminate desirable traits throughout the herd.
- 3. Cost-Effectiveness:** While FTAI may involve initial costs related to hormone treatments and training of personnel, the long-term economic benefits often outweigh these costs include: Reduced Need for Bull Maintenance: Fewer bulls are needed on farms, leading to savings on feed, housing, and veterinary care.
- 4. Market Competitiveness:** Farmers who adopt FTAI can improve their market position by Producing Higher Quality Offspring: Enhanced genetic traits can lead to better-quality meat and milk, making products more competitive in the market and Meeting Consumer Demand: Ability to produce livestock that meet specific market demands for quality and consistency.
- 5. Risk Mitigation:** FTAI can help mitigate risks associated with breeding programs like: Disease Control: Reducing the need for bulls can lower the risk of sexually transmitted diseases within the herd and Predictability in Breeding Outcomes: Synchronization protocols allow for better planning and management of breeding schedules.
- 6. Sustainability and Environmental Impact:** Adopting FTAI can contribute to sustainable farming practices: Efficient Resource Use: Better reproductive performance can lead to more efficient use of land, feed, and water resources. and Lower Carbon Footprint: Increased productivity per animal can contribute to reduced greenhouse gas emissions per unit of output.
- 7. Challenges and Considerations:** Despite its benefits, there are challenges that can affect the economic viability of FTAI: Initial Investment: The cost of training personnel and acquiring the necessary equipment for hormone treatment and insemination.

Conclusion

The economic significance of Fixed-Time Artificial Insemination in buffalo is substantial, offering numerous benefits in terms of reproductive efficiency, genetic improvement, cost-effectiveness, market competitiveness, risk mitigation, and sustainability. While challenges exist, effective implementation and management of FTAI programs can lead to increased profitability for buffalo farmers and contribute positively to the overall livestock industry. Continuous research and development in this area will further enhance its economic impact and adoption among farmers

Implementing reproductive control programs, including FTAI programs, is crucial for reducing non-productive days,

increasing productivity efficiency, accelerating genetic progress, and increasing profitability. Basic knowledge on buffalo reproductive physiology and recognizing these factors can enhance the good outcomes. As advancements in reproductive technologies continue, these methods stands out as a valuable tool for buffalo farmers seeking to optimize breeding outcomes and contribute to sustainable and profitable livestock production.

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