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Artificial Insemination in Goats using Frozen Semen at an Organized Farm in the Temperate Himalayan Region of Jammu and Kashmir

Research Article

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ABSTRACT

This study aims to investigate the impact of modern management practices on reproduction and pregnancy in crossbred dairy goats (Boer×Local). The goats were maintained at the Mountain Research Centre for Sheep and Goats at the State Agricultural University to develop a dairy goat breed suitable for the climatic conditions and local needs. This research focuses on the effects of estrous synchronization and artificial insemination (AI) on pregnancy rates. In this study, 20 female goats were divided into two groups. Group I was treated with cloprostenol (125 µg) for estrous synchronization, and estrous signs were observed over the course of one week. In Group II, a buck goat was used as a biological stimulator for estrous detection and synchronization (buck effect). Estrous signs were recorded. For AI, frozen semen was obtained from the Maharashtra Goat and Sheep Research and Development Institute in India. Insemination was performed twice at 12 h intervals, and only semen with over 60% progressive motility was used. Pregnancy detection was conducted using ultrasonography and kidding records. Pregnancy was confirmed via transabdominal ultrasound on day 25 post-mating, and goats were re-examined on day 60 of pregnancy to check for fetal viability. The results indicated that estrous synchronization and AI significantly affected pregnancy rates and reproductive quality. This research will assist farmers and researchers in improving management practices in dairy goat reproduction and emphasizes the necessity of employing scientific and modern techniques in the livestock industry.

KEY WORDS artificial Insemination, buck effect, goat, pregnancy rate, synchronization.

INTRODUCTION

India's goat population has reached 148.88 million, reflecting a 10.1% increase since the previous census, according to the 20th Livestock Census conducted by the Ministry of Animal Husbandry and Dairy of India. This significant growth highlights a rising inclination towards goat farming, likely due to their lower resource requirements-such as minimal land, fodder, and labor-compared to larger livestock. Goats have gained prominence in livestock farming because of their economic value, high reproductive rates, short generation intervals, and adaptability to diverse climatic conditions (Aggarwal *et al.* 2022). The 12th Livestock Census of India indicates that there are 71 million breeding-ready female goats and 17 million male goats. Under natural conditions, a single male goat can mate with 50 females annually. However, advancements in artificial insemination (AI) using frozen semen can significantly enhance this capacity, enabling the insemination of up to 3,000 females per year. As a result, while natural breeding requires 1.5 to 2 million males to cover the breeding-ready females, AI reduces this need to only 50000 males (Ranjan *et al*. 2020; Ranjan *et al*. 2025). Despite this potential, the goat-rearing sector faces challenges, including a high percentage of non-descriptive and non-breeding goats (67% nationally) and limited use of scientific breeding techniques. Addressing these issues is crucial for enhancing goat productivity, particularly in milk production (Ranjan *et al*. 2020; Dubeuf *et al*. 2023).

AI plays a pivotal role in national goat breeding programs. Despite its high demand, its application remains limited due to challenges such as the lack of standardized methods for sperm processing, effective freezing protocols, and efficient sperm transfer techniques into the female reproductive system (Wildeus, 2000). In intensive production systems, AI offers a reliable means for genetic improvement and reproduction control. This technique accelerates genetic advancements by identifying superior male goats early and disseminating their genes more widely. It also enables better management of goat populations by synchronizing estrus and ovulation cycles and allowing breeding outside traditional seasons. AI minimizes disease transmission risks and facilitates the storage and transport of genetic material through frozen semen. This approach supports the exchange of improved genotypes without health risks (Leethongdee and Ponglowhapan, 2014).

Using frozen semen in AI ensures the long-term preservation of valuable genetic material, even after an animal's death. This method allows the distribution of high-quality semen to distant farms without compromising its quality. However, pregnancy rates with frozen semen are generally lower than with fresh semen. While fresh semen yields pregnancy rates of 65-70%, occasionally reaching up to 80%, frozen semen typically achieves rates of 20-40% (Galián *et al*. 2023). The freezing and thawing process often damages sperm cells, resulting in significantly reduced quality and quantity of viable sperm (Thiangthientham *et al*. 2023).

Environmental factors such as nutrition, health status, temperature, and humidity significantly influence the reproductive activity of small ruminants (Barbas *et al*. 2024). Hormonal interventions using progestogens and gonadotropins during non-breeding seasons have also been effective in enhancing productivity and optimizing flock management (Abecia *et al*. 2012).

Estrus synchronization is a technique that aligns the estrous cycles of a group of female animals through the administration of exogenous hormones and complementary methods, resulting in synchronized ovulation. This approach is widely used in goat and sheep flock management to enhance productivity, shorten generation intervals, and facilitate genetic improvements. Estrus synchronization is essential in programs involving timed mating, AI, oocyte recovery, and embryo transfer (Habeeb and Kutzler, 2021). It serves as a foundation for employing advanced reproductive technologies, enabling faster genetic progress by increasing the offspring of genetically superior animals. Synchronization of follicular waves is particularly critical in achieving high pregnancy rates in AI and multiple ovulation and embryo transfer (MOET) programs (Doğan *et al*. 2024).

Various methods are available for synchronizing estrous cycles, including manipulation of the luteal or follicular phases. Hormones such as progestogens, prostaglandins (PG), equine chorionic gonadotropin (eCG), and gonadotropin-releasing hormone (GnRH) are commonly employed (Ranjan *et al*. 2025). Estrus synchronization offers several advantages, including reduced generation intervals, improved reproductive efficiency, and higher pregnancy rates in AI and embryo transfer programs. Additionally, the use of PGs, which induce luteolysis of the corpus luteum and shorten the luteal phase, can reduce drug residues in animal tissues (Evans *et al*. 2004). Synthetic PG analogs have shown higher efficacy (Jiang *et al*. 2023). However, these methods require precise management and expertise, and their application can involve risks such as the development of follicular cysts or other health issues associated with hormone use (Penna *et al*. 2013). Additionally, the "buck effect," where exposure to a sexually active male induces estrus in females outside the breeding season, can enhance synchronization outcomes (Lukanina *et al*. 2023; Dea *et al*. 2024). The presence of an active buck during synchronization programs has been shown to improve results (Cosentino *et al*. 2022).

With the anticipated growth in the global human population and the corresponding demand for increased milk and meat production, assisted reproductive technologies, including estrus synchronization, have become increasingly vital in goat reproductive management. These technologies offer viable solutions to improve productivity and address reproductive constraints, thereby meeting the growing population's needs. This study aims to standardize the AI process in indigenous and crossbred goats using frozen-thawed sperm.

MATERIALS AND METHODS

Animals and their management

Cross-bred does (Boer×Local) were used in the study. The animals were maintained at the Mountain Research Centre on Sheep and Goat of the State Agriculture University to develop a milch goat breed, considering the huge demand from local people (orchardists, small and marginal farmers, landless nomadic population, and urban residents) for a dairy goat breed adapted to the agro-climatic conditions of the region. The animals were reared semi-intensively and housed in a collective pen, fed a mix of maize and bran (200-300 g per animal), and dehydrated alfalfa, barley/paddy hay, or any other seasonal fodder. A mineral mixture and water were provided *ad libitum*, along with vaccination and deworming as per the farm schedule.

Oestrous synchronization and breeding

Twenty cross-bred does were divided into two groups (I and II), each consisting of 10 animals. Group I was synchronized using cloprostenol at a dose of 125 µg and was monitored for signs of oestrus for up to a week. An apronized buck was introduced to Group II during the oestrus cycle, serving as both a biological stimulator for oestrous induction/synchronization and for detection.

Oestrus was established based on: i) scoring of oestrus signs, ii) reaction of the apronized buck, and iii) per-vaginal examination. Scoring was employed for various oestrus signs typically observed in goats, which was further confirmed by the apronized buck and through per-vaginal examination using a speculum to locate the open Os Cervix and assess the coloration and mucus around the Os Cervix.

Artificial insemination

Frozen semen was procured from the Maharashtra Goat and Sheep Research and Development Institute in India. The straws were stored in liquid nitrogen at the research center until further use. After detecting oestrus, AI was performed twice at 12 h intervals (~24 and 36 h after the onset of oestrus) to improve the chances of conception. The straws were dry-thawed, and only those that demonstrated over 60% progressive motility were used for insemination.

Pregnancy detection

Conception for the first, second, and third services was confirmed through non-return rates, ultrasonography, and kidding records. Pregnancy was verified by transabdominal ultrasound scanning on day 25 after mating, using a real-time portable B scanner equipped with a 5.0–7.5 MHz linear array transducer. The goats were considered pregnant when an embryonic heartbeat was detected. Subsequently, the goats were re-examined to check fetal viability at 60 days of pregnancy. Finally, after parturition, the kidding rate and prolificacy were recorded.

RESULTS AND DISCUSSION

Estrus synchronization

All goats in Group I exhibited signs of estrus within 72 h after the administration of cloprostenol. The estrus synchronization after a single injection indicated that these animals were in the luteal phase of their cycle. Goats in Group II showed signs of estrus within a week, which could be attributed to biological stimuli or the presence of a buck equipped with a harness. The presence of a buck goat after a period of separation is beneficial for inducing and synchronizing estrus during the breeding season without additional treatments.

Estrus detection

Behavioral signs of estrus in goats were not prominent, with only behaviors such as mounting and restlessness observed (Table 1). Tail movements and vocalizations were somewhat useful for detecting estrus. Goats in temperate climatic conditions are recognized as cautious animals and do not exhibit estrus signs as clearly as goats from other regions. Since mounting alone is not a reliable indicator of estrus in goats, estrus synchronization and the use of vasectomized or harnessed bucks in the herd are essential for timely AI.

Table 1 Observed oestrus signs as per score card

Parameter	Score
Off-feed	-
Vaginal discharge	-
Aggressiveness	-
Bleating	+
Tail wagging/flagging	+
Mounting other animals	++
Restless	++
Hyperaemia of vaginal mucous membrane	++
Vaginal mucous	+++
Os Cervix	+++

In this study, the use of a harnessed buck resulted in a 100% success rate in detecting estrus, which was confirmed by vaginal examination. The examination revealed abundant vaginal discharge, hyperemia of the mucous membrane, and cervical dilation (Table 1). Therefore, using a buck goat during the breeding season, especially after separation, is a natural and cost-effective method for synchronization.

Pregnancy rate

The pregnancy rates for the first and second services are shown in Table 2. An overall pregnancy rate of 75% was achieved, which is higher than that reported in many other studies. This may be related to improved techniquesto, timely detection of estrus, and appropriate timing of AI. In Group I, the pregnancy rate was only 50%, while in Group II, it reached 100%. All inseminated animals were examined via ultrasound on day 25 after mating and were rechecked at appropriate intervals (Figure 1).

Table 2 Conception rate in synchronized and unsynchronized groups

Item	Synchronised		Unsynchronised		Overall	
	A.I.	Conceived	A.I.	Conceived	A.I.	Conceived
1st Service Conception rate	10	2 (20%)	10	7(70%)	20	9 (45%)
2nd Service Conception rate	8	3 (37.5%)	3	3(100%)	11	6 (54.5%)
3rd Service Conception rate	2	0 (0%)	0	0	2	0 (0%)
Overall	10	5 (50%)	10	10 (100%)	20	15 (75%)

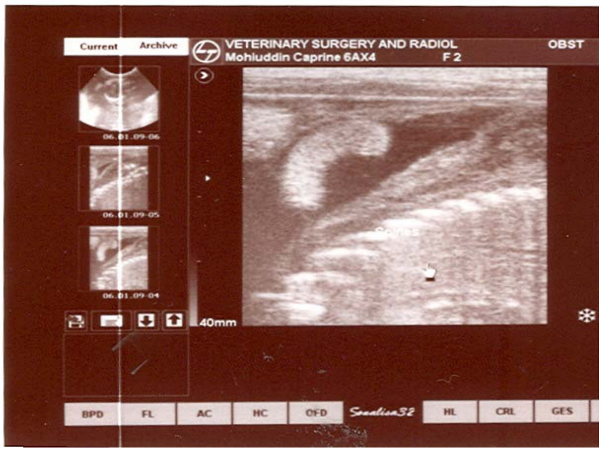

Figure 1 Ultrasonography of a doe (No-6AX4) for pregnancy detection

Dairy goats often undergo several hormonal treatments for estrus synchronization during their reproductive period to improve reproductive efficiency and economic benefits (Sun *et al.* 2024). In this study, all goats in Group I exhibited signs of estrus within 72 h after the injection of cloprostenol. The estrus synchronization after a single injection indicated that these animals were in the luteal phase of their cycle. Contrary to our results, some researchers have reported that using two doses of sodium cloprostenol spaced 11 days apart results in a higher estrus response (92.8% compared to 75%) than a single dose in goats (Omontese *et al.* 2013).

Maia *et al.* (2017), examined the effect of two doses of 37.5 µg of d-cloprostenol at intervals of 7, 10, and 11.5 days. Their results indicated that intervals of 7 and 11.5 days resulted in higher synchrony in the occurrence of estrus after the second injection.

The use of cloprostenol in different programs and intervals has induced and synchronized estrus in goats. Other researchers reported that two doses of PGF2α are administered at intervals of 9 to 11 days. This method ensures that nearly all animals are in the luteal phase of the reproductive cycle, enhancing the response to the second injection (Amiridis and Cseh, 2012). In this study by Cherian *et al.* (2023), the third injection of d-cloprostenol induced estrus signs in 100 % of cases. The pregnancy rate in goats receiving two doses of d-cloprostenol at an 11.5-day interval was reported to be 78.1%, while in goats receiving luteolysin at a 7.5-day interval, it was 88.9% (Bonato *et al.* 2019). Therefore, drug dosage, the time interval between doses, the age of the corpus luteum, the breeding season, and the simultaneous use of other hormones can influence the efficiency of estrus synchronization (Ranjan *et al.* 2025). Protocols based on PGs, progestogens, and biological stimulation play a significant role in improving reproductive management. Studies have shown that the presence of sexually active bucks, especially during transitional seasons, can increase pregnancy rates. These findings indicate that the selection and modification of synchronization and reproductive management protocols, especially under different environmental conditions and for various breeds, are essential (Véliz-Deras *et al.* 2020).

Goats in Group II showed signs of estrus within a week due to the presence of a buck, and in line with our results, Whitley and Jackson (2004), reported that an initial injection for synchronization is not essential, and the influence of the presence of a buck can be sufficient on its own. Combining these methods can be more economically efficient for producers. Goats in Group II exhibited signs of estrus within a week. Stimulation by the presence of a buck played a crucial role in synchronizing estrus and pregnancy rates in female goats treated with norgethisterone (Mellado *et al.* 2000). These results align with previous studies, including those by Umberger *et al.* (1994), which showed that the effect of buck presence is as effective as PMSG-hCG in stimulating corpus luteum activity.

In this experiment, the pregnancy rate in Group I was only 50%, while in Group II, it reached 100%. Laparoscopic AI, which involves injecting thawed frozen sperm into the uterus, has a pregnancy rate of 60–80% (Cseh *et al.* 2012), whereas cervical AI shows a lower pregnancy rate (16–40%) (Kumar and Naqvi, 2014). The reduced pregnancy rate with thawed frozen sperm may be due to early capacitation of sperm and decreased lifespan, which limits the time of fertilization of the oocyte (Ranjan *et al.* 2025). In Norwegian dairy goats, vaginal AI with 200 million fresh sperm showed an 85.5% non-return rate and a 74.3% kidding rates (Paulenz *et al.* 2005). In contrast, vaginal insemination with frozen and thawed sperm had lower pregnancy rates.

Field trials have shown that using 400 million frozen sperm thawed through vaginal AI results in a 64% non-return rate and a 58.3% kidding rate (Nordstoga *et al.* 2010).

The pregnancy rate in laparoscopic AI with thawed frozen sperm was reported by Anakkul *et al.* (2014), to be 56.67%. Additionally, pregnancy rates in Kashmir goats were reported to be 52.1% (Ritar *et al.* 1990), and in Angora goats with frozen sperm, it was reported to be 54% (Gibbons and Cueto, 2011). Similar studies, such as Loubser *et al.* (1983), reported pregnancy rates of 76.7%, 90%, and 34.8% for natural mating, AI with fresh sperm, and frozen sperm in Angora goats, respectively.

CONCLUSION

The use of natural methods, such as employing buck for estrus detection and synchronization, significantly reduces the costs and side effects associated with hormones and is introduced as an effective strategy in goat reproductive management. Additionally, the application of advanced AI techniques with thawed frozen sperm, especially with precise timing, not only improves pregnancy rates but also facilitates the transfer of superior genetic traits to the local population in specific climatic conditions, such as the Jammu and Kashmir region. These methods greatly contribute to enhancing reproductive efficiency and sustainable livestock development. Consequently, utilizing buck as an alternative to hormones can help reduce costs and side effects. Moreover, AI with frozen sperm can serve as a successful strategy in the temperate climatic conditions of Jammu and Kashmir, leading to the introduction of superior productive traits to the resilient and adaptable local population.

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