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The Effect of Non-Genetic Factors on The Success of Artificial Insemination of Goats in Nepal

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ABSTRACT

The detailed study on the success of artificial insemination in goats has not been done so far in Nepal. Hence, an experiment was carried out to reveal the effect of non-genetic factors on the success of artificial insemination in goats in Tanahun, Chitwan and Surkhet districts of Nepal from August 2018 to July 2022. Altogether 1023 Khari goats were inseminated with the frozen semen of Boer goats, which was imported from Australia. The effect of season, time of insemination, type of heat, number of inseminations, and parity of dam on artificial insemination was recorded and data were analyzed using IBM SPSS 26. The result showed that season, time of insemination, type of heat and number of inseminations significantly affect the success of artificial insemination in goats. In the case of the summer season, the success rate of A.I. was 75.65% whereas 44.12% in winter. Similarly, the highest rate (74.36%) was found after 18 hours of unset of heat and only 9.86% in the case of <=9 hours. Likewise, higher success (68.09%) was observed in natural heat than in induced heat (55.83%). Double insemination increased (69.70%) the rate of success of A.I., than to single insemination (51.80%) in both types of heat. Not only season, time and doses, but parity of dams also affects the success rate of artificial insemination in goats significantly. The highest success was found in the second to fifth parity of the dam, and the lowest in the first parity doe.

Keywords: Boer goat, dam, induced heat, Khari goat, time of insemination

INTRODUCTION

Livestock is an integral part of Nepalese agriculture where 65% population are engaged in this sector which contributes 24.09% of the total national gross domestic product (GDP) and among this sector, livestock covers 24.01 percent (MoALD, 2024). Among livestock species goat farming is an emerging and important enterprise that is used mainly for meat production. There are 15.29 million goats in Nepal which produce 86,280 MT of meat and accounting for 19.27% of the total meat production of the nation (MoALD, 2024). This production does not meet the increasing demand of goat meat, so live castrated bucks are imported from outside the country, especially from India and China.

The productivity of goats do not increase because the indigenous breeds have low producing ability as compared to the exotic breeds. From few years ago, cross breeding of Khari with pure Boer was done in Nepal. The Boer goat has faster growth rates and is heavier than the Nepalese local goat breeds. The mature Boer buck weight in the range of 110-135 kg, and the doe weight around 90-100 kg (RADA, 2010), whereas the adult body weight of the Khari goat was around 20-40 kg (Joshi and Shrestha, 2003). The daily live weight gain of the Boer goat crossbreds has been found between 100 to 200 gm in the farmers' field (Pandey, 2008). Similarly, Boer goat and its crosses have 1.63 to 2.2 litter size, whereas the indigenous breed and their crossbreds have only 1.0 to 1.8. Likewise, the Boer goat possesses strong disease resistance, adapts to adverse climatic conditions and has superior mothering capacity (Pandey, 2008).

The average one-year weight of Khari is 26.24±0.62 kg, whereas 50% Boer crossbreed reaches 40.03±0.86 kg (NGRP, 2021). This result means that the 50% Boer crossbreed produces at least 50% more meat than the Khari goat breeds. That is why, if Boer bucks can be used across all Nepalese local goat breeds, the national meat production would be increased by 50 percent. But there is scarcity of breeding stock of pure Boer buck and farmers use buck which is produced in their own farm for breeding that is why inbreeding problem occurs in most of the area. So artificial insemination is necessary to overcome this problem in goats. Nowadays, government as well as private farms have started artificial insemination in goats. But a detailed study on the success of artificial insemination in goats has not been done so far in Nepal. Hence, this experiment was carried out to determine the effect of non-genetic factor in the success of artificial insemination in goats in Nepal.

MATERIALS AND METHODS

Duration and site of study

The study was conducted from August 2018 to July 2022 at the National Goat Research Program (NGRP), Bandipur, Tanahun and its command area. Additionally, the study included locations in Chitwan and Surkhet districts.

Animal selection

Altogether 1023 Khari female goats were included in this experiment. Among them 339 females were used for the study of the effect of different timing on the success of A.I. in goats, 149 for seasonal effect, 304 for types of heat (natural and induced) and number of inseminations, and 231 for the effect of parity of dam. In case of induced heat, the following protocol was used. The CIDR, which was used in goat, contains 0.3g progesterone, which is administered on day zero and the intra-muscular application of PMSG with a 200 IU concentration was done. Then CIDR application and artificial insemination was done according to the following procedure.

0 day	15 days	17 days	19 days
CIDR application	PMSG insertion	CIDR withdraw	Artificial insemination

Data collection and analysis

The primary data of dam parity, season, time after onset of heat, types of heat, doses of semen, date of insemination, expected kidding date and detailed information of farmers were recorded. Heat detection was done after 21 days of insemination. Visual observation and abdominal palpation were done every month. Finally, recording the kidded does near the expected kidding date. After data entry and coding the analysis was done using the chi-square test through the Statistical Package for Social Science (SPSS) version 26, software.

RESULTS AND DISCUSSION

Time of onset of heat

The time of onset of heat in goats is an important factor for the success of artificial insemination which was categorized as ≤9 hours, 12, 15, 18, 21 and 24 hours. A total of 339 goats were inseminated within these different time durations. Among them the success of artificial insemination was found higher when AI should perform 18 hours after onset of heat. This study revealed that this factor was influenced significantly ($P<0.001$) for the success of artificial insemination in goats. The time wise success rate of artificial insemination in goats is presented in Table 1.

Kifaro (2007) reported that the optimal timing of insemination is an important factor in the success of artificial insemination because does do not ovulate until late estrous or shortly after the end of standing heat. Therefore, recognizing the signs of standing heat is important. However, the optimal time of insemination is determined by observing changes in the cervical mucus. As the doe progresses through estrous, mucus turns from clear and thin at the beginning of standing heat to cloudy and stringy during mid to late heat. Insemination should be performed in does before or at the time when the mucus turns cloudy, which is usually 12 to 15 hours after the onset of estrous. If the doe continues to exhibit heat after insemination, she should be inseminated again after 12 hours, particularly if the program uses frozen semen or cooled semen. In dairy goats, does should be observed for heat using a teaser buck and inseminated accordingly. Similarly, Fonseca and Alvim (2018) revealed that the ideal time to perform AI should consider the estimated mean time between the last hormonal intervention and estrous onset and the time between the latter and ovulation, due to their high variation Besides, the type of mucus observed is also an index of the most appropriate moment (Fonseca et al., 2017b). One of the earliest ultrasound-assisted ovulation studies conducted every 4 hours identified that AI performed after ovulation resulted in a high pregnancy rate when early diagnosed (18 days of estrous cycle), but pregnancies could be lost in the following weeks (Fonseca et al., 2012).

The basic premise is to inseminate before ovulation and to give enough time for the sperm to be fully capacitated for fertilization at the most appropriate time for the female gamete. Likewise, Lehloenya et al. (2005) indicated that goats must be inseminated 12 hours after the onset of estrus and 5 to 10 hours before the expected ovulation. The highest success rate of artificial insemination after 18 hours of onset of heat which might be due to the more opening of cervix at that time and match the time of sperm and ova to reach in ampulla of oviduct where fertilization occurs.

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Parity of the dam

Dam parity also influences the success of artificial insemination of goats. The vagina and cervix of median dams do not open as widely as other dams, so intrauterine AI is difficult in the first parity dams, and the success rate of AI was very low. The satisfactory result was found in the second to fifth parity and decreased from the sixth parity. The detailed effect of parity on the success rate of AI in goats is presented in Table 2. This study revealed that this factor significantly influenced ($P<0.001$) the success of artificial insemination in goats. breeding season, environmental conditions, parity, breed, farm, depth of semen deposition, extender composition and hormone treatment (Nunes & Salgueiro, 2011). Anel et al. (2005) revealed that the age of the ewe significantly influenced fertility and conception rate. The best fertility rates were recorded in ewes between 1.5 to 4.5 years old, and beyond this age, fertility declined remarkably. Fertility also decreased depending on the number of previous parturitions, and a high correlation found among the age and number of lambing ($r = 0.85$; $P < 0.001$). Several factors are reported to affect the success of AI, including nutrition,

Table 1. Effect of inseminated time after onset of heat on the success of artificial insemination in goats

Factors	No. of AI	Success rate (%)	χ^2 Value	P value
Overall	339	35.69	86.634	0.000
Time of onset of heat		***		
≤9 hours	71	9.86		
12 hours	47	19.15		
15 hours	52	42.31		
18 hours	78	74.36		
21 hours	49	38.78		
24 hours	42	14.29		

Note: ***: Significant at 0.1% level ($P<0.001$)

Table 2. Effect of parity of the dam on the success of artificial insemination in goats

Factors	**No. of AI**	**Success rate (%)**	χ^2 **Value**	**P value**
Overall	231	63.60%	31.547	0.000
Parity		***		
First	25	20.00%		
Second	33	72.73%		
Third	44	75.00%		
Fourth	40	75.00%		
Fifth	35	74.29%		
Sixth	32	59.38%		
Seventh	22	45.45%		
Note: ***: Significant at 0.1% level (P<0.001)				

Table 3. Effect of season on the success of artificial insemination in goats

Factors	**No. of AI**	**Success rate (%)**	χ^2 **Value**	**P value**
Overall	149	68.49%	12.085	0.001
Season		***		
Summer	115	75.65%		
Winter	34	44.12%		

Note: ***: Significant at 0.1% level (P<0.001)

Season of the year

The breeding season in goats varies throughout the year. During the winter months, only a small proportion of goats exhibit estrus, whereas nearly all does show heat during the summer. Cold weather may also lower the post-thaw temperature of semen, resulting in reduced semen quality. Consequently, the success rate of artificial insemination (AI) was markedly lower during the cold season and differed significantly ($P < 0.001$) from that observed in warmer weather. The detailed seasonal effects on AI performance are presented in Table 3.

The reproduction of goats is affected by changes in day length over the year. Photoperiod affects the secretions of melatonin from the pineal gland, which influences gonadotropin-releasing hormone production (Fatet et al., 2011). Amoah & Gelaye (1997) reported that conception rates in goats range from 50% to 70%, and this depend on the season of insemination, and the fertility and significantly influenced by the AI season. The probability of pregnancy was reduced when insemination took place during the colder seasons (autumn and winter). In contrast, the fertility of Mediterranean breeds inseminated with cooled semen has been reported to be high throughout the year (Roca et al., 1997). Similarly, Anel et al. (2005) found significant differences in the success of AI with respect to season; higher success was obtained in the breeding season (September to January period), whereas lower in the non-breeding season, particularly in the July to August period. Likewise, Karatzas et al. (1997) indicated that lower pregnancy rates occur when AI is performed during the non-breeding and Arrebola et al. 2012 found that the success of AI in hot weather was 51%, whereas in the cold season it was only 44.00%. All these findings are similar to this result.

Types of the heat

The type of estrus, whether natural or induced, influenced the success of artificial insemination (AI) in goats. Pregnancy rates were significantly higher ($P < 0.05$) in relation to estrus type. The detailed effects of natural and induced estrus on AI success are presented in Table 4. Smith (2009) reported that the average heat lasts from 24 to 36 hours and the ovulation occurs near the end of estrus. It is essential that does be inseminated before ovulation so that sperm cells can undergo a process called capacitation. Agossou and Koluman (2018) revealed that the pregnancy rates for naturally mated, and artificially inseminated goats were 93 % and 70 % respectively. Anel et al. (2005) indicated that estrous synchronization with hormonal treatment could have a negative effect on fertility, and that fertility decreased with the number of previous inseminations. The 55.83% conception rate obtained in this experiment is close agreement with those obtained by Motlomelo et al. (2002) of the range 47 to 60 % following the use of medroxyprogesterone acetate (MAP) and fluorogestone acetate (FGA) sponges and controlled internal drug release (CIDR) devices for synchronizing estrus in goats. Hafez & Hafez (2000) also found that lower pregnancy rates were reported when AI was performed in synchronized estrus goats than with natural estrus.

Table 4. Effect of types of heat on the success of artificial insemination

Note: *: Significant at 0.5% level (P<0.05)

Factors	**No. of AI**	**Success rate (%)**	χ^2 **Value**	**P value**
Overall	304	61.51	5.319	0.021
Types of heat		*		
Natural	141	68.09		
Induced	163	55.83		

Number of inseminations

The number of inseminations performed during both natural and induced estrus had a marked influence on the success of artificial insemination (AI) in goats. A statistically significant difference (P < 0.001) was observed in pregnancy rate according to the number of inseminations conducted. The detailed effects of insemination frequency on AI success are presented in Table 5. Yotov et al. (2016) reported that the pregnancy rate in goats inseminated once during natural estrus was 45.2%, while those inseminated once after estrus synchronization achieved 58.3%. When goats with synchronized estrus received double insemination, the pregnancy rate increased to 63.6%. In contrast, pregnancy rates in goats bred during natural estrus generally ranged from 40–50%. Our results were consistent with these findings.

Table 5: Effect of number of inseminations on the success of AI in goats

Factors	**No. of AI**	**Success rate**	χ^2 **Value**	**P value**
Overall	304	61.51%	16.798	0.001
Types of heat		***		
Single insemination	139	51.80%		
Double insemination	165	69.70%		

Note: ***: Significant at 0.1% level (P<0.001)

CONCLUSION

This experiment showed that the success rate of artificial insemination (AI) in goats was highest when insemination was performed 18 hours after the onset of natural estrus. The conception rate was also greater when AI was carried out during the normal breeding season in the does of second to sixth parity. In addition, double insemination at 12-hour intervals produced the most satisfactory results. For optimal AI performance, several management practices are essential. These include using well-trained inseminators, ensuring high-quality frozen semen, checking semen quality prior to use, accurately detecting the onset of estrus, and observing the color and characteristics of the cervix, vaginal mucosa, and mucus. Proper semen handling including thawing at 37 °C for 30 seconds as well as good feeding and housing management, and keeping inseminated does away from bucks, are also important factors for improving conception rates.

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AUTHORS' CONTRIBUTIONS

Dipak Adhikari – Overall management of this experiment, AI done, Data management, data analysis, paper writing.

Saroj Sapkota – Data management and paper writing

Buddhi Ram Acharya – Assisted in artificial insemination of goat and record keeping

Purna Bahadur Shrestha - Artificial insemination of goat, record keeping and computer entry
Nabaraj Poudel - Data management and data analysis
Nirajan Bhattarai - Guidance of paper writing

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