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Research Article

Evaluation on the Efficiency of Artificial Insemination Following Estrus Synchronization of Dairy Cattle: In the Case of Sodo Zuria District, Ethiopia

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Abstract

The study was conducted from November 2016 to April, 2017 in selected kebeles of Sodo zuria district, Wolaita zone. A cross-sectional type of study design was carried out with the objective of determining the success rate of artificial insemination following estrus synchronization; and the study was also focused on determining the associated factors on conception rate of cows/heifers. Out of 1007 synchronized animals, 925 animals (714 local and 211 cross bred) were responded to the hormone PGF2α. As a result, 91.9% estrus response rate was obtained. All cows/heifers responded for estrus was inseminated and at day 90 of post artificial insemination; pregnancy diagnosis was made by trans-rectal palpation and the overall conception rate of 46.2% was obtained. All factors considered during the study time; namely cow breed, body condition score, parity, insemination time and bull species have no significant ($P > 0.05$) effect on conception rate. However, crossbred animals (50.2%), animals with good body condition score (48.3%), parity > 5 (49.2%) and insemination time between 10 hrs and 16 hrs (48.2%) had high conception rate. It was concluded that the effectiveness of PGF2α used to synchronize estrus in dairy cows/heifers was good and the overall conception rate (46.2%) was better which is greater than the national level conception rates (7.14 to 40.23) to first inseminations. Development practitioners who aimed to improve dairy cattle productivity should have to give great attention to genetic and non-genetic factors in commencement of synchronization and artificial insemination.

Keywords: *Artificial Insemination; Conception Rate; Cow/Heifer; Estrus Synchronization*

Introduction

Livestock play a significant role in the economy, social and cultural value of Ethiopia and it constitutes an essential link to the economy through the generation of income and the satisfaction of the food needs of the people. Ethiopian cattle population is ranked first in Africa and estimated about 53.99 million. Out of this the female cattle constitute about 55.48% and the remaining 44.52% are male cattle. 98.95% of the total cattle in the country are local breeds and remaining are hybrid and exotic breeds that accounted for about 0.94% and 0.11%, respectively [1].

In Ethiopia, dairy production is still in extensive system and the average daily milk production of indigenous cows is 1.37 liters/day [2]. The introduction of reproductive techniques such as estrus synchronization and artificial insemination are becoming instrumental to solve the effects of these limiting factors as well as to make possible the application of more intensive systems of production and to facilitate the genetic improvement of the productive characteristics of the herd [3]. Reproductive performance of cows and heifers is one of the most important factors that influenced the profitability of the dairy sector. A major component in reproductive management is estrus detection and artificial insemination of the cow at the correct time in the estrus cycle [4].

Estrus synchronization (ES) programs have been available for the past 25 years and have enjoyed success as a tool to make artificial insemination more practical. The synchronization of estrus/ovulation and AI remain the most influential technologies available to cattle producers for genetic improvement and reproductive management [5]. It involves manipulating or controlling the estrous cycle of females, so that they can be bred at approximately the same time. All synchronization programs require good management, cows having regular estrous cycles, and in good body condition (more than body condition score of 4). With attention to detail and adequate feed, these programs can work well [6].

Artificial insemination (AI) has been defined as a process by which sperm is collected from the male, processed, stored, and artificially introduced into the female reproductive tract for the purpose of conception. Semen is collected from the bull, deep-frozen and stored in a container with Liquid Nitrogen at a temperature of minus 196°C and made for use. Artificial insemination has become one of the most important techniques ever devised for the genetic improvement of farm animals. It has been widely used for breeding dairy cattle as the most valuable management practice available to the cattle producer and has made bulls of high genetic merit available to all [7,8].

Currently, AI is undertaken by one or two AI technicians based at district level. They are mainly providing services for dairy cows in urban and/or peri-urban areas-hence little or no AI services are available for the meat and butter system in rural areas. Cows which are in heat are reported to the AI technicians by the owners. Technicians in some cases visit the farm to inseminate the cows or the farmer usually brings the cows to AI sites or the district offices for insemination. The poor field performance of artificial insemination could be associated to a number of factors. It was found that the conception rate of the cows/heifers was dependent on breed of the bull, breed of the cow/heifer, time of insemination and parity [9].

Despite the wide application of AI and its success throughout the developed world, the success rate in Ethiopia is still low 46.7% by Belachew [10] and 27% by Desalegn [11] owing to a number of technical, financial and managerial problems [12,13]. It is in this context, this study was undertaken with the objectives of to determine the success rate of artificial insemination following estrus synchronization, to determine associated factors on success of AI on cows/heifers and to determine the incidence of estrus following the injection of PGF2α in cows and heifers.

Materials and Methods

Study area

The study was conducted in Sodozuria district, Wolaita zone of Southern Nation Nationalities and Peoples Regional State. The zone's main town (Wolaita sodo) is located 330 km southwest of Addis Ababa following the tarmac road that passes through Hosanna to Arbaminch. It has 6°54'N 37°45'E latitude and 6.900°N 37.750°E longitude and has a total land area of 4,541 km^2. It is composed of 12 districts and 3 registered towns. Sodozuria district is one the districts found in the zone and is located at a distance of 390 km (to the south) from Addis Ababa. The district has 34 rural kebele administrative and nine kebeles were included in this study. The population of this district is about 163,771 out of which 80,525 are male and 83,246 are female [14]. Majority of the population resides in the rural areas and their livelihood mainly depends on subsistence agriculture. The total livestock population of the study area was, cattle 128,783, sheep 35,290, goat 9013, equine 8,316 and poultry, 86,979 [15]. The altitude falls in the range between 1500 - 3200 m.a.s.l. The agro-ecology is dominated by midland that covers about 87% of the total area, and the remaining 13% is highland with rugged mountains and slopes. The average annual rainfall is 1200 mm per annum, while the daily temperature varies from 15°C to 30°C. Livestock production in the area includes cattle (oxen, milking cows and young stock), goats and sheep, equines (horses and donkeys), poultry (mostly local chickens but some improved breeds). The main livestock feed sources is natural pasture and crop byproducts including hay and straw (barley, teff, and wheat) [16].

Study population

A study population comprises local/native and crossbred cows and/or heifers found in nine kebeles of Sodozuria district. The body condition of animals were determined on 1 - 9 scale using method described in Nicholson and Butherworth [17] and animals were divided in to three groups (1 - 3 = poor, 4 - 6 = moderate and 7 - 9 = fat body condition). Animals with very poor BCS (< 3) were not selected for insemination during sampling since estrous expression is highly influenced by body condition [18].

Study design

A cross-sectional type of study design supported by data recording and observation were carried out from November 2016 to April 2017 with the objective of determining the success rate of artificial insemination following estrus synchronization and determining associated factors on pregnancy rate of cows/heifers.

Sampling method and sample size determination

This study was purposely conducted in Sodozuria district, because of the synchronization program campaign were implemented by the Livestock and Fisheries Bureau of Southern Nations and Nationalities Peoples Regional State to improve the dairy cattle productivity and availability of good infrastructure and feed for the animals. Nine kebeles of the district were purposely selected based on increased number of dairy cows, availability of cows/heifers fulfilling criteria for synchronization and AI, good awareness and experience of farmers in dairying and access to market and attitude of farmers to adopt market oriented commodity development. In this study a total of 1007 cows/heifers were considered.

Study methodology

Prior to synchronization and AI the willingness of the farmers were determined. Then, history of each cow/heifer like body condition, breed, parity and other related information were recorded during the study. The reproductive status of the animals was evaluated and recorded from history, clinical examination and rectal palpation before hormone treatment. Only cycling, non-pregnant cows carrying a corpus luteum were chosen. An intramuscular injection of hormone products (2 ml of Estrumate) was used for estrus synchronization. The cows/heifers were closely monitored for their manifestation of estrus signs (mounting, bellowing activities and mucus discharge) for about 5 days; and thereby the heat sign was confirmed by rectal palpation. All cows/heifers manifesting two or more signs of estrus mentioned above were then inseminated. One inseminator was assigned for insemination at each site. Frozen semen (-196°C) of bulls (Holstein and Jersey) were brought from Kality National Artificial Center, Ethiopia. At day 90 post AI, pregnancy diagnosis was made by trans-rectal palpation method [13].

Data analysis

All the data were entered in to Microsoft excel sheet. Analysis of the data were performed by using a computer software SPSS for windows (version 20.0). The fixed effects of body condition score, breed, parity, estrus induction, and duration to AI on pregnancy rate were computed using cross tabulation. The relationships between variables were computed using Pearson correlation. The level of significance was held at $P < 0.05$ to show statistically significant differences among variables. As suggested by Sharifuzzaman., *et al.* [19] the conception rate (CR) is manipulated as:

$$CR = \frac{\text{number of cows/heifers pregnant}}{\text{number ofcows/heifers inseminated}}$$

Result

Overall synchronization and estrus response

During the study, a total of 1007 animals, 775local and 232 crossbred cows and heifers were synchronized, respectively and 925 cows/heifers shown estrus. The rate of estrus response was 91.9% (925/1007).

onception rate

Out of 925 animals shown estrus and inseminated with semen from different bull species, an overall conception rate of 46.2% (427/925) was obtained (Table 1).

Factors Synchronized		Number cows/heifers				Conception rate (%)	P-value
		Estrus response	Inseminated	Cows/heifers pregnant			
Breed	Local	775	714 (92.13%)	714	321	45.0%	0.177
	Cross	232	211 (90.95%)	211	106	50.2%	
Body condition score	Medium	478	438(91.63%)	438	192	43.8%	0.178
	Good	529	487 (92.06%)	487	235	48.3%	
Parity	Heifers	365	331 (90.68%)	331	148	44.7%	0.905
	1 - 3	308	289(93.83%)	289	135	46.7%	
	4 - 5	271	246(90.77%)	246	115	46.7%	
	> 5	63	59(93.65%)	59	29	49.2%	

***Table 1**: The effect of different factors on conception rate and estrus response of cows/heifers.*

The effect of different factors on conception rate

In this study, the effects of different factors like, cow breed, body condition score, parity, insemination time and bull species on conception rate were determined (Table 1).

Effect of cow breeds on conception rate

There were 714 local and 211 crossbred cows/heifers were inseminated and out of this 321 (45.0%) and 106 (50.2%) were pregnant, respectively.

Effect of body condition score on conception rate

The body condition of animals was grouped as medium and good. There were 192 (43.8%) medium and 235 (48.3%) good body conditioned cows/heifers were determined.

Effect of parity on conception rate

Animals included in the study were grouped in different parities. 148 (44.7%) were heifers (zero parity), 135 (46.7%) were animals with parity 1 to 3, 115 (46.7%) were animals with parity 4 to 5 and 29 (49.2%) were animals with parity > 5.

Effect of insemination time on conception rate

In different insemination time ranges the conception rate was also differs and the obtained conception rates were: 4 hrs - 10 hrs (45.1%), 10 hrs - 16 hrs (48.2%), 16 hrs - 22 hrs (45.3%) and > 22 hrs (46.6%) (Table 2).

Factors Inseminated		Number cows/heifers		Conception rate (%)	P-value
		Cows/heifers pregnant			
Insemination time	4 - 10 hrs	264	119	45.1%	0.902
	11 - 16 hrs	220	106	48.2%	
	17 - 22 hrs	267	121	45.3%	
	> 22 hrs	174	81	46.6%	
Bull ID	10/269	231	110	47.6%	0.642
	75/279	125	54	43.2%	
	07/202	318	153	48.1%	
	8/244	251	110	43.8%	
Overall conception rate				46.2%	

***Table 2:** The effect of Insemination time and Bull ID on conception rate of cows/heifers.*

Effect of bull ID on conception rate

Animals included in the study were inseminated with semen of different bull IDs. There were 4 different bull IDs, 10/269, 75/279, 07/202 and 8/244 and the respective conception rates of 47.6%, 43.2%, 48.1% and 43.8% were obtained (Table 2).

Discussion

Out of 1007 synchronized animals, most of the cows/heifers925, 714 local and 211 cross bred, were responded to PGF2α and the rate of estrus response was 91.9%. There has been limited research conducted to determine if genotype influence the effectiveness of PGF2α that initiates luteolysis [20]. Estrus response rate obtained in the current study (91.9%) was lower than that reported by Legesse., *et al*. [13] which was 97.7%.

In this study, the overall conception rate was 46.2%, which is higher than that of 27% reported by Desalegn [11] and lower than that of Woldu., *et al*. [12] which was 48.3% and Legesse., *et al*. [13] which was 60.4%. But, it was closely agreed with Belachew [10] which was 46.7%. The variation in conception among the studies could be AI delivery system, nutrition and management, accuracy of heat detection, appropriate timing of insemination, insemination techniques, and quality and quantity of semen. Similar study was made by Legesse., *et al*. [13] conception rate depends mainly on time of insemination, genotype, body condition scores, age, parity, bull ID and AI technicians.

There was no significant difference ($P > 0.05$) in first service conception rate among crossbred (50.2%) and indigenous (45.0%) cows and/or heifers, but in this study higher conception rate was observed in crossbred when compared to the native cattle. The variation in conception among crossbred and native cattle could be due to the agro-ecology where the study animals were found, genotype, heat detection, and semen quality and quantity and insemination time. Some other possible reasons reported for the lower proportion of indigenous cow conceiving at first insemination are that the Zebu does not exhibit overt estrus signs like crossbred cattle [21]. Estrus manifestations have been known to be short, erratic and mostly less evident or silent heat further requiring a meticulous observation and timely insemination to result in successful pregnancy [13,22].

The association between BCS and conception rate was not significant ($P > 0.05$). Normally, good body condition of cows/heifers is expected to have a positive impact on conception rate [23]. Conception rate tended to increase as the body condition of the animals increased and in this study also cows/heifers with good body condition (48.3%) had high conception rate relative than medium (43.8%), which is in line with findings of Derouen., *et al*. [24] that revealed cows with a body condition score six or seven has higher pregnancy rate compared to cow with a body condition score of four or five. Good BCS especially during the mating period has been confirmed to have a positive impact on CR [25].

Although there is no significant ($P > 0.05$) deference in conception rate among the different parity groups, heifers tend to have lower conception rate 44.7% than primiparous and multiparous cows. The absence of significant differences between parities in conception rate in this study was consistent with the study of Woldu., *et al* [12]. Paul., *et al*. [26] and Grimard., *et al*. [27] confirmed that parity has a significant effect on conception rate and on the fertility. The absence of significant differences between parities in conception rate among the different parity groups could be the environment, BCS and semen quality and quantity.

For conception to occur, insemination must take place at the correct stage of the cow's estrus cycle since ova remains viable for about 12 - 18 hrs after ovulation [28,29]. First service conception rate of the current result had no significant ($P > 0.05$) difference among the time of insemination and was done between 4 hrs - 10 hrs, 10 hrs - 16 hrs, 16 hrs - 22 hrs and > 22 hrs. But the current finding showed that conception was relatively similar among the above insemination times, 45.1%, 48.2%, 45.3% and 46.6% respectively after the onset of estrus. Time of insemination of the current study contradicts the report of Miah., *et al*. [30] indicated that first service conception rate was higher between insemination time 11 to 14 hrs (60.3%) and lower above and below this range.

Report by Sinishaw [31] also indicated that animals should be inseminated within 24 hours of the onset of heat because late and early insemination may influence the CR of both the heifers and cows. The variation in conception rate among different studies could be due to inaccuracy of heat detection, time and season of insemination, skills of the AI technician.

The bull ID also had not significantly ($P > 0.05$) influence conception rate. But it indicated that the effect of bulls on pregnancy varies from 43.2% to 48.1%. The difference in conception among bulls could be due to quality and quantity of semen, disease and management of the bull. Shamsuddin., *et al*. [32] also indicated that breed of bull, and attributes of semen quality and quantity have shown to have significant effects on conception rate. Not only the bull itself influence the conception rate under AI service, but also the way semen collected, processed, transported, handled and inseminated [13,33].

Conclusion and Recommendations

Proper animal selection, heat detection efficiency, farmers' awareness to detect heat and on time bringing of cattle for insemination should be satisfactorily considered for effective synchronization. In this cross-sectional study the effectiveness of PGF2α used to synchronize estrus in dairy cows/heifers was good (91.9%) and the better overall conception rate (46.2%) which is greater than the national level conception rates (7.14 to 40.23) to first inseminations was obtained. However, different factors such as cow breed, BCS, parity, time of insemination and bull ID were influenced conception rate. Higher conception rate was observed in crossbred and animals with good body condition. Different conception rates were recorded among different considered factors.

Based on the highlighted conclusion, the following recommendations were forwarded:

- Great attention should be given to various factors in commencement of synchronization and AI.
- Successful heat detection methods and subsequent proper timing of insemination should be required in increasing conception efficiency.
- Further study on skill of inseminator, technique and site of semen deposition, insemination season; and on the quantity, quality and preservation of semen should also be conducted.
- Improving the nutritional conditions of animals selected for dairy production is of paramount importance.

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