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EVALUATION OF ALFAGLANDIN C AND ASSOCIATED FACTORS ON EFFICIENCY OF COWS' ESTRUS SYNCHRONIZATION AND ARTIFICIAL INSEMINATION IN NORTH SHOA OROMIA, ETHIOPIA

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ABSTRACT

Synchronization of estrus involves handling the estrus cycle so that a large number of cows can be bred at approximately the same time. Proper cow/heifer selection as well as efficient coordination are all key elements for the success of synchronization programs which were lacking in the study area. The study was conducted with the objective to evaluate the effect of Alfaglandin C and fixed factors on estrus synchronization and efficiency of Artificial Insemination (AI) in North Shoa zone of the Oromia region. The study population encompassed indigenous and crossbred cows and heifers found in six purposively selected kebeles (smallest administrative unit within a district) from the three selected districts (Wucale, Dagam and Kuyuu). Multistage sampling procedure was used to select target districts, kebeles and experimental cows/heifers. A total of 180 cows and heifers fulfilling estrus synchronization criteria were selected purposively and injected with synchronizing hormone (Alfaglandin C). The level of significance among categorical variables was determined using the chi-square (x^2) test. About 70.6% of the cows and heifers injected with Alfaglandin C exhibited estrus. Exhibition of estrus following hormone injection was significantly ($p<0.05$) lower in Wuchale district compared with that of the other two districts. Likewise, the agroecology, farming system, herd group, and breed had a significant ($p<0.05$) effect on estrus exhibition. Among cows and heifers inseminated following estrus exhibition, 62.2% conceived as confirmed by pregnancy diagnosis (PD) test conducted at 45-day post AI, which dropped to 58.3% as observed by the PD test conducted three months' post AI. Agroecology, farming system, herd group, and genotype of cows and heifers showed significant ($p<0.05$) influence on the conception rate (CR). The highest CR was observed among cows of Kuyuu district, which was significantly ($p<0.05$) different from that of the other two districts. The overall calving rate was 91.1%. The semi-intensive part of the study also showed better estrus synchronization response and better reproductive performances which directly associated with the management practices. Treating industrial byproducts, better management, and promoting AI can achieve better estrus synchronization and efficiency of artificial insemination.

Key words: alfaglandin C, calving rate, conception rate, district, estrus exhibition, pregnancy diagnosis

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INTRODUCTION

Ethiopia is a country with huge animal genetic resources in terms of diversity and population. According to the country's livestock sample survey report in the year 2021, there were about 70,291,776 cattle population [1] and 28 recognized indigenous cattle breeds [2]. Cattle play various economic, cultural and social roles and are used to improve the well-being of farming families through animal-source food supply, balancing nutrition, family income and savings insurance.

North Shoa zone of the Oromia region is known to have huge number of cattle with a substantial proportion of indigenous x Holstein Friesian (HF) crossbred population, which is triggered by the long-standing practice of artificial insemination (AI) in several districts of the zone [3]. In the year 2019, there were about 1,519,495 cattle heads in the zone of which 79% were indigenous breeds and 21% were crossbreeds with various exotic blood levels [3]. Small-scale dairy farming is among the major market-oriented agricultural activities in the zone [3]. An increasing number of medium- and large-scale milk processing plants established in the area can be observed, which should contribute to respond to the increasing demand for milk and milk products of the urban population of Addis Ababa and surrounding major cities and towns.

Synchronization of estrus (heat) involves manipulating the estrus cycle of females so that a large number of cows can be bred at approximately the same time [4]. In Ethiopia, hormonal synchronization of estrus has been implemented for the past few years and has been used as a tool to make AI more practical by increasing the probability of estrus detection, pregnancy rates of dairy cattle and the number of calves born when feed is more available and market demand for dairy products increases [5]. Research works conducted on estrus synchronization in different parts of the country reported varying outcomes. According to a previous report by Bainesagn [6] for instance, 72.3% of the cows and heifers responded positively following injection with synchronizing hormone prostaglandin F2alpha (PGF2α). Likewise, Yeshimebet *et al*. [7] stated that with healthy and cyclic heifers in good body condition and skilled AI technicians, the onset of estrus response may approach 75%. Another research report by Dereje [8], also indicated that 75.6% of the trial cows and heifers were responsive to the hormonal treatment.

The reports from the zonal Livestock and Fisheries Development Bureau, averred that, although estrus synchronization has been practiced over several years, their results were not comprehensive. This is because, major variables such as estrus exhibition, conception, calving, and abortion rates were not recorded. The effect of fundamental factors including agroecology, genotype, parity and body condition were also not recorded and properly analyzed. As suggested by Ahmed and Mohammed [9], well-designed monitoring and evaluation system, awareness creation among key stakeholders, proper training for participating AI technicians, proper cow/heifer selection as well as efficient coordination are all key elements for the success of such synchronization programs. These preconditions are deficient in most, if not all, synchronizations and AI campaigns conducted earlier in the zone.

Various research findings reported different results of estrus synchronizations on the success of AI in many parts of the country [6, 7, 8]. However, significant limitations can be observed in the monitoring and evaluation systems used as well as recording during the whole process of heat detection, synchronization, AI and pregnancy diagnosis. Efficient monitoring, evaluation and record tracking are essential to properly evaluate the effect of estrus synchronization and associated factors on the efficiency of AI service delivery. Therefore, this research work was designed to evaluate the efficiency of hormone-induced heat synchronization and AI, to identify the major factors affecting field level hormone induced heat synchronization and AI in the North Shoa zone of Oromia.

MATERIALS AND METHODS

Description of the study area

The study was conducted in three selected dairy potential districts in the North Shoa zone of the Oromia region. The area is located at 9^0 00’-10^0 44’ North latitude and 37 ^{0}57’ - 39^0 33’ East latitude. The agro-ecological zones of the study area include highland, midland and lowland, respectively accounting for 52, 41, and 7%. The maximum and minimum temperatures respectively, were 35^0 and 11.5^{0}C with an average value of 21.5^{0}C. The majority of the farmers in the zone are engaged in dairy cattle production and there were 1,323,045 cattle population in the zone of which 79% are indigenous and 21% being crossbreeds [3].

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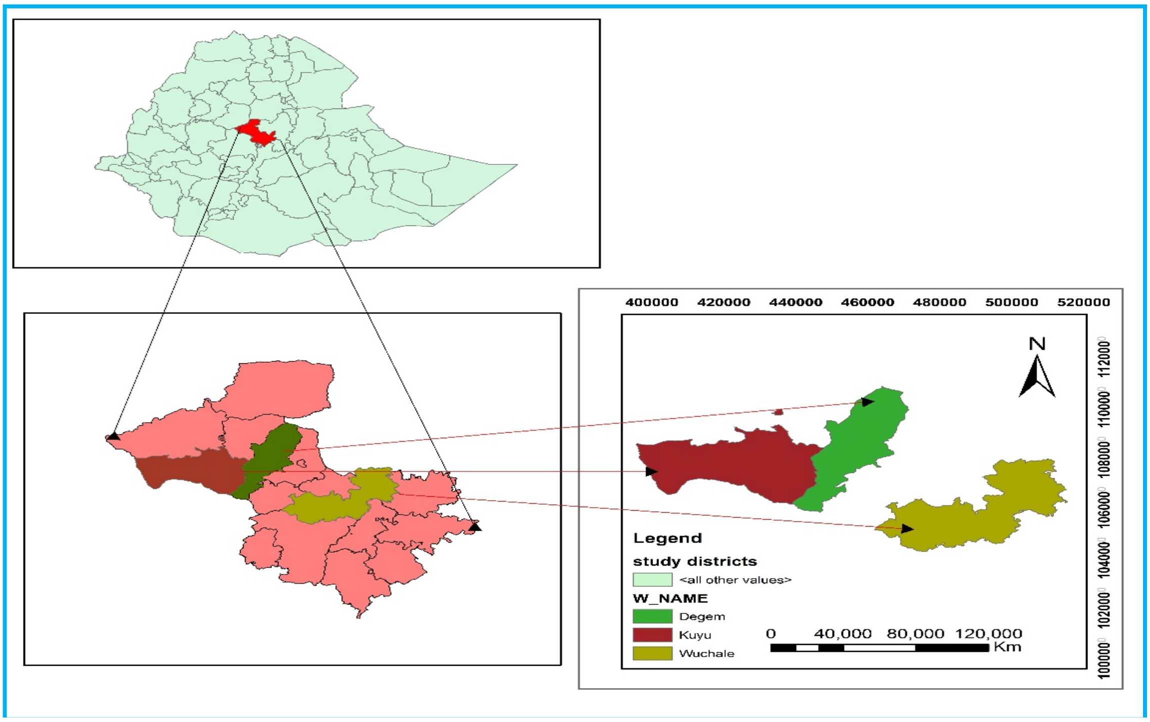

Figure 1: Map of study area

Study population

The study population encompassed indigenous and crossbred cows and heifers found in six purposively selected kebeles (smallest administrative unit within a wereda/district) from the three selected districts/weredas (*Wucale, Dagam* and *Kuyuu*) since they are known by higher dairy cattle potential. Based on the body condition of cows and heifers evaluated and determined by using the 1- 5 Body Condition Score (BCS) as described by Maqhashu [10], the animals were divided into five groups. Cows and heifers with emaciated body condition score (BCS 1) and very fat body condition score (BCS 5) were not selected for heat synchronization or insemination as estrus expression is highly influenced by body condition. Cows and heifers included in the experiment, therefore, ranged from BCS 2 to BCS 4. As indicated by an earlier research report, a body condition score of 3 - 4 in females' increases pregnancy rates, with quicker re-conception rates after calving, however, being too fat, narrows the reproductive canal, while thin cows due to limited body reserves can be more prone to metabolic diseases [11].

Study design

A longitudinal type of study design consisting of animal selection, hormone injection, insemination, data recording, and observation was employed with the objective of determining the success rate of AI following hormone induced estrus synchronization and determining associated factors on pregnancy rate and calving rate of cows/heifers.

Study procedure and sampling method

The study was planned in two phases: Phase 1: Rapid preliminary survey to select study target weredas, kebeles, farms and animals and Phase 2: Animal response to hormone-induced heat synchronization and AI followed by monitoring the success rate.

Phase I: Rapid preliminary survey: Prior to commencing the actual investigation, discussions were held with zonal and district-level livestock and fisheries development agents (DAs) about the distribution of weredas that have potential for dairy production. A multistage-purposive sampling procedure was used based on the potential for dairy cattle production and the agro-ecology of the districts and kebeles. Accordingly, three districts (Degem, Kuyuu and Wuchale), encompassing highland and midland Kebeles with high dairy cattle potential were selected. Two *Kebeles* (one from the highland and the other from midland agro-ecology from each district) having higher dairy cattle potential were selected making the total number of kebeles six. Consequently, out of a total of 518 cows and heifers tested, 180 dairy cows and heifers fulfilling the synchronization criteria were purposively selected (Table 1). In each agro-ecology, represented by a *kebele* within a wereda, target farmers were selected from nearby villages for ease and interest of proper monitoring and follow-up. Moreover, the kebele-level agricultural extension stations are located at the target villages from which participating farmers were selected. This created a conducive environment as Development Agents, veterinarians, and extension workers based at such stations are available making communications with target farmers easier.

Phase 2: Animal response to hormone-induced heat synchronization and AI: Characteristics and reproductive history such as body condition, breed, parity and other related information of each cow and heifer were recorded at the start as well as during the study. In addition to the information obtained from the owner, clinical examinations and rectal palpations were performed prior to the hormone treatment and recorded. Only cycling and non-pregnant cows showing a functional *Corpus luteum* (CL) were selected for the study. Accordingly, cyclic cows and heifers that were healthy, good performing, with mature *Corpus luteum*, free from any detectable reproductive tract abnormalities and pregnancy, and had body condition scores within the 2-4 range received a single injection of 2ML Lutalyse/Alfaglandin C, Lutalyse® or dinoprost tromethamine is a prostaglandin product used to control the timing of estrus and ovulation (each vial contains 250 mcg cloprostenol

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solution) https://www.drugs.com/vet/alfaglandin-c-can.html. Cows and heifers were observed for any external symptoms of estrus (clear vaginal discharge, mounting other cattle, allowing other cattle to mount them, restlessness) for about 5 days. While exhibiting such heat signs, animals were monitored for their reproductive status by performing rectal palpation. All open cows/heifers expressing two or more signs of estrus were then inseminated by AI technicians/veterinarians trained and assigned for each study target *kebele* using laboratory-confirmed frozen semen (-196°C) sourced from the National Animal Genetic Improvement Institute (NAGII) located at Kality. Two pregnancy diagnosis tests were conducted, the first one 45 days and the second three months' post-AI via trans-rectal palpation method [12]. Artificial insemination technicians/veterinarians that were regular/fulltime employees of their respective districts received a prior refresher training tailor-made for the current study purpose, which was also helpful to ensuring effective monitoring and proper data recording.

Data collection and analysis

Data on the date of heat synchronization, heat exhibition, pregnancy diagnosis, fixed factors and other relevant variables were collected using an appropriate format prepared to serve the purpose. Data were entered into a Microsoft Excel spreadsheet. The statistical analysis was performed using the Statistical Analysis System (SAS) version 9.4 [13]. The fixed effects considered were district, agroecology, body condition score, breed and herd group (heifers or cows). The level of significant difference among categorical variables was determined using 95% confidence interval in the chi-square test. The formulas used to estimate values of the major dependent variables expressed in percentages are presented below.

$$\text{Estrus detection rate} = \frac{no\ of\ cows/heifers\ in\ estrus * 100}{no\ of\ cows/heifers\ hormone\ injected}$$

$$\text{Conception rate} = \frac{no\ of\ cows/heifers\ concieved * 100}{no\ of\ cows/heifers\ inseminated}$$

$$Calving\ rate = \frac{no\ of\ cows/heifers\ delivered\ a\ live\ calf * 100}{no\ of\ cows/heifers\ concieved}$$

RESULTS AND DISCUSSION

Estrus exhibition rate

The current estrus response result (70.6%) (Table 2.), using Alfaglandin C is in agreement with an estrus synchronization by means of the PGF2α reported earlier [6, 14]. Accordingly, healthy cyclic heifers with good body condition and skilled AI technicians' estrus response may approach 75% [7]. Similarly, a research report indicated 75.6% of cows/heifers were responsive to hormonal treatment [8].

Estrus exhibition in Wuchale district is significantly ($p<0.05$) lower compared with that in the other two districts. The differences in estrus results following the hormone injection might be caused by the difference in the capacity of AI technicians to identify fitting animals. A synchronization report indicated different AI technicians have varying results [15].

In the semi-intensive farming system, positive heat was observed from 93.6% of cows/heifers and this was significantly ($p<0.05$) higher than in the extensive production system (65.8%). This might be due to the fact that most of the farmers engaged in this type of dairy farming fulfill the management practices so that they achieve better. Likewise, most farmers under semi-intensive farming were engaged in the commercial type of dairy production and had a near approach with extension workers and AI technicians regarding general husbandry and management practices. Management practice carried out by the farmers in general has a remarkable role in the reproduction of animals. Management including nutrition of the herd is essential for the successful implementation of several synchronization programs in both cows and heifers [16]. In harmony with the current study, heat exhibition of the heifer was better than cow as indicated by previous researchers [17]. In contrast, estrus rate of cows following $PGF_2α$ injection was better than heifers as reported by the investigation made in West Shoa zone of Oromia [6]. The results of different studies clearly indicated the effect of parity in different protocols of the synchronization program. However, the effect should depend on the health status and management [18].

Better estrus exhibition from cows/heifers under BCS 3 and poor estrus exhibition was observed from BCS 2. Similarly, cows/heifers with BCS 3 and 4 show more advanced estrus exhibition than those categorized under BCS 2 which was in tandem with the reports of Maqhashu *et al.* Jemal *et al.* [11, 19]. In similar way, others, Girmay *et al.* [17] stated synchronization implemented with poor body-conditioned animals resulted in a low level of heat detection. Better estrus exhibition of cows/heifers with BCS 3 and 4 might be due to their better response toward Alfaglandin C. It was also opined that cows/heifers with a body condition score of 3 and 4 had higher rate of estrus response than those with body condition score of 2 [6].

Conception rate

A conception rate of 62.2% was obtained as confirmed by the first pregnancy diagnosis (PD) test conducted 45 days' post-insemination. It was reduced to 58.3% following the second PD test conducted three months' post-insemination (Table 3.). More pregnancy reduction in three-month post-AI PD test was observed in *Degem* and *Kuyuu* districts than Wuchale. It was therefore confirmed that there was higher rate of abortion in these two districts than Wuchale district during the early stage of pregnancy. Farmers and AI technicians in the districts stated the contamination of grazing environment and water by cement manufacturing industries through its waste were rising abortion during the earlier stage of gestation. This is a common challenge that owners were facing in their dairy cattle for natural and artificial breeding. The conception rate detected in this finding was much higher than the Ethiopian national conception rate of 27% [20] and the conception rate of 13.1% [21] in Bahirdar milk shade area.

Among the districts considered in this investigation, better conception rate was observed in Kuyuu district (69.8%) and the lowest conception rate was observed in *Degem* district (55.6%). The conception rate observed in Kuyuu was significantly ($p<0.05$) higher than that of *Degem* and *Wuchale* districts. The difference in the conception rate result of different districts might be due to the motivations of AI technicians by the Public Private Partnership for Artificial Insemination Delivery (PAID) through providing an incentive based on their achievement. Those technicians engaged are properly attended to during and post- AI activities since they earn 1 US$ for each achievement per artificial insemination, conception and calving. Moreover, there was relatively better AI facilities particularly in Kuyuu district. On the other hand, the lack of motivation and skills of AI technicians due to lack of career training, lack of support, and readily available inputs in Ethiopia contributed to the unsuccessfulness of the AI service in different parts of the country [22, 23]. The typical action taken by public partnership for artificial insemination delivery (PAID) in the study area, particularly in Kuyuu district is the best trend that needs to be expanded in different parts of the country for better improvement of the sector.

Regarding agroecology, a higher conception rate was recorded in the highland than midland and there was significant ($p<0.05$) difference between the two

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categories. The conception rate in the semi-intensive farming system was higher by 32.1% than that of the extensive farming system in the 45 days' post-AI PD test. From the two-farming systems, pregnancy reduction was observed in extensive type of management system. It seems due to the cause that in such type of dairy production, cows/heifers were exposed to environmental effluences produced from industries while grazing and watering in the communal grazing lands and watering points. Additionally, these production systems showed a significant ($p<0.05$) difference in the conception rates of cow/heifer. This result supports the report: cows/heifers reared in intensive system resulted in higher pregnancies (62.0%) than those kept extensively (55.6%) [7]. Similarly, Mekonnen *et al.* [24] noted that reproductive efficiency was poor in most smallholder extensive dairy cattle production systems, which leads to cows failing to become pregnant with various factors including management problems, nutrition and semen handling practice.

The current investigation revealed that about 10% of better conception rate was recorded by heifers than cows. In line with the current result slightly higher positive pregnancy was detected from heifers than those of cow as reported in North Shoa Amhara [7]. Though heifers resulted in better conception rate than cows, the pregnancy reduction from 45 days to the three-month post-AI PD test in cows and heifers was 1.4 and 7.15%, respectively. Higher pregnancy reduction rates in heifers than cows during the gestation period of the two groups might be due to heifers' poor resistance to environmental effluences. Generally, the effect of parity should depend on the health status and management of dairy animals [17, 18].

In the current result, majority (67%) of cows/heifers with open cervix showed positive conception than the partially open (30%) and closed cervix (20%). Furthermore, the conception rate observed in open cervix status was significantly ($p<0.05$) different from both partially open and closed cervix status. A harmoniously researched report indicated higher conception rate detected from cows/heifers with open cervix than partially opened and closed cervix [15].

The conception rate result on 45 days' post-AI PD test of indigenous cows/heifers were slightly better than their counterpart Holstein Friesian (HF) cross. The pregnancy rate of the indigenous and HF cross were reduced by about 2% and 7%, respectively on the three-month post-AI PD test. More pregnancy reduction of the HF cross till the three-month post-AI PD test might be an indication for lower resistance toward environmental stresses. In agreement with the current result, better conception rate of the indigenous dairy cattle than the HF cross dairy cattle has been reported by previous research [6]. On the other hand, others Girmay *et al.* [17] indicated that from the indigenous cows and heifers treated with one shot of

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prostaglandin, 31.6% became pregnant and from the cross, 33.3% resulted in conception.

Concerning the frozen semen, from the four bulls, the highest conception rate (from bull number 2676) resulted in 32% better conception rate than the lowest (from bull number 4630). The variation on the conception rate obtained with semen of different bulls might be due to the difference in semen profile for each of bull ID number. In terms of degree of success of conception of semen from different bulls, the uppermost was 83.3% while the lowermost bull was 40% [7]. On the other hand, reduced variations had been observed on the success rate of bulls on the conception rate where the bull with the highest conception rate recorded 37.5% and the bull with the lowest conception rate recorded 27.3% [17].

Calving rate

As shown in Table 4, the overall calving rate in this experiment was at (91.1%), and was in agreement with the previous reports [7]. On the other hand, calving rate recorded in the current experiment was higher than that (26.9%) reported by Seidel [25]. There were significant ($p<0.05$) differences between Wuchale and the other two districts with regard to calving rate. Lower calving rate was observed in *Degem* district which might be due to the influences of cement-producing industries which are directly located in the highland *kebele* from which sampled animals were taken. Similarly, lower calving rate was observed in Kuyuu district which might be related to the low potential of this district. Pregnancy reduction trend between the 45 days and three months' post-AI PD test in *Degem* and *Kuyuu* districts thus minimized the calving rate.

The average calving rate observed in the highland agroecology was 4.7% which was significantly ($p<0.05$) lower than that recorded in the midland agroecology. Lower calving rate result from the highland might be due to the fact that cement-producing industries are unfortunately located in the highland sampled *kebele* of the aforementioned districts.

Cows recorded 8.3% better calving rate than the first calver-heifers and there was a significant difference ($p<0.05$) between these two herd groups. As described in the conception rate, the first calver-heifers might lowly resist effect of environmental wastes released from the cement factory than the adult cow, as a result, there is pregnancy reduction which decreases the calving rate. Contrary to the current investigation, a slight difference between the calving rates of cows and heifer where heifers achieved better has been reported elsewhere [7].

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Calves' sex ratio
Efficient genetic enhancement can be reasonably achieved by the management of offspring's sex ratio through the differential increase in the number of female or male calves based on the breeding objective of the farm [26]. The current result in general revealed more male calves are observed than female. While in the *Degem* district, male to female ratio of the calves born was 1:1 (50%:50%), the proportion of male calves born within the framework of the current study was high in Kuyuu (58.8%) and Wuchale (68.3) districts (Table 5). This result attributed to the breeding method used in this experiment is entirely by AI. The increased number of males in the current experiment might be due to the appearance of more Y chromosomes than the X in the straws used for the administration of AI. Besides, population of X chromosomes might be reduced during the semen processing and storage than the Y chromosome. Correspondingly, findings reported high proportion of male calves were born from cows/heifers that were artificially inseminated [27, 28].

Among breeds of cows/heifers included in this experiment, slightly more female proportion than male calves were observed by the indigenous breeds. Calves' sex proportion was significantly ($p<0.05$) different between the indigenous and HF crossbred cows/heifers. In relation to the breeds of cows/heifers, Frehiwot [26] indicated there are notable differences between dairy and beef type breeds in terms of calf sex ratio. It is noted that beef-type breeds produced more male calves when compared with dairy-type breeds. However, the underlying genetic background is not clearly known. On the contrary, the birth of more female calves to Horro and high-grade Friesian cows that stated such apparent differences probably occurred by chance and/or attributed to the insufficient sample size used in the study [29].

Although more male calves were observed than females both in the current cows and heifers herd group, the proportion of female was slightly more in the cow herd. This herd group showed significant ($p<0.05$) difference in the calves' sex ratio. In relation to the parity of cows/heifers, reports indicated various results of female to male sex ratio. Goshu and Singh [30] indicated the proportion of female calves born was 48% at first calving heifers whereas, it had a value of 41% and 51% for second calving and fifth to seventh calving, respectively.

Concerning the frozen semen of different bulls, there was 25% difference between those resulting in the highest and lowest proportion of female and male calves. The calves sex ratio for the frozen semen of bull number 1858 was significantly ($p<0.05$) different with 2676 and 4630, similarly calves sex ratio was significantly

($p<0.05$) different between the frozen semen of bull number 2627 and 4630. Differences in the sex ratio of frozen semen from different bulls might be caused by the proportional difference between the X and Y chromosomes in the straws. In this regard, frozen semen of bull having a more proportion of Y than X chromosome might resulted more male calves. On the other hand, semen processing might reduce the proportion of X chromosome that finally tends to the delivery of fewer proportion female calves in artificially inseminated cows/heifers.

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

In the current study, various animal and environmental factors played a vital role in the dairy cattle estrus synchronization using Alfaglandin C and the efficiency of AI. Within the framework of the investigation, significantly better achievement in estrus exhibition, conception rate, and calving rate had been observed for those districts in which AI technicians practically received motivations and incentives for their rendered services. The semi-intensive part of the study also showed better estrus synchronization response and better reproductive performances which are directly associated with the management practices. Pregnancy reduction trend throughout the gestation period and lower calving rate of cow/heifer was recognized in areas where some industrial by-products such as cement manufacturing industries are common. Therefore, estrus synchronization and efficiency of AI can be enhanced by better management of the cow and heifer and motivations for AI technicians.

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Table 1: Sample target study areas with the corresponding number of cows/heifers

Districts	Kebele	Agro-ecology	Cows/heifers tested	Cows/heifers selected
Wucale	Muketuri 01	Highland	98	39
	Adere Gurduma	Midland	87	21
Degem	Ana Degem	Highland	89	35
	Alidoro Abo	Midland	76	25
Kuyuu	Kuyuu o1	Highland	93	39
	Debena Agelo	Midland	75	21
Total			518	180

Chi-square value (X^2), Holstein-Friesian (HF), Body Condition Score (BCS), Values with different superscript are and * are significantly different

Table 2: Effect of alfaglandin C injection and related factors on estrus exhibition

Variables	Sample size	Positive		X^2	p-value
		Frequency	Percent		
Overall	180	127	70.56		
District					
Degem	58	45	77.59^a		
Kuyuu	66	53	80.30^a	13.89*	0.01
Wuchale	56	29	51.79^b		
Agroecology					
Highland	113	85	75.22^a	3.18*	0.04
Midland	67	42	62.69^b		
Farming system					
Extensive	149	98	65.77^a	9.53*	0.02
Semi-intensive	31	29	93.55^b		
Herd group					
Cows	108	71	65.74	3.01	0.08
Heifers	72	56	77.78		
Breed					
Indigenous	82	44	84.69^a	20.67*	0.001
HF Crossbred	98	83	53.66^a		
BCS					
BCS 2	47	32	68.09^a	181.22*	0.04
BCS 3	103	74	71.84^b		
BCS 4	30	21	70.00^b		

Chi-square value (X^2), Holstein-Friesian (HF), Body Condition Score (BCS), Values with different superscript are and * are significantly different

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Table 3: Conception rates following PD tests conducted 45 days and 3 months post AI

Variable	45 days PD test result		X^2	P value	3 months PD test result		X^2	P value
	Positive	Percent			Positive	Percent		
Districts								
Degem	25	55.56^{a}			23	51.11		
Kuyuu	37	69.81^{b}	130.3*	0.03	35	66.04	2.37	0.36
Wuchale	17	58.62^{a}			16	55.17		
Total	79	62.20			74	58.27		
Agroecology								
Highland	60	70.59^{a}			56	65.88^{a}	6.13*	0.01
Midland	19	45.24^{b}	135.7*	0.01	18	42.86^{b}		
Farming system								
Extensive	54	55.10^{a}			49	50.00^{a}		
Semi-intensive	25	86.21^{b}	137.0*	0.001	25	86.21^{a}	12.04*	0.001
Herd group								
Cow	41	57.75^{a}	10.37*	0.011	40	56.34	3.01	0.08
Heifer	38	67.86^{b}			34	60.71		
Cervix status								
Open	75	66.96^{a}			70	62.50^{a}		
Partial	3	30.00^{b}	137.4*	0.001	3	30.00^{b}	135.2*	0.002
Closed	1	20.00^{b}			1	20.00^{b}		
Breed								
Indigenous	52	62.65^{a}			50	60.24		
HF Cross	27	61.36^{b}	118*	0.02	24	54.55	0.38	0.54
Bull								
1858	8	40.00^{a}			8	40.44^{a}		
2627	32	66.67^{b}	133.7*	0.028	31	64.58^{b}	16.34*	0.031
2676	18	72.00^{b}			15	60.00^{b}		
4630	21	61.76^{ab}			20	58.82^{ab}		

AI (Artificial Insemination), Chi-square value (X^2) and Values with different superscript and * are significantly different

Table 4: Calving rates among sample animals by location, agroecology and herd group

Variables	Calving		Abortion		X^2	p-value
	Frequency	%	Frequency	%		
Districts						
Degem	22	88.00[a]	3	12.00		
Kuyuu	34	91.89[b]	3	8.11	42.5*	0.04
Wuchale	16	94.12[b]	1	5.88		
Agroecology						
Highland	54	90.00[a]	6	10	36.13*	0.01
Midland	18	94.74[b]	1	5.26		
Herd group						
Cows	39	95.12[a]	3	4.88	78.04*	0.017
Heifers	33	86.84[b]	5	13.16		

Chi-square value (X^2) and Values with different superscripts are significantly different

Table 5: Calves sex ratio with districts, breeds, herd group and bull number

Variables	Female		Male		X^2	p-value
	Frequency	%	Frequency	%		
Districts						
Degem	11	50.00[a]	11	50.00		
Kuyuu	14	41.18[a]	20	58.82	87.0*	0.04
Wuchale	5	31.25[b]	11	68.75		
Total	30	41.67	42	58.33		
Breed						
Indigenous	25	52.08	23	47.92	43	0.06
HF cross	5	20.83	19	79.17		
Herd group						
Cows	17	43.59	22	56.41	35	0.07
Heifers	13	39.39	20	60.61		
Bull number						
1858	2	25.00[a]	6	75.00		
2627	12	38.71[ab]	19	61.29	89*	0.01
2676	7	50.00[bc]	7	50.00		
4630	9	47.37[cd]	10	52.63		

Chi-square (X^2) and Values with different superscript and * are significantly different

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