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Original Research

Analysis of Breeding Techniques and Evaluation of Efficiency of Artificial Insemination after Estrus Synchronization in Dairy Cattle

Iyasu Lefamo[1*], Yosef Tadesse[2], Mengistu Urge[2] and Daniel Abebe[1*]

[1] College of Agriculture and Natural Resources, Jinka University, P.O. Box 165, Jinka, Ari Zone, South Ethiopia Regional State, Ethiopia

[2]School of Animal and Range Sciences, College of Agriculture and Environmental Sciences, Haramaya University, P.O. Box 138, Dire Dawa, Ethiopia

Abstract

This study was conducted in order to evaluate breeding practice and examine the efficacy of estrus synchronization in dairy cattle in Lemo and Misha district smallholder production systems. In addition, 65 local and 55 crossbred were selected using random sampling and treated with a single dose of prostaglandin. Estrus induction, conception rate, and services per conception were evaluated in the study. Result indicated that both natural mating and artificial insemination (AI) were being in the study areas. According to respondent, AI adoption rate ,comparative success rates of methods, or farmers attitudes, significant traits given attention in the selection of breeding animals were high milk yield, fast growth rate, disease resistant, and good body condition. Reproductive performance was evaluated using age, body condition, and parity. However, the AM/PM rule was applied in timed artificial insemination, whereby animals showing estrus in the morning were inseminated the same evening, and those seen in the evening were inseminated the following morning. The protocol enabled insemination to occur 8-12 hours after observation estrus onset. Thereby maximizing conception rate, following a single injection of prostaglandin, the reproductive performance recorded revealed that 54.2% (n=65/120) of synchronized cows were pregnant, as confirmed through rectal palpation 90days post-insemination. Conception was higher in the action research group, requiring fewer services per conception (1.8 ± 0.4) than routine practice (2.5 ± 0.6; $p < 0.05$). The study conclude that its successful estrus synchronization and breeding program depend on improving AI technician efficiency , semen quality, and overall herd management practices.

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***Corresponding Author:**

E-mail:

iyasulefamo2009@gmail.com

danifaya91@gmail.com

INTRODUCTION

Ethiopia possesses Africa's largest stock of animals, as the sector contributes 15-17% GDP and 35-40% of agri-GDPs (FAO, 2021). The livestock sector is at the core of the livelihood of smallholder farmers, providing food, income, draft power, and cultural significance. Despite its importance to the economy of Ethiopia, livestock industry productivity remains plagued by genetic limitations, nutritional management, widespread diseases, and reproductive management (CSA, 2021; Tesfaye et al., 2015). Some of the research conducted in Ethiopia has critically examined the effectiveness of artificial insemination (AI), estrus synchronization, and other reproductive technologies. These include most prominently Shiferaw et al. (2003), who offered seminal research on reproductive performance among Ethiopian crossbred dairy cows and documented, whereas Tadesse et al. (2014) pointed to the field-level achievement of AI schemes in a number of regions. Apart from that, livestock is also a significant rural resource that performs not only a nutritive and revenue function Beyond its production function, the livestock sector in Ethiopia performs: in addition to food products, livestock supplies critical exports in the form of live animals, hides, and skins, which bring foreign exchange to the country (FAO, 2020; MoA, 2021). Of the livestock species, cattle, mostly native zebu breeds, play a multi-purpose role by offering milk, meat, draught, and manure used for fertilizer and fuel (FAO, 2010). Despite their acclimatization to the environment, Ethiopia's native cattle have very low productivity due to interrelated constraints: This is primarily due to gene-based limitations of native cattle , restricted inputs, prevalence of disease, and reliance on traditional pastoral systems (CSA, 2015; Shiferaw et al., 2003). Inefficient animal production refers to the absence of adequate quantity or access to needed resources and materials required for effective animal husbandry. The inputs are responsible for increasing productivity, health, and profitability. Environmental stress, insufficient technical knowledge, inadequate input and market infrastructure, and absence of support services are other contributing factors (Azage et al., 2010). Breeding practices of cattle in Ethiopia varied and included controlled bull schemes, natural service, and artificial insemination (AI) with or without hormonal synchronization (Bainesagn, 2015).

While natural mating is predominant in the majority of the highland and mid-altitude areas, selective application of AI by some farmers is also the case (Tesfa, 2009). Seasonal breeding is the norm in Ethiopian farmers, where mating is synchronized to take place at the same time as the rainy season. This optimizes calving during periods of better feed availability, which increases calf survival and general reproduction efficiency. Maximizing reproductive performance lies at the heart of maximizing dairy profitability. Precision Reproductive Technologies to Improve Genetics offer practical solutions to reproductive inefficiencies and enable genetic improvement via timely breeding and the option of accessing superior genetics (Kouamo & Sawadogo, 2012). Ethiopia's Livestock Paradox: Predominant Herd Size, Hidden Potential (FAO, 2021).

However, the performance of dairy cattle is significantly below optimal. Underperformance can largely be ascribed to a range of factors, including poor indigenous breed genetic merit, poor nutrition, poor veterinary care availability, restricted access to new technology, and excessive dependence on traditional breeding practices (FAO, 2010; CSA, 2015). In spite of efforts to improve reproductive efficiency through new technologies such as artificial insemination (AI) and estrus synchronization, conception and calving rates have remained inconsistent and typically low under field conditions. Seminal Ethiopian Research on Cattle Productivity, revolutionary findings, Shiferaw et al. (2003) and Genzebu et al. (2016) have assessed the reproductive performance of crossbred and local Cows under different management Systems in Ethiopia.

The study disclosed that body condition score (BCS), time of insemination, parity, and season significantly affect conception rate. However, studies on this are limited. Very few studies have been conducted. Reproductive Performance of Dairy Cows in Lemo and Misha Districts, Southern Ethiopia, where livestock is a part of livelihood and where AI service provision is growing. Further, while studies like Kouamo and Sawadogo (2012) have attempted to review issues pertinent in other African countries, variations in regional agro-ecology, breed types, and facility support are location-specific and limit their applicability to Ethiopia. Therefore, the current research attempts to fill the above-mentioned knowledge gap through evaluation of breeding practice, Artificial Insemination (AI) effectiveness, and Dairy Cows' Reproductive Performance in the Southern Ethiopia (Lemo & Misha Districts) and thereby present location-specific recommendations for improving reproductive success. Therefore, the current study was conceived with the objective to assess dairy cattle production, breeding Practices & AI Efficiency following Synchronization in Lemo & Misha Districts, Southern Ethiopia.

MATERIALS AND METHODS

Study Area

Fieldwork was conducted in Ethiopia's Hadiya Zone (SNNPR), 232 km south of the capital city, Addis Ababa, in two dissimilar districts. Ecologically, the zone consists of 24% highland, 65% mid-altitude, and 11% lowland landscape. It has a mean annual rainfall of 1260 mm, with altitude variation from 540 to 2940 m above sea level and a mean annual temperature of 22.02°C as per the National Meteorological Agency of Ethiopia (NMA, 2020) and the Central Statistical Agency (CSA, 2021). The study particularly emphasized the Lemo (mid-altitude) with the mean altitude of 1800–2100 meters and Misha (highland) districts has an elevation normally above 2300 meters, purposively selected based on availability of AI infrastructure, dairy cow populations, road conditions, farmer expertise, and market proximity as reflected by the Lemo Woreda Finance and Economic Development Office (LWFEDO, 2017).

Household Selection and Sample Size:

Multistage sampling was applied for sampling household units for the study. Lemo and Misha districts were purposively selected first because of agro-ecological heterogeneity, availability of artificial insemination (AI) facilities, and extension services.. Three Kebeles having relatively higher dairy cattle numbers and accessibility of AI services in every district were selected following consultation with local agricultural experts. 20 randomly selected dairy farmers from each Kebele, 30 farmers were selected systematically, which provided a total sample size of 120 farmers. The sample was ascertained based on the consideration of available resources, the number of dairy farmers who use AI services, and representativeness in agro-ecological zones. Selection was qualified if the farmer possessed any dairy cow and previous experience with AI services. The houses that were sampled served as a benchmark for the subsequent animal selection and reproductive performance assessment

Design and Animal Selection

One hundred twenty dairy cows, 65 local and 55 crossbreds, from both districts (60 from each district) were purposively sampled, based on purposive sampling, to serve as representatives of genotypes that prevail and in controlling factors of reproductive performance, as is the case with field-based estrus synchronization studies. Cows were selected based on genotype, feed availability, age (3–9 years), parity (1st to 5th), health status, and body condition score (BCS 2–4 on a scale of 1–5; Nicholson & Butterworth, 1986). Animals received a single intramuscular injection of 5 ml $PGF_2\alpha$ (Lutalyse™) with 5–10 ml gauge needles. Animals were given intramuscularly a single dose of 5 ml prostaglandin $F_2\alpha$ (Lutalyse™) using 5–10 ml gauge needles according to the procedure previously used in field experiments under Ethiopian conditions have shown synchronization to be effective with similar methodologies (Shiferaw et al., 2003; Genzebu et al., 2016). Animals that showed signs of estrus between 24 and 120 hours' post-injection were inseminated. Post-injective timing beyond this window was found to affect conception outcomes**.**

Sampling and Participants

Two districts were selected purposively.. From these, three rural Kebeles were randomly selected from each district, proportionally selected based on the number of dairy cows owned in each Kebele, ensuring that sampling reflected actual dairy cattle distribution and production potential. This approach resulted in a total sample of 120 households. In addition, Four Focus Group Discussions (FGDs) were conducted in each with 8-12 members chosen based on purposive sampling, two in Misha District and two in Lemo District. Each FGD involved participants, women, youth, elders, and community leaders. Breeding history, AI use, reproductive problems, and conception success perception were debated.

Data Collection Methods

Data Sources

Primary Data

Primary data were collected directly from dairy farmers through structured questionnaires, focus group discussions (FGDs), and key informant interviews. The questionnaire yielded data on household members, herd structure, breeding, availability of AI services, estrus detection, and reproduction performance. FGDs and interviews are used to explore local knowledge, attitudes, and perceptions through qualitative observations regarding local knowledge, attitudes, and perceptions regarding AI, natural mating, and conception success.

Secondary Data

Secondary data were gathered from district livestock offices, AI technicians, and others. These included data on AI coverage, technician deployment, conception rate, breeding service records, and population counts of general livestock. Related literature and available results from research were also reviewed in an effort to guide the study's design and to position findings in context. GDs), and key informant interviews. The questionnaire gathered information on farm household structure, composition of herd, breeding plan, access to AI service, estrus detection, and reproductive performance. FGDs and interviews provided qualitative data on local understanding, attitude, and perceptions regarding AI, natural service, and conception rate. Estrus Detection and Insemination

Farmers were also taught to identify estrus symptoms before synchronization. AI was conducted following the AM/PM rule (Peter & Ball, 2004). Inseminations were conducted by an experienced AI technician from the local livestock office using frozen Holstein Friesian semen from the National Artificial Insemination Center, Kality. Cows that did not return to estrus were presumed pregnant and conception was confirmed by rectal palpation 90 days after insemination.

Pregnancy Diagnosis and Embryonic Mortality

Pregnancy was assessed by rectal palpation 90 days post-AI, since it was not possible to conduct progesterone tests. Positive diagnosis of pregnancy was validated by the numerator/denominator.

Data Analysis

The data were entered into Microsoft Excel (2010) and analyzed using SAS software (Version 9.1.2**).** Quantitative data were analyzed by the General Linear Model (GLM), while qualitative variables were analyzed by chi-square (χ^2) tests. Where there were significant differences ($P < 0.05$), Least Significant Difference (LSD) and Tukey's post hoc tests were employed to test the means. Survey data were calculated in SPSS in order to derive descriptive and inferential statistics. Focus Group Discussion (FGD) data was audio-recorded, transcribed verbatim and qualitatively analyzed through thematic content analysis. The transcripts were carefully read, coded and categorized into themes and sub-themes in relation to study objectives. This qualitative analysis helped triangulate the quantitative findings and provided further insight into participants' experiences and perceptions.

Models for evaluation of single shot prostaglandin injection.

Yijklmno= μ +wl +dj+bk+pl+tm+an+eijklmno

Where Yijklmno =the response variables=Pregnancy diagnosis (positive and negative)

μ= Overall mean

wi= Fixed effect of i^{th} district (i=2, Lemo and Misha)

dj= Fixed effect of j^{th} dam breed (j=Local, crossbred)

bk= Fixed effect of k^{th} body condition

pl= Fixed effect of l^{th} parity

tm= Fixed effect of m^{th} time in hrs (m=24-48,48-72,72-96 and 96-120; AI time interval)

an= Fixed effect of n^{th} age and

eijklmno=residual error

Conception rate and services per conception were determined as a percentage of pregnancies confirmed through rectal palpation of the genital tract on day 90 post-insemination, relative to the number of cows and heifers artificially inseminated using frozen semen during the period (Sharifuzzaman et al., 2015). Conception rate (%) was determined by dividing pregnant cows by total inseminated cows and multiplying by 100.

$$\text{conception rate} = \frac{number\ of\ cows\ pregnant\ X\ 100}{number\ of\ cows\ inseminated}$$

The number of services per conception was calculated using total number of service/ inseminated per total number of cows conceived.

$$\text{Number of service per conception} = \frac{total\ number\ of\ sevices}{total\ numberr\ of\ cows\ conceived}$$

$$\text{Estrous rate} = \frac{numbr\ of\ cows\ showed\ estrous}{number\ of\ cows\ treated\ with\ prostaglandin\ hormone\ (PGF2\alpha)}$$

Indices were calculated to rank the reasons for keeping cattle, preferred traits, and reasons for AI failure, following the method described by Kosgey (2004). The index for each reason was calculated based on the assignment of weights to ranks: 5 for the first rank, 4 for the second, 3 for the third, 2 for the fourth, and 1 for the fifth. The sum weighted score for a given reason was then divided by the sum weighted score for all reasons, providing a relative ranking of each factor.

RESULTS

Breeding Practices

Natural mating was the predominant breeding method in the Lemo district, with artificial insemination (AI) as a backup. Natural mating and AI were used equally by farmers in Misha district, an indication that could be due to improved access to AI services and possibly increased awareness. Despite challenges of adaptability, immunity to diseases, and feed demand, farmers as a whole favored superior breeds due to their higher milk productive capacity. Mating method choice was largely based on the availability of bulls, transport to AI service points, and previous conception success rates. These answers indicate how farmers' breeding strategy choices are driven by practical restrictions and perceived benefits (Table 1).

Major Reproductive Problems in Dairy Cattle

As indicated in Table 2, the most common reproductive problems that were documented from farmers included non-cycling (32.5%), repeat breeding (26.7%), poor conception rates (18.3%), hard calving (12.5%), and abortion (10.0%). These issues as a whole indicate severe reproductive inefficiencies in the study regions, with non-cycling and repeat breeding being the most prevalent issues confronting herd fertility and production.

Table 1. Type of Mating and Mating Preference of Respondents

District	Mating system					
	Only natural bulls (n=60)	AIS (n=60)	Both(n=120)	Natural P(n=60)	AI P(n=60)	Both P(n=120)
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Lemo	29(48.3)	28(46.7)	28(46.7)	29(48.3)	28(46.7)	28(46.7)
Misha	31(51.7)	32(53.3)	32(53.3)	32(53.3)	32(53.3)	32(53.3)
Total	60(100)	60(100)	60(100)	60(100)	60(100)	60(100)

Where, AIs=artificial insemination service, N=number of respondents, P=preference

Table 2. Dairy Cattle Major Reproductive Problems in Study Areas Sampled Households

Reproductive problems	District			
	Lemo (N=60) Mean±SE	Misha(N=60) Mean±SE	Overall mean	P-Value
Failure to cycle	1.4±0.06	1.4±0.06	1.4±0.04	0.071
Poor conception rate	1.0±0.0	1.0±0.0	1.0±0.0	0.042
Repeat breeder	0.56±0.06	0.48±0.06	0.52±0.4	0.332
Abortion	3.2±0.14	2.68±0.14	2.9±0.1	0.261
Calving problem/dystocia	5.6±0.07	5.7±0.2	5.68±0.48	0.048

*Where, SE=Standard error=Number of sampled respondents *=P<0.05*

The overall conception rate of Estrus Synchronization and Mass Insemination (OSMI)

Estrus Response

A high estrus response (94.4%) was observed after PGF2α administration. Crossbreds responded faster than local **breeds (P < 0.05). The overall conception rate** was 48.6%, showing a moderate level despite variations in estrus response and mating methods. The overall conception rate was 48.6% (Table 3).

Services per Conception

Crossbreds had a lower average NSC (1.9) than locals (2.1), and a higher conception rate (Table 3).

Genotype Effect

Significant differences (P<0.05) were noted across agro ecologist. Crossbred cows had better CR in mid-altitudes, while locals did better in highlands (Table 4).

Parity Effect

Parity significantly influenced CR (P<0.05), with second and fourth parity animals showing better conception in both districts (Table 4).

Body Condition Score

Cows with BCS 4 and 5 had better conception rates. BCS was a significant factor in Lemo (Table 4).

Age Effect

CR varied significantly with age (P<0.05), peaking in cows aged 3–7 years and declining after 8 years (Table 4).

Timing of Insemination

Considerable variations were noted among agro-ecologies (P < 0.05), with crossbred females conceiving in higher proportions in midland areas (Lemo), while local breeds performed better in highland areas (Misha) (Table 4). Conception was highest when insemination occurred 24–48 hours post-estrus, with significant differences observed across timing groups (P < 0.001) (Table 5).

Table 3. Oestrus Response Rate, Response Interval, NSC and Conception in Dairy Cattle for (OSMI) (N=986)

Parameters	N	Estrus response rate (%)	Response interval after PGF2a (hrs.)				Insemination	NSC	N (CR %)
			24 to 72		72 to 120				
Genotype		N (%)	M	%	M	%			
Local	565	531(93.9)	440	82.9	91	17.1	531	2.1^{NS}	242(45.6) ^{NS}
Crossbred	421	400 (95.0)	347	86.5	53	13.5	400	1.9^{NS}	211(52.7) ^{NS}
Overall	986	931 (94.4)	787	84.5	144	15.6	931	2.0	453(48.6)

*Where, N=number of PGF2α injected, M=number of inseminated, NS=Non significant, n=number of pregnant cow, *=P<0.05*

Table 4. Conception Rate and Factors Affecting Conception in Synchronized Dairy Cattle for (OSMI) (N=986)

Factors	**Agro ecology**								
	Highland(Misha)					**Midland(Lemo)**			
	N	**Estrus rate %**	**Inseminated**	**Conceived**	**Conception rate %**	**Inseminated**	**estrus rate %**	**Conceived**	**Conception rate (%)**
Genotype								*	
Local	565	47.0	266	183	68.8	263	46.5	59	22.4
Crossed	421	47.7	201	103	51.2	201	47.7	108	53.7
Parity (both breed)					*			*	
1st	120		62	25	40.3	42	25	59.5	
2nd	564		282	132	46.8	257	138	53.7	
3rd	45		14	1	7.1	23	5	21.7	
4th	223		114	55	48.2	106	61	57.5	
5th	34		20	8	40	11	3	27.3	
BCS	Both breed				NS			*	
2	84		0	0	0	84	5	5.9	
3	206		96	34	35.4	101	47	46.5	
4	216		120	59	49.2	93	50	53.7	
5	480		230	107	46.5	207	151	72.9	
Age					*			NS	
3 to 4	543		324	178	54.9	219	131	59.8	
5 to 7	321		127	62	48.8	181	73	40.3	
8 to 9	122		26	7	26.9	54	2	3.7	

*Where, N =number of inseminated, NS= significant, *=p<0.05*

Table 5. Influence of Time of the Insemination

Variable TI (hrs.)	**N**	**Conceived**	**CR %**	**P- Value**
24 to 48	456	331	72.6%[a]	<0.001
48 to72	279	94	33.7%[b]	
72 to 96	155	23	14.8%[c]	
96 to 120	41	5	12.2%[d]	

Where -number of cow inseminated, CR% -conception rate, P-probability TI-insemination time

Reproductive Performance of Synchronization in Field Trials

Estrus Response

100% estrus response was observed in field trials. Crossbreds showed a shorter response interval than local cows (Table 6).

Table 6. Oestrus Response Rate, Response Interval, NSC and Conception Rate in Dairy Cattle Cows (N=120)

	N	**Estrus response rate (%)**	**Response interval after PGF2a (hrs.) 24 to 72**		**72 to 120**		**Insemination**	**NSC**	**CR%(n)**
Genotype		N (%)	N	%	N	%			
Local	65	65(100)	44	67.7	21	32.3	65	2.4	41.5(27)*
Crossbred	55	55(100)	51	92.7	4	7.3	55	1.44	69.09(38)*
Overall	120	120(100)	95	79.2	25	20.8	120	1.84	54.2(65)

*Where, N=number of inseminated and PGF2α injected, NSC=Number of service per conception rate, CR=Conception rate, n=Number of pregnant cows *=P<0.05*

Services per Conception

As presented in Table 6, a lower NSC was associated with a higher conception rate and the conception rate was significantly higher in crossbred cows (69%) compared to local breeds. The overall conception rate recorded across all animals in the study was 54.2%.

Genotype

Crossbred cows in highlands had higher first-service CR than local breeds (Table 7).

Parity

Second and third parity cows had the highest CR. Higher parity was associated with declining fertility (Table 7).

Body Condition

Higher CR was observed in cows with BCS 4 and 5, though not statistically significant in all districts (Table 7).

Age

CR peaked in cows aged 5–7 years and dropped after 8 years, especially in the highlands (Table 7).

Table 7. Conception Rate and Factors Affecting Conception in Synchronized and Inseminated Dairy Cattle (N=120)

Factors	**Agro-ecology**										
	N	**Highland (Misha)**					**Midland(Lemo)**				
		Estr		**Ins**	**Co**	**C**	**Estr**		**Ins**	**Co**	**C**
Ge		N	%				N	%			
Lo	6	3	5	65	9	2	3	4	32	18	5
Cr	5	2	4	65	21	7	2	5	28	17	6
Parity		N =120				*					*
1	7			7	2	2			0	0	0
2	4			22	16	7			20	13	6
3	3			19	11	5			19	15	7
4	1			7	0	0			10	4	4
5	1			5	1	2			11	3	2
BC						N					N
2	8			0	0	0			8	3	3
3	1			9	4	4			7	1	1
4	1			11	5	4			5	0	0
5	8			40	21	5			40	31	7
Ag						*					N
3	3			24	12	5			13	9	6
5	6			25	16	6			37	26	7
8 to 9	21			11	2	18.18			10	0	0

*Where, N =number of inseminated, NS= Non-significant, *=p<0.05*

Insemination Timing

Insemination timing significantly influenced CR (P<0.001), with 24–48 hours' post-estrus being optimal (Table 8).

Table 8. Effect of Time of Insemination on Conception Rate

Variable	(N =120)		CR %	P- Value
TI (hrs.)		Conceived		
24 to 48	50	43	86%[a]	<0.001
48 to72	34	17	50%[b]	
72 to 96	15	3	20%[c]	
96 to 120	21	2	9.5%[d]	

Where=number of cow inseminated, CR%=conception rate, TI=times of insemination

DISCUSSION

Findings of this study in Tables 1 to 8 reflect a reasonable summary of breeding management, efficiency of estrus synchronization, reproductive performance, and determinants of reproductive performance in dairy cows of Southern Ethiopia. Artificial insemination and natural mating existed side by side in the studied areas in spite of certain differences in the districts' preferences. This coexistence conforms to earlier observations but also reflects certain observed developments. For example, as opposed to Debir (2016), evidence in this study indicates that there is an increase in the application of AI, and this could be explained by the increasing availability of AI services, increased availability of competent technicians, and genetic improvements in bull selection. The 94.4% rate of estrus response attained is higher compared to that attained by Bainasagn (2015) as a result of the use of more effective hormone synchronization methods as well as improved cow handling. This implies that properly managed estrus synchronization programs can record higher success rates, particularly where animal selection and health status are well established. Despite an optimum estrus response rate, the conception rate was moderate at 48.6%. This inconsistency is in agreement with previous research convergence with these observations of Debir et al. (2016) reported concavity to reveal persistent problems such as improper insemination timing, variability in technician skill, and poor semen quality. These emphasize the need for increasing technical skill and allowing for timely insemination within the best time period, 24 to 48 hours after the commencement of estrus—advocated by Diskin (2018) and Debir et al. (2016).

Breed difference analysis revealed that the services per conception (NSC) were higher and conception rates were lower in the local crossbreed. This is likely due to genetic constraints, poor feeding, and estrus detection problems, findings in confirmation with Debir et al. (2016). These differences confirm the need for problem-based breed-specific management intervention

Body condition score (BCS) and parity were also significant determinants. Second to fourth parity cows in moderate to good body condition had enhanced reproductive performance, which also agrees with research by Shiferaw et al. (2003) and Tadesse et al. (2014). This also underlines the importance of maintaining the cows in optimal body condition and avoiding extreme parity breeding. It also declined in cows over the age of 7 years, as shown by the work of Destalem (2015) and Gebeyehu (2005), supporting age-related declines in reproductive performance.

Finally, while synchronization and AI protocols are promising technologies for application in reproductive improvement, their success would depend very much on animal attributes (breed, age, parity, BCS) and management practices (insemination timing, competence of skill of technician, and nutrition of animal). Understanding these interactive factors is necessary to be able to reap the full potential benefits of reproductive technology in Southern Ethiopia.

CONCLUSION

Action research in Lemo and Misha districts indicated that artificial insemination (AI) and natural mating are both practiced in these two districts. However, the effectiveness of the AI program, especially when combined with estrus synchronization, was shown to be below optimum under existing management. The conception rate revealed that the action research achieved the highest percentage at 54.2% which was higher than the rate ever achieved by the Agricultural, Animal, and Fishery Offices of Lemo and Misha districts through their Oestrus Synchronization and Mass Insemination (OSMI) schemes. This indicates that with improved management and accurate application, the effectiveness of AI can be significantly enhanced. Perception surveys of farmers and development agents revealed varying levels of awareness and satisfaction with AI services. Some appreciated the possibility of genetic improvement, while others felt worried about conception rates being low, insemination timing being improper, and there being no skilled technicians. These perceptions indicate the need for focused training, better communication, and better technical backstopping. Finally, improving estrus synchronization and AI programs' efficiency requires not just technical enhancement but also strategic coordination. Proper heifer and cow selection, heat detection early enough, and quality service delivery are basics. Synchronization and insemination procedures should be well-coordinated and complemented by farmer training and improved veterinary services. This will help improve dairy cattle productivity in the two districts.

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Data Availability Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflict of Interest Statement

The authors declare that they have no competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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