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Artificial Insemination Performance and Estrus Synchronization in Smallholder Dairy Cattle in Horro Guduru Wollega Zone, Oromia, Ethiopia

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Abstract

A study was conducted on artificial insemination (AI) performance and synchronization status in the Abay Choman and Jimma Ganati districts of Horro Guduru Wollega Zone from November 2021 to March 2022. Ninety-two respondents were randomly selected from six kebeles for interviews. The mean age at first service (AFS) was 41.45 months for pure Horro, 24.71 months for Holstein Friesian-Horro crossbreed, and 27.92 months for Jersey-Horro crossbreed. Calving interval (CI) was 20.93 months for the pure Horro breed, 13.81 months for the Holstein-Friesian-Horro crossbreed, and 15.08 months for the Jersey-Horro crossbreed. Lactation lengths (LL) were 8.88 months for Jersey-Horro crossbreeds, the highest (9.08 months) in Holstein Friesian-Horro, and lower (7.10 months) for pure Horro. Breeding methods included natural mating alone (3.2%), artificial insemination (AI) only (35.9%), and AI and natural mating (60.9%). The overall conception rate of conventional AI was 56.3% at 60+days post-pregnancy diagnosis. Low conception rates were linked to management issues, poor heat detection, and semen handling. Animal selection, training AI technicians, and farmer training programs to increase AI and synchronization efficiency are recommended.

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INTRODUCTION

Ethiopia has a large and diverse livestock population, supported by favorable agro-ecological conditions for livestock production. According to CSA (2022), the country has 66.3 million cattle, 45.7 million goats, 38 million sheep, and 41.4 million chickens. The livestock sector contributes significantly to the national economy, accounting for 45% of Ethiopia's agricultural GDP, 18.7% of the cumulative GDP, and 16–19% of total foreign exchange profits (Kemal et al., 2024).

Within the livestock sector, the dairy sector holds an important role in food security and household income, particularly among smallholder farmers in Sub-Saharan Africa (SSA). In Ethiopia, indigenous breeds constitute about 97.4% of the total cattle population, while crossbreeds and exotic breeds account for only 2.3% and 0.3%, respectively (Lemessa et al., 2023). Indigenous dairy cattle are well adapted to a tropical environment; however, their production performance was relatively low due to limited inputs, genetic makeup, and traditional husbandry practices, in addition to environmental challenges (Michael et al., 2021).

The productivity of local breeds is generally low, primarily due to two major factors: their genetic makeup and the influence of the surrounding environment. While environmental challenges such as poor feeding, inadequate housing, and limited healthcare can often be addressed through improved management practices at the household or community level, the genetic limitations of these breeds require more advanced solutions (Kebede et al., 2024).

One effective approach is the use of Artificial Insemination (AI), which enables the introduction of superior genetic material from high-performing breeds. By combining better environmental management with genetic improvement through AI, it is possible to significantly enhance both the productivity and overall performance of local breeds (Woldeyohannes et al., 2023).

Assisted reproductive technologies such as artificial insemination (AI) and estrus synchronization have been introduced in Ethiopia to enhance cattle reproduction and accelerate genetic improvement (Mueller et al., 2022). AI involves the manual deposition of semen into the female reproductive organ, while estrus synchronization manipulates the estrus cycle to induce a large proportion of females to come into heat at the same time. Despite their potential, the effectiveness of AI service and estrus synchronization programs in the Horro Guduru Wollega Zone has been questioned largely due to inadequate assessment and evaluation of the reproductive performance of mass-synchronized and inseminated dairy cows. Effective cow management and proper selection, along with maintaining a high body condition score, are among the most critical factors for the success of estrous synchronization and AI services (Shanku, 2022).

Statement of the problem

Although artificial insemination (AI) and estrus-synchronization protocols have been promoted across Ethiopia to improve genetic gain and reproductive efficiency, there is limited context-specific evidence from Horro Guduru Wollega Zone about how these technologies perform under local smallholder conditions. Existing general studies report variable conception and pregnancy rates, but they often aggregate data across agro-ecologies, management systems, breeds, and service-delivery models. This leaves several important, actionable gaps for Horro Guduru Wollega, like the field-level effectiveness of common synchronization protocols and their comparative conception/pregnancy rates in the dominant local genotypes and management contexts; and quantification of key drivers of AI success, such as estrus-detection accuracy, timing of insemination, bull vs. technician semen handling and cold-chain reliability, technician skill and training, and seasonal/heat-stress effects under smallholder resource limits. Therefore, this study was conducted in selected districts of the Horro Guduru Wollega zone to evaluate the performance of artificial insemination and the status of estrus synchronization.

Hypothesis

H_0: Estrus synchronization has no significant effect on conception rate of dairy cows under smallholder conditions in Horro Guduru Wollega Zone.

H_1: Estrus synchronization significantly improves conception rates of dairy cows under smallholder conditions in Horro Guduru Wollega Zone.

MATERIALS AND METHODS

Description of the study area

The study research was done in the Horro Guduru Wollega zone, one of the zonal administrations of the Oromia region, Ethiopia. The zone is found approximately 314 km west of Addis Ababa, the capital of the country, at geographical coordinates 09º29´N and 37º26´E, and an altitude of about 2,296 masl. The area is favorable for diverse agricultural activities, including the production of cereal and horticultural crops, livestock production, and fisheries. Livestock production is a key component of the local agricultural system, with various species raised in the area (Figure 1).

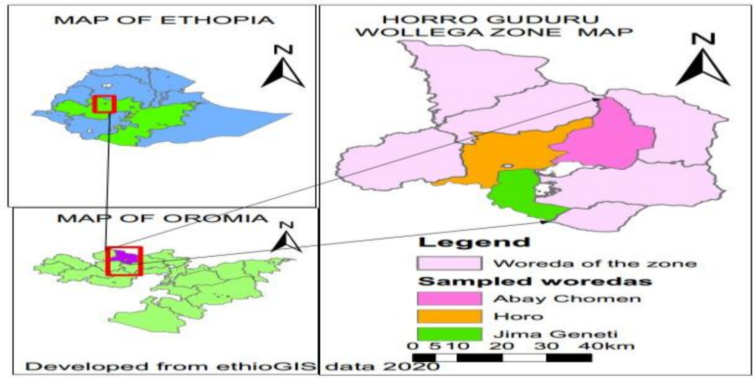

Figure 1. *Map of the study area*

Study Population and Design

The study employed a cross-sectional study. It involved administering questionnaires to smallholder dairy cattle owners to evaluate the performance of artificial insemination (AI) and the status of the estrus synchronization. The survey also aimed to identify challenges faced by farmers, such as the accessibility of AI services during weekends and holidays, access to inputs and AI technicians (AITs), the knowledge level of animal owners, and their satisfaction with AI and estrus synchronization services. Data were collected through a questionnaire followed by face-to-face interviews.

Sampling Techniques and Sample Size Determination

From the total kebeles in Abay Choman and Jimma Ganati districts, three kebeles were purposively selected from each district based on their long-standing experiences with estrus synchronization. In each selected district, 61 respondents were interviewed using pre-tested structured questionnaires. These included 46 dairy cow-owning households using artificial insemination, 11 animal production experts from the district and selected kebeles, 3 para-veterinarians, and 1 artificial insemination technician.

The sample size was determined using the formula recommended by Yamane (1973) at a 95% confidence interval to ensure representativeness. The sample size was calculated using the formula described by Yamane (1973),

$$n = \frac{N}{1 + Ne^2}$$

During the study period, approximately 557 households in the selected kebeles owned at least one dairy cow of any breed.

Here, N = 557 and e = 0.08, we get n=122. Accordingly, 92 dairy cow-owning households and 30 staff members were selected, making a total of 122 respondents for the study.

Data collection and analysis

Primary data were collected from November 2021 to March 2022 for applicable research activities. Secondary data were collected through a semi-structured questionnaire and focus group discussions. Thirty individuals from the three districts were involved in the focus group discussions, during which they ranked dairy cows based on trait performance and AI status. The collected data were entered into Microsoft Excel and analyzed using the Statistical Package for Social Sciences (SPSS) Version 23. An index ranking system was applied to quantify and prioritize factors affecting artificial insemination and estrus synchronization.

RESULTS AND DISCUSSIONS

Results

The assessment illustrated that 73.91% and 26.09% of the family heads were male-headed and female-headed, respectively. The survey categorized the age of the family head into four categories (Table 1).

Table 1

Socio-economic characteristics of the respondents in the study area.

Households Character of respondent	Variable	Number(N)	Respondents (%)
Sex of HH head (%)	Male	68	73.91
	Female	24	26.09
Age category of HH head	Between 18-30 years	9	9.79
	Between 31-45 years	46	50
	Between 46-60 years	35	38.04
	Above 60 years	2	2.17
Educational status of HH heads	Informal education	8	8.7
	Elementary attended	37	40.2
	High school attended	25	27.18
	Diploma/degree	22	23.92
Marital Status of HH	Married	84	91.3
	Divorce	3	3.3
	Widows	4	4.3
	polygamy	1	1.1
		Mean	(±SD)
Family size (no)	Per HH	5.76	±1.901
Total land	Per HH	2.04	±1.747

The study shows that the personal and household characteristics of farmers play a big role in how well artificial insemination (AI) and estrus synchronization work in the community. Most of the households were male-headed (73.91%), giving men greater access to resources, extension services, and decision-making power, while women often faced more challenges due to limited labor and finances. Many household heads were between 31 and 45 years old (50%), an age group usually more open to trying new practices, while older farmers tended to rely more on traditional methods. Education also made a difference, since 91.3% of respondents had formal schooling; they were better able to detect estrus, call technicians on time, and manage their cattle effectively. The fact that most were married (91.3%) also helped, as family support provided the extra hands needed for regular animal handling and close observation during synchronization. Altogether, these factors, gender, age, education, and marital status, shaped how farmers engaged with AI and synchronization, showing that technology adoption depends not only on the tools available but also on the people using them.

The study revealed that 55.4% of households owned oxen for farming, with an average cattle herd size of 7.84 ± 1.36 animals. The average landholding per household was 2.04 ± 1.74 hectares, of which 1.43 ± 1.29 hectares were devoted to crop cultivation and 0.6 ± 0.70 hectares to grazing. These land and livestock resources are directly relevant to the adoption and success of AI and estrus synchronization, as adequate herd size, grazing area, and management capacity influence farmers' ability to provide proper nutrition, regular observation, and timely intervention, critical factors for achieving higher conception and pregnancy rates in smallholder dairy cattle. In households with limited land or small herds, the challenges of estrus detection and synchronized breeding may reduce AI efficiency and overall reproductive performance (Table 2).

Table 2

Cattle herd size and Land holding capacity of households in the study area

Type of cattle	N (%)	Mean ±SD
Cattle /cows	92(100%)	3.26±1.683
Oxen	51(55.4%)	1.39±1.555
Bulls	50(54.35%)	0.89±1.124
Heifers	81(88.44%)	1.88±1.300
Calves	89(96.74%)	2.08±1.170
Average cattle herd size	92(100%)	7.84±1.366
Landholding	Mean	SD
Total land	2.04	±1.747
Crop land	1.43	±1.293
Grazing land	0.6	±0.703

Drinking water and feed resources

Table 3 below illustrates the water sources, feed resources, and feeding methods of dairy cattle. According to the present assessment, 48.9%, 25%, 14.1% and 12% sourced water are from rivers, pipes, streams, and ponds, respectively. This study found that 55.4%, 32.6%, 6.5%, and 5.4% of animal feed sources were natural pasture, crop residue, improved forage, and supplements, respectively.

Table 3

Sources of drinking water, feed resources, and the feeding system in the study area

Source of water	Number of respondents	%HH
Rivers	45	48.9
Stream	13	14.1
Pond	11	12
Other(pipe water)	23	25
Feed resource		
Natural pasture	51	55.4
Crop residue	30	32.6
Supplementary feed	5	5.4
Improved forage	6	6.5
Feeding system of dairy cattle		
Grazing	75	81.5
Cut and carry system	17	18.5

Productive performance of dairy cows

The assessment evaluated the milk yield of pure Horro cows, Holstein-Horro crossbreeds, and Jersey-Horro crossbreeds. Milk yield was recorded at the beginning, middle, and late stages of lactation for each breed. The average daily milk yield was 1.5 liters for Horro cows, 4.7 liters for Holstein-Friesian (HF) crosses, and 3.1 liters for Jersey crosses, resulting in an overall average daily yield of 3.9 liters for crossbred cows. The average lactation length was 7.1 ± 0.92 months for Horro cows, 9.08 ± 2.0 months for HF-Horro crosses, and 8.8 ± 1.86 months for Jersey-Horro crosses (Table 4).

The productive performance of dairy cows in the study area provides important context for the application of artificial insemination (AI) and estrus synchronization programs. The assessment showed that pure Horro cows produced an average of 1.5 liters of milk per day, while Holstein-Horro and Jersey-Horro crosses produced 4.7 liters and 3.1 liters, respectively, resulting in an overall average of 3.9 liters per day for crossbred cows.

Lactation lengths also varied, with Horro cows averaging 7.1 ± 0.92 months, HF-Horro crosses 9.08 ± 2.0 months, and Jersey-Horro crosses 8.8 ± 1.86 months. These differences in milk yield and lactation duration are directly relevant to AI and estrus synchronization because cows with higher productivity and longer lactation periods are often prioritized for breeding interventions to maximize genetic gain and herd improvement. Furthermore, understanding breed-specific performance helps in planning synchronization schedules, timing insemination, and predicting reproductive efficiency, as higher-yielding crossbred cows may have different nutritional and management needs to achieve optimal conception and pregnancy rates.

Table 4

Average milk yield and lactation length in the study areas

Breed	Milk yield Beginning	Milk yield at Mid	Milk yield at Late	N	Mean ± SD	Mean Lactation ± SD of LL
Horro cow	1.6	1.7	1.1	79	1.4634±0.80119	7.10±0.9258
HF cross cow	6.2	5.3	2.6	56	4.69107±0.88787	9.08±2.002
Jersey cross cow	3.9	3.4	2.1	77	3.1249±0.76773	8.88±1.867

Reproductive Performance of Dairy Cows

The study revealed that the average age at first service (AFS) was 41.45 ± 6.23 months for local Horro heifers, 27.92 ± 5.26 months for Jersey-Horro crossbred heifers, and 24.71 ± 6.08 months for Holstein-Friesian (HF) × Horro crossbred heifers. The calving intervals were 56 months for the local Horro breed and 77 months for both Jersey × Horro and HF × Horro crossbreds (Table 5).

These reproductive indicators are directly relevant to artificial insemination programs, as heifers with lower AFS and cows with optimal calving intervals are more suitable for timed-AI and estrus synchronization, allowing for more efficient herd reproduction and genetic improvement. In contrast, longer AFS and extended calving intervals in local breeds may reduce the effectiveness and adoption of AI, highlighting the need for management interventions such as nutrition optimization and timely estrus detection to improve reproductive efficiency under smallholder conditions.

Table 5

Reproductive performance and breeding practice of dairy cows in the study areas

Breed	Parameters	No of respondents	Mean ± SD
Horro cow	Age at first service (month)	79	41.45±6.234
Horro cow	Calving interval (month)	79	20.93±.6.284
HFXHorro	Age at first service (month)	56	24.71±6.087
HFXHorro	Calving interval (month)	l56	13.81±3.12
JersyXHorro	Age at first service (month)	77	27.92±5.26
JersyXHorro	Calving interval (month)	77	15.09±3.55

N=number of household; SD=Standard Deviation; HF=Holstein Friesian

Trait Preferences of Farmers for Dairy Cattle

As shown in Table 6, focus group discussions revealed the community's preferred traits in dairy cattle. Farmers primarily valued milking potential, high growth rate, breeding ability, feeding behavior, temperament, and disease resistance. Approximately 90% of respondents prioritized cows with high milk yield, while breeding ability and rapid growth rate were the second most important criteria, cited by 53% of respondents.

These preferences are directly relevant to artificial insemination (AI) programs, as selecting cows with desirable traits, particularly high milk production and reproductive efficiency, can maximize the benefits of AI and estrus synchronization. By aligning breeding strategies with farmers' trait preferences, AI interventions can improve both productivity and farmer satisfaction, ensuring better adoption and long-term sustainability in smallholder dairy systems.

Table 6

Trait preference of farmers for dairy cattle in the study area (Total of 30 staff)

Parameter rank	No of respondent	Percentage of response
High milk yield	1st (n=27)	90%
High growth rate	2nd (n=16)	53%
Breeding ability	3rd (n=16)	53%
Good temperament	4th (n=9)	30%
Disease resistant	5th (n=10)	33%
Feeding behavior	6th (n=15)	50%

Farmers' perception of estrus synchronization and mass Insemination

Among the 92 respondents, 74 (80.4%) participated in mass estrus synchronization programs. However, 93.5% (69/74) of these participants expressed dissatisfaction with the outcomes, reporting that only 9.8% of inseminated cows became pregnant, while 90.2% failed to conceive. The main challenges identified were poor semen quality, inappropriate timing of the synchronization campaigns, limited awareness of mass synchronization procedures, inadequate selection of cows for AI, and low technical efficiency of AI services (Table 7). These findings underscore that while estrus synchronization and mass insemination hold potential for improving reproductive performance, their success is highly dependent on proper cow selection, technician skill, campaign planning, and awareness among farmers, highlighting critical areas for intervention to enhance AI efficiency and adoption.

Table 7

Farmers' perception of mass synchronization and constraints

Parameters	Yes(%	No%
Do you participate in synchronization?	80.4	19.6
Conceive cows/heifers	9.8	90.2
Satisfaction with the mass synchronization	6.5	93.5
common problem of Synchronization AI service Conception failure	percent	Rank
Semen quality has a problem	31.5	1st
Wrong season of the campaign	26.5	2nd
lack of Awareness of the mass synchronization	17.4	3rd
Poor selection criteria for cows	8.7	4th
AI technicians' efficiency	6.5	5th
The combination of all the listed problems	9.8	

Common Causes of Failure in Hormone Treatment

As shown in Table 8, focus group discussions and expert responses indicated that failures of artificial insemination following mass synchronization were due to multiple factors. The leading causes included lack of farmer awareness (Index = 0.24), poor heat detection (Index = 0.23), late availability of AI services (Index = 0.19), low skill or efficiency of AI technicians (Index = 0.14), long distances between AI centers and dairy farms (Index = 0.13), and the cost of services (Index = 0.17). These findings highlight that both technical and socio-economic constraints, ranging from farmer knowledge and cow management to service accessibility, significantly affect the success of estrus synchronization and AI programs, emphasizing the need for targeted interventions to improve reproductive outcomes in smallholder dairy systems.

Table 8

Causes of AI failure in selected Districts of Horo Guduru Wollega Zone

Parameter rank	1st	2nd	3rd	4th	5th	6th	*Index*	Ranking
Awareness	17	6	3	2	2	0	0.24	1st
Heat detection	7	11	10	2	0	0	0.23	2nd
Availability	1	10	11	6	1	1	0.19	3rd
AIT efficiency	1	3	1	12	13	0	0.14	4th
Distance	4	0	4	8	6	8	0.13	5th
Service charge	0	0	1	0	8	21	0.07	6th

Index = [(6 for rank1) + (5 for rank2) + (4 for rank3) + (3 for rank 2) + (2 for rank 1)] divided by the sum of all weighted reasons mentioned by the respondent

Artificial Insemination (AI) Service Provision

Table 9 presents the findings from focus group discussions (FGDs) on AI service provision. The discussions highlighted notable inconsistencies in service delivery and identified the main challenges as a lack of input supply (35.9%, 11/30), limited availability of AI service sites (20.9%, 6/30), and a shortage of AI technicians in the districts (43.5%, 13/30). These constraints directly affect the timely and effective implementation of estrus synchronization and AI programs, limiting reproductive efficiency and reducing the potential benefits of improved genetic gain in smallholder dairy herds.

Table 9

Training of AI service provision in selected Districts of the study area.

Reason for the inconsistency of AI	Number	Percentage
Unavailability of the AI service on time	11	35.9
AI service located at a distance	6	20.9
AI technician shortage	13	43.5
Total	30	100

Discussions

Socio-economic Characteristics of Households in the Study Areas

These findings are consistent with a report from Southwestern Ethiopia, which indicated that 76.6% of households were male-headed and 23.4% were female-headed (Alilo, 2022). This suggests that the study area is predominantly populated by male-headed households, which is advantageous for artificial insemination success.

This age distribution differs from the findings of Alilo (2022), who reported that 70% of participants were aged 30-45 years, 16.7% were 15-29 years, and 13.3% were 46-65 years old. The high proportion of respondents within the productive age group in the present study may potentiate dairy farming productivity of the area. The 5.76 average family size was similar to the finding of Zewdie et al. (2022), who reported an average family size of 6.02±2.52 in Benishangul Gumuz town. The presence of large family sizes indicates a potential labor force for labor-intensive agricultural and other related labor-based activities in the study areas. A large number of family heads (93.30%) had formal education, indicating strong potential for the adoption of agricultural extension technology. This percentage is higher than that reported by Alilo (2022), who found that 66.7% of the study populations were literate. The marriage status of 91.3% married, 4.3% widowed, 3.3% divorced, and 1.1% in polygamous unions in this study surpasses those reported by Alilo (2022), where 80% were married, 8.3% single, 6.7% widowed, and 5% divorced. The predominance of married respondents is advantageous for managing dairy animals, as dairy farming involves labor-intensive tasks such as feeding, milking, and cleaning, all of which contribute to sustaining agricultural productivity and farmers' livelihoods.

Land Size held by farmers

These figures are higher than both the national average of landholding of 0.83 hectares per household and the Oromia regional state average of 1.15 hectares per household (Leta et al., 2021). During interviews, most respondents responded that communal grazing land is gradually diminishing. This challenge is attributed to population growth, as well as the expansion of residential areas and crop land.

Cattle holding of the respondents

The survey revealed that the average number of cattle per household was 7.8 heads. This finding is consistent with the report of (Benti et al., 2021) from West Shewa, which noted that cattle holdings per household have been gradually declining in mixed crop–livestock production systems due to cropland expansion and increased population pressure. The resulting reduction in grazing land has contributed to a shortage of forage resources.

Drinking water, feed resource, and feeding system

The assessment showed that 48.9% of households sourced water for dairy cattle from rivers, 25% from pipes, 14.1%from streams, and 12% from ponds. This study is in line with Liu et al. (2023), who reported that 50%, 28.9%, and 21.1% of households' respondents sourced water for dairy cattle from rivers, pipes, and ponds, respectively.

Regarding feed resources, 55.4% of households depend on natural pasture, 32.6% on crop residues, 6.5% on improved forages, and 5.4% on supplements. These results are comparable with CSA (2020), which indicated that in rural Ethiopia, grazing land accounts for 55.23% of feed resources, followed by crop residues at 30.84%, with other sources comprising smaller proportions. Furthermore, the study revealed that 81.5 of respondents use grazing as the primary feeding system, while only 18.5% practiced a cut-and-carry feeding system.

Milk yield and Lactation length

Compared to the findings of Bekuma et al. (2020), who reported mean daily milk yields of 1.18 ± 0.52 liters for indigenous cows and 5.83 ± 0.28 liters for crossbred cows, the present study recorded higher yields for local breeds but lower yields for crossbreeds. The relatively low average daily yields of crossbred cows in this study may be attributed to poor management practices, consistent with the observations of Duguma et al. (2020). The average lactation lengths were 7.10 months for native Horro cows, 9.08 months for HF cross Horro, and 8.88 months for Jersey-Horro crosses.

The average lactation length for the Jersey-Horro crossbred cow in the present study was 8.98 months. This is comparable to findings of Bekuma et al. (2020), who reported average lactation lengths of 7.15 months for local cows and 8.87 months for crossbreds in Gimbi District, Oromia Region, Ethiopia. Similarly, Tefera et al (2020) documented lactation length of 7.36 months for local dairy cattle and 9.28 months for crossbreds. Pre-pubertal growth rates and reproductive development are strongly influenced by management practices, particularly the provision of adequate feed. Delayed sexual maturity extends the non-lactating and unproductive phase of heifers or cows, resulting in significant economic losses. The relatively shorter average lactation length observed in the present study may be attributed to a combination of genetic, management, and environmental factors.

Reproductive performance of dairy cows

A study conducted in West Wollega reported an Age at first services of 44.45 ± 0.167 months for local breed heifers, which is longer than the current finding (Benti et al., 2021). The calving intervals (CI) recorded in the present study were 20.93 ± 6.28 months for local cows, 13.81 ± 3.12 months for Holstein-Horro crossbreds, and 15.08 ± 3.55 months for Jersey-Horro crossbreeds. The CI for local cows in this study is slightly shorter than the 20.93 ± 6.28 months is shorter than the 22.19 ± 7.73 months reported from Dendi district, West Shoa Zone, Oromia Regional State (Duro, 2022). Meanwhile, the CI for crossbreds in the present study is comparable to the 14.48 ± 1.04 months reported for crossbreds in Gimbi District, West Wollega Zone (Bekuma et al., 2020).

However, the same study reported a CI of 15.09 ± 3.55 months for cross-breeds, which is comparable with the calving interval of cross-breeds reported from Gimbi District, West Wollega zone. A prolonged calving interval reduces the annual production cycle and limits the amount of milk a cow can produce over a given period. The length of the CI is influenced by environmental conditions, the nutritional quantity and quality, housing systems, and breeding management practices.

About breeding methods in the study districts, 60.9% of respondents reported using both bull mating and AI, 35.9% relied exclusively on AI, and 3.2% depended solely on natural bull mating. This finding differs from that of Shanku (2022), who reported that in Addis Ababa, 77.4% of respondents used AI exclusively, 19.4% practiced both artificial insemination (AI) and natural mating, and 3% relied on natural mating alone. The continued reliance on natural breeding practices in the present study areas presents a significant barrier to genetic improvement in Ethiopia's cattle population.

Trait preference of farmers for dairy cattle

The results of the current study revealed that farmers' trait preference for dairy cattle was primarily based on milking potential, fast growth rate, breeding ability, feeding behavior, good temperament, and disease resistance. These findings are consistent with those of Lemessa et al. (2023), who reported that in the East Gojam Zone, the most important criteria for trait preference among respondents were milk production, traction power, breeding capacity, growth rate, adaptability, body size, and cow temperament.

Farmer's awareness of the timing of Artificial Insemination (AI)

The present study revealed that 82.6% (76/92) of cows received AI service on the same day they exhibited heat. This finding is comparable to the findings of Howlader et al. (2019), who reported that 65% of cows were inseminated within six hours of showing estrus. In contrast, 17.4% (16/92) of respondents in the current study indicated that insemination was performed more than 24 hours after heat detection. Delayed AI service, particularly beyond 12 hours after the onset of estrus, has been associated with a conception failure rate of up to 62% (Howlader et al., 2019).

The variation in insemination timing may be attributed to factors such as the dairy owner's awareness, distance from the AI service center, and limited technician availability, particularly during weekends and holidays. Regarding the mode of AI service delivery in the study area, respondents reported three main approaches: at the AI service center, at home, or a combination of both. The majority (51.1 %, 47/92) took their cows in heat to the AI service center, while 18.5 % (17/92) received AI service at home. The remaining 30.4% (28/92) used both options, either transporting the cow to the service center or calling AI technicians when available.

Farmer's perception of estrus synchronization and mass insemination

Among the 92 respondents in this study area, 74 (80.4%) participated in mass synchronization programs. Of these, 93.5% (69/74) expressed dissatisfaction with the output, primarily because 90.2% of the synchronized cows failed to conceive. Only 9.8% of the inseminated cows became pregnant, which is far below the national average conception rate for mass synchronization (60%) reported by Jeyakumar et al. (2023). Respondents identified conception failure and repeated heat cycles as the main sources of dissatisfaction.

The perceived causes of synchronization failure were ranked as follows: poor semen management (31.5%), conducting the campaign during the wrong season, specifically the dry season when feed is scarce (26.5%), lack of farmer awareness about mass synchronization(17.4%), poor selection of cows for AI (8.4%), and low efficiency of AI technicians (6.5%). These findings are aligned with the observations of Singh (2024), who reported that the number of services per conception is influenced by multiple factors, including technical, environmental, and management-related constraints.

Common cause of Hormone Treatment failure

According to focus group discussions and expert feedback, the failure of Artificial insemination followed by mass synchronization was attributed to several factors. The most frequently mentioned causes were: lack of farmer awareness (Index = 0.24), poor heat detection (0.23), late availability of the artificial insemination service time (0.19), low efficiency or skill of artificial insemination technicians (0.14), long distances between artificial insemination center and dairy owner (0.13), and the cost of service(0.17) (Table 5).

Training and Provision of AI Services

The present study revealed that artificial insemination (AI) services were not provided consistently. Focus group discussions (FGDs) confirmed this inconsistency and identified the root causes as: lack of input supply (35.9%, 11/30), limited service sites where AI is only provided at the district level (20.9%, 6/30), and insufficient number of technicians available in each district (43.5%, 13/30). This result contrasts with the findings of Ibrahim et al. (2014) in selected districts of the Jimma zone, where 59% of respondents stated interruption in AI service. In their study, the main reasons for interruptions were unavailability of AI technicians (27%), service discontinuation on weekends and holidays (24.6%), and lack of input supply (7.4%), reflecting a different pattern of service inconsistency compared to the current findings.

CONCLUSSIONS

This study showed that dairy production in the Horro Guduru Wollega Zone is constrained by feed and water shortages, weak extension services, and challenges in reproductive management. Artificial insemination and estrus synchronization were found to have low efficiency, with conception rates differing significantly between indigenous and crossbred cows. Major contributing factors included poor heat detection, delayed or inconsistent AI service provision, limited farmer awareness, and inadequate technician capacity. While farmer perceptions highlighted semen quality and campaign timing as major constraints, alternative explanations such as nutritional deficiencies, seasonal stress, and reproductive health issues may also have influenced outcomes. Overall, the statuses of synchronization and mass artificial insemination, as well as owners' perceptions about technology, were found to be low. Conception rates differed significantly between crossbred and local dairy cattle, mainly due to genetic differences.

Recommendations

Effective estrus synchronization and AI require accurate heat detection, timely insemination, proper animal selection, and farmer training in reproductive management. Programs should align with periods of adequate feed availability and adoption of cost- and labor-efficient technologies. Conventional AI should be performed at the optimal time after estrus onset to maximize conception rates.

CRediT Authorship Contribution Statement

Sinshewu Abdisa Feyissa: Conceptualization, Data Collection, Model Development, Analysis & Writing Original Draft. **Belay Beyene Wakuma:** Data Analysis & Model Validation. **Firisa Woyessa Ejeta:** Supervision, Review & Editing.

Declaration of Competing Interest

The authors declare that there is no conflict of interest.

Ethical approval

The study was done through a questionnaire of volunteer respondents. The study does not have an impact on animal or human health.

Data Availability

The datasets that support the findings of this study are available from the corresponding authors upon reasonable request.

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