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Constraints and Opportunities in Artificial Insemination and Oestrus Synchronization Service

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ABSTRACT

This study investigated the challenges and opportunities associated with artificial insemination (AI) and oestrus synchronization (ES) services among cattle farmers in the Roma community in Lesotho. These reproductive technologies play a vital role in improving cattle genetics and productivity. However, their adoption remains limited in many developing regions. The study aimed to evaluate the availability, accessibility, affordability, and effectiveness of AI and ES services, as well as farmers' perceptions, satisfaction levels, and the influence of extension support and training. A cross-sectional descriptive research design was used, involving 60 randomly selected cattle farmers from six villages. Data were collected using structured questionnaires and analyzed using descriptive statistics and chi-square tests in SPSS version 20. The findings indicated that access to AI and ES services was generally low across all villages, with no significant differences in availability, affordability, or service frequency ($p > 0.05$). Farmers reported key challenges, including long travel distances to service providers, high costs, limited availability of skilled technicians, and delays in service delivery. Although AI services were slightly more accessible than ES, both were inconsistently provided. Farmers expressed neutral satisfaction regarding service quality and communication, but dissatisfaction with costs and delays. Extension services and training opportunities were minimal, leaving most farmers dependent on informal knowledge sources. Despite these constraints, farmers acknowledged the benefits of AI and ES and recommended improved access, reduced costs, increased training, and more skilled personnel, highlighting that strengthening institutional support is essential to enhance adoption and improve cattle productivity in the region.

INTRODUCTION

Artificial insemination (AI) and oestrus synchronization(ES) are reproductive technologies that have demonstrated substantial effectiveness in improving livestock productivity and genetic advancement worldwide. Artificial insemination involves the deliberate deposition of semen into the female reproductive tract by artificial means to achieve conception, while oestrus synchronization refers to the manipulation of the estrous cycle so that females exhibit heat within a predetermined period (Webb, 2003; Desalegn & Eskindir, 2023). The combined use of these technologies enhances breeding efficiency by accelerating the dissemination of superior genetics and improving reproductive performance in livestock populations (Perry *et al.*, 2010). Artificial insemination is considered one of the most significant tools for genetic improvement of farm animals, contributing to disease control and facilitating the widespread use of males with high genetic merit, particularly in dairy and beef cattle production systems (Bearden *et al.*, 2004). Oestrus synchronization further improves reproductive management by reducing human error, lowering labour requirements, and facilitating planned breeding, especially in large herds (Pursley *et al.*, 2004). The synchronization of estrus allows females to be bred within a short period, thereby shortening the calving season, improving calf uniformity, and enhancing the efficiency of AI programs (Stephen *et al.*, 2000). A condensed calving season enables better herd management, closer supervision during parturition, and reduced losses at calving (Belete & Mulugeta, 2021). Additionally, uniform calving periods improve herd health management, allowing for coordinated vaccination schedules and routine husbandry practices, which ultimately reduce labour and operational costs (Larson *et al.*, 2010). The application of AI also maximizes the use of superior sires, facilitates rapid dissemination of desirable genetic traits, increases selection efficiency, and enables the introduction of new genetic material through semen importation instead of live animals (Verma *et al.*, 2012). Moreover, AI combined with sexed semen technology can achieve over 90% accuracy in producing calves of the desired sex, thereby improving herd replacement strategies (Naniwa *et al.*, 2019).

Despite these advantages, the adoption of AI and oestrus synchronization remains limited among smallholder farmers in many developing regions. Farmers' perceptions and acceptance of these technologies are often influenced more by the number of calves produced rather than the biological response to hormonal treatments (Alemayehu *et*

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al., 2019). Furthermore, the effectiveness of AI programs depends largely on proper animal husbandry practices and adequate management, without which the expected benefits may not be realized (Debir *et al.*, 2016). Although AI is widely recognized as one of the most effective reproductive tools in cattle breeding, alongside natural mating, its success relies on efficient service delivery, trained personnel, and farmer awareness (Berg, 2020). In Lesotho, adoption of artificial insemination and oestrus synchronization remains low despite their proven benefits. Farmers encounter several constraints, including limited availability of trained technicians, high service costs, and inadequate access to synchronization drugs. In addition, insufficient knowledge and awareness among farmers regarding the use and benefits of these technologies contribute to poor utilization. The low adoption of AI and oestrus synchronization ultimately affects reproductive performance, slows genetic improvement, and reduces overall cattle productivity. Therefore, this study aimed to determine the challenges and opportunities associated with the delivery and adoption of artificial insemination and oestrus synchronization services in the lowlands of Maseru.

LITERATURE REVIEW

Artificial insemination (AI) and oestrus synchronization (ES) have evolved as key reproductive technologies that enhance livestock productivity and genetic improvement. Oestrus synchronization involves the regulation of the estrous cycle to enable breeding within a defined period (Getabalew *et al.*, 2019). These technologies facilitate planned mating, shorten the calving interval, improve calf uniformity, and increase the efficiency of AI programs (Lamb, 2010; Noseir, 2003). Hormonal treatments such as prostaglandin F2α (PGF2α) are widely used, particularly in tropical systems where estrus detection is challenging and cycles are often irregular (Legesse, 2016). The availability and accessibility of AI and ES services remain critical determinants of their adoption. Studies indicate that although some smallholder farmers have shifted toward AI and express willingness to use the service, access is often limited by inadequate service delivery, low conception rates, and irregular availability of inputs and skilled personnel (Medhin *et al.*, 2009; Solomon *et al.*, 2016). Furthermore, a significant proportion of farmers report inconsistent access to AI services due to shortages of technicians, interruptions during weekends and holidays, and logistical constraints such as poor infrastructure and transport limitations (Juneyid *et al.*, 2017; Mekonnen & Berhe, 2020). These challenges contribute to uneven service delivery across regions and districts, affecting adoption and utilization rates.

Farmer satisfaction with AI and ES services is generally influenced by service reliability, conception success rates, and accessibility. Evidence shows that dissatisfaction is often linked to irregular service provision, limited technician availability, and poor heat detection support, leading many farmers to prefer natural mating over AI (Debir, 2015; Samuel, 2015). Additional constraints such as input shortages, long distances to service centers, and frequent technician turnover further reduce user satisfaction (Tegegne *et al.*, 2012; Medhin *et al.*, 2009). Despite these challenges, some studies report moderate satisfaction levels where services are consistent and conception rates are acceptable (Gebre, 2015). Overall, satisfaction levels remain mixed and largely dependent on service quality and accessibility. Extension services and training play a fundamental role in improving the adoption and effectiveness of AI and ES technologies. Training enhances farmers' knowledge of reproductive management, heat detection, and proper timing of insemination, while also improving technicians' technical competence (Syarif *et al.*, 2025; Mushonga *et al.*, 2017). Access to extension services and continuous farmer education increases awareness of the benefits of AI, including improved genetics, higher milk yield, and disease resistance (Kashoma & Ngou, 2023). Studies also show a strong association between access to training and AI adoption, highlighting disparities between trained and untrained farmers in technology uptake (Gebre *et al.*, 2022). Strengthening extension systems and improving farmer agent interactions are therefore essential for successful implementation.

Improving AI and ES service delivery requires addressing systemic constraints such as inadequate technician training, insufficient inputs, poor infrastructure, and limited motivation of service providers. Key strategies proposed in the literature include increasing the number of trained AI technicians, improving logistics and transport systems, and providing incentives to retain personnel (Baheriw *et al.*, 2013; Gebremedhin *et al.*, 2009). In addition, enhancing farmer awareness, strengthening institutional support, and promoting cooperative knowledge-sharing platforms can improve service utilization. Policy interventions such as subsidies and targeted investments in rural infrastructure are also recommended to expand access and affordability (Omondi *et al.*, 2017). Despite their potential, the use of AI and ES is constrained by multiple technical, managerial, and environmental factors. Common challenges include poor heat detection, lack of skilled technicians, limited farmer awareness, inadequate nutrition, and long distances to AI centers (Belete *et al.*, 2018; Fekata *et al.*, 2020). Reproductive performance is further affected by factors such as breed type, animal health, management practices, and environmental conditions (Shiferaw *et al.*, 2005). In many rural settings, limited availability of services and weak support systems reduce the effectiveness of AI programs, leading to low conception rates and suboptimal reproductive outcomes (Tegegne *et al.*, 2012). Despite these constraints, AI and ES present significant opportunities for livestock improvement. The availability of hormonal protocols, growing demand for dairy products, and increasing interest among smallholder farmers provide a favorable environment for adoption (Fekata *et al.*, 2020). AI facilitates genetic improvement through selective breeding and reduces the need for maintaining breeding bulls, thereby lowering costs and increasing selection intensity (Gebremedhin *et al.*, 2009).

Moreover, synchronization protocols enhance breeding efficiency by enabling timed insemination and improving estrus response rates, particularly when optimized methods such as double PGF2α injections are used (Haile *et al.*, 2023; Masho *et al.*, 2024).

MATERIALS AND METHODS

Study Area

The study was conducted in Roma community which is situated about 34 km southeast of Maseru the capital city of Lesotho. Roma lies at an altitude of 1,600 - 1,800 meters above sea level, with coordinates around 29.28°S latitude and 27.73°E longitude. Roma had a temperate climate, characterized by warm ranging from 20 -25°C, rainy summers (October - April) and cold from 5-7°C, dry winters (May - August). Roma experienced the average annual rainfall of 700 - 900 mm, which mainly supports mixed crop-livestock farming. Source: Lesotho Meteorological Service, 2025.

Study design and Sample determination

A cross-sectional descriptive study design was employed to evaluate the current status of artificial insemination (AI) and estrus synchronization (ES) services in Roma. Both purposive and random sampling techniques were used to select participants. Roma was purposively selected due to its high concentration of cattle farmers and its accessibility for data collection. Subsequently, six villages Khobeng, Tloutle, Ha Seqoma, Ha Shale, Mokhokhong, and Moling were randomly selected. From each village, ten farmers were randomly chosen and interviewed, resulting in a total sample size of 60 respondents.

Data collection

The data were collected using close-ended questionnaires instructed by the researcher and the questionnaire included dichotomous form and multiple-choice questions were administered based on availability, accessibility, affordability, perceptions, and satisfaction with AI and ES services. Also, a Likert scale was used to measure farmers' opinions and attitude based on accessibility, affordability, satisfaction, knowledge, training and overall perception of services.

Data Analysis

The collected data were entered into the Statistical Package for the Social Sciences (SPSS) (Version 20) for analysis. The cross - tabs within the descriptive statistics were applied to tabulate percentages and summarize data. Inferential statistics, particularly chi-square tests, were applied to assess associations between socio-economic factors and the adoption of AI and ES services and value les that ($p < 0.05$) was considered significant.

RESULTS AND DISCUSSIONS

Demographic profile of farmers

The demographic characteristics of farmers across the surveyed villages are presented in Table 1. Age distribution differed significantly among villages ($p < 0.05$), whereas education level, gender, marital status, and occupation did not show statistically significant differences ($p > 0.05$). Younger farmers (<20 years) were mainly represented in Ha-Shale and Mokhokhong, while no respondents in this age category were recorded in Tloutle, Khobeng, and Ha-Seqoma. The economically active age group (20 - 40 years) was most prominent in Khobeng, suggesting a relatively younger farming population in this village. This may be attributed to migration patterns, land availability, and increased engagement of younger households in agricultural activities. Farmers aged 40 - 60 years were predominantly found in Tloutle and, to a lesser extent, in Ha-Seqoma and Moling, while older farmers (>60 years) were more common in Mokhokhong and Ha-Shale. Educational attainment did not differ significantly among villages ($p > 0.05$). Most respondents had primary or secondary education, while only a few had attained high school or tertiary education. This pattern may reflect limited access to higher education in rural areas, financial constraints, and early school dropout due to household responsibilities such as farming. Tertiary education was only reported in Khobeng and Ha-Seqoma, indicating uneven distribution of higher education across the study area. Gender distribution was relatively balanced across villages ($p > 0.05$), indicating that both male and female farmers actively participate in cattle production. Similarly, marital status and occupation showed no significant variation among villages ($p > 0.05$), suggesting comparable socio-economic characteristics across the study population. The results indicate that although age distribution varied significantly among villages, other demographic variables remained relatively uniform. Most farmers belonged to economically active age groups, although older farmers were more dominant in certain villages. These findings are consistent with Tesfaye *et al.* (2023), who reported that middle-aged farmers are more involved in livestock production due to their combination of experience and physical capacity. Likewise, Kassa and Bekele (2022) observed that older farmers tend to rely more on traditional breeding practices, which may limit adoption of reproductive technologies. The limited educational attainment observed in this study may constrain farmers' understanding and adoption of artificial insemination (AI) and oestrus synchronization (ES) technologies. Comparable findings were reported by Mekonnen *et al.* (2024), who noted that higher education levels are positively associated with the adoption of improved livestock technologies. Furthermore, the relatively equal gender participation aligns with Mugisha *et al.* (2022), who reported increasing involvement of women in livestock production systems across sub-Saharan Africa. These demographic characteristics suggest that while socio-economic factors alone may not fully explain adoption differences, they still influence awareness, perception, and decision-making regarding reproductive technologies.

Table 1: Demographic profile of farmers

Parameter's	Different villages (%)						
	Tloutle	Ha-Shale	Mokhokhong	Khobeng	Ha-Seqoma	Moling	p-Value
AGE							
<20	0.0	50.0	25.0	0.0	0.0	25.0	0.028
20-40	4.3	17.4	13.0	34.8	13.0	17.4	
40-60	36.8	5.3	5.3	10.5	21.1	21.1	
>60	14.3	21.4	35.7	0.0	21.4	7.1	
EDUCATION							
Primary	28.6	10.7	21.4	10.7	17.9	10.7	0.436
Secondary	7.1	28.6	21.4	14.3	7.1	21.4	
High School	6.2	18.8	6.2	25.0	18.8	25.0	
Tertiary	0.0	0.0	0.0	50.0	50.0	0.0	
GENDER							
Female	15.8	21.1	13.2	18.4	18.4	13.2	0.676
Male	18.2	9.1	22.7	13.6	13.6	22.7	
MARITAL - STATUS							
Single	0.0	23.5	11.8	35.3	11.8	17.6	0.182
Married	22.0	14.6	19.5	9.8	19.5	14.6	
Divorced	50.0	0.0	0.0	0.0	0.0	50.0	
OCCUPATION							
Unemployed	28.6	4.8	23.8	4.8	19.0	19.0	0.178
Student	0.0	0.0	0.0	0.0	0.0	100.0	
Farmer	14.8	25.9	18.5	22.2	11.1	7.4	
Teacher	0.0	0.0	0.0	0.0	100.0	0.0	
Other	0.0	20.0	0.0	30.0	20.0	30.0	

Means within a row with different superscript are significantly significant ($p<0.05$) and means within a row with different superscript do not differ significantly ($p >0.05$).

Farmers availability and accessibility to artificial insemination and estrus synchronization services

Farmers' access to AI and ES services across villages is summarized in Table 2. There were no statistically significant differences ($p > 0.05$) among villages in terms of service sources, distance to service providers, affordability, frequency of service delivery, and technician availability. This indicates that farmers across the study area experience similar structural constraints in accessing these services. Technician availability was generally reported to be low across all villages, leading to delays and insufficient service provision. This may be attributed to the limited number of trained personnel, uneven distribution of services, and challenges associated with retaining technicians in rural areas. Although distance to service providers did not differ significantly ($p = 0.517$), farmers in Tloutle and Ha-Shale reported travelling longer distances compared to those in Moling and Mokhokhong, where services were relatively closer. These differences may reflect variations in geographic accessibility, infrastructure, and transportation availability. Affordability was also not significantly different among villages ($p = 0.440$). However, farmers in Moling frequently perceived AI and ES services as expensive, while those in Tloutle and Ha-Shale expressed mixed views. Overall, the high cost of services was reported to compete with other household expenditures, thereby limiting adoption. Similarly, service frequency did not differ significantly ($p = 0.428$). Farmers in Moling reported more regular service provision, whereas those in Khobeng indicated occasional services, and other villages reported limited or no service availability. This inconsistency suggests weak coordination among service providers and limited institutional capacity. The findings indicate that access to AI and ES services is generally low across all villages, with major constraints including long travel distances, high costs, and limited technician availability. These results are consistent with Lemma and Kebede (2023), who reported that inadequate distribution of AI technicians contributes to service delays in rural areas. Similarly, Hailu *et al.* (2024) found that distance and transportation challenges negatively affect access to AI services. The irregular supply of semen and synchronization drugs also limits the effectiveness of AI programs, as reported by Ojango *et al.* (2022). In addition, the perceived high cost of services aligns with Mumba *et al.* (2023), who identified cost as a major barrier to adoption among smallholder farmers. The absence of significant differences among villages suggests that these constraints are systemic and widespread across the study area.

The availability of AI and ES services across villages is illustrated in Figure 1. AI services were most available in Moling, whereas Khobeng recorded the lowest availability. This may be due to Moling's proximity to service centers and better technician coverage. In contrast, ES services were reported to be highest in Khobeng, while other villages showed very low availability, possibly reflecting stronger cooperative involvement or better extension support in Khobeng. Tloutle farmers reported relying mainly on self-provided ES services, indicating limited professional support and weak extension services.

Table 2: Accessibility and availability of Artificial insemination and oestrus synchronization.

Parameters	**Different villages (%)**						**p-values**
	Tloutle	Ha shale	Mokhokhong	Khobeng	Ha seqoma	Moling	
Nearest AI and ES							
11-20	0.0	0.0	0.0	100.0	0.0	0.0	0.517
More than 20km	50.0	0.0	0.0	0.0	0.0	50.0	
neutral	15.8	17.5	17.5	15.8	17.5	15.8	
How often are AI and ES offered							
Regularly	0.0	0.0	0.0	0.0	0.0	100.0	0.428
Occasionally	0.0	0.0	0.0	100.0	0.0	0.0	
Not at all	17.2	17.2	17.2	15.5	17.2	15.5	
How would you rate affordability							
Affordable	100.0	0.0	0.0	0.0	0.0	0.0	0.440
Expensive	0.0	0.0	0.0	0.0	0.0	100.0	
Neutral	15.8	17.5	17.5	15.8	17.5	15.8	
Very expensive	0.0	0.0	0.0	100.0	0.0	0.0	
Accessibility of AI technicians							
Always available	50.0	0.0	0.0	50.0	0.0	0.0	0.517
Sometimes available	0.0	0.0	0.0	0.0	0.0	100.0	
neutral	15.8	17.5	17.5	15.8	17.5	15.8	
Delay in receiving AI and ES							
Yes, sometimes	0.0	0.0	0.0	0.0	0.0	100.0	0.517
No	50.0	0.0	0.0	50.0	0.0	0.0	
Neutral	15.8	17.5	17.5	15.8	17.5	15.8	

Means within a row with different superscript are significantly significant ($p<0.05$) and means within a row with different superscript do not differ significantly ($p<0.05$).

The availability of AI and ES services across villages (Figure 1) shows that AI services were most accessible in Moling, while Khobeng recorded the lowest availability. This variation may be attributed to differences in proximity to service centers and the presence of trained technicians. In contrast, ES services were reported to be more available in Khobeng, possibly due to stronger cooperative involvement or better extension support. Farmers in Tloutle largely relied on self-provided ES services, indicating limited professional assistance and weak institutional support. The main sources of AI services and perceived improvements in accessibility are illustrated in Figure 2. Cooperatives were the primary source of AI services in Tloutle and Ha-Shale, reflecting the importance of community-based service delivery. In Mokhokhong and Khobeng, farmer-provided services were more common, suggesting reliance on informal systems. The National University of Lesotho (NUL) farm was occasionally mentioned as a service provider across villages. Perceptions of improved access to AI services differed significantly among villages ($p < 0.05$), with farmers in Tloutle and Ha-Shale reporting improved access, while those in other villages expressed dissatisfaction. These findings suggest that cooperative-based service delivery is associated with more favorable perceptions of access. This is consistent with Mwangi *et al.* (2022), who highlighted the role of cooperatives in improving access to AI services in rural areas. Similarly, Desta *et al.* (2023) reported that community-based breeding programs enhance service accessibility in contexts where government support is limited. However, reliance on informal service providers may compromise service quality and reduce conception rates. Khan *et al.* (2024) emphasized that professional AI technicians achieve better reproductive outcomes compared to untrained personnel. Therefore, the limited involvement of institutional service providers underscores the need for stronger collaboration between research institutions, extension services, and local stakeholders.

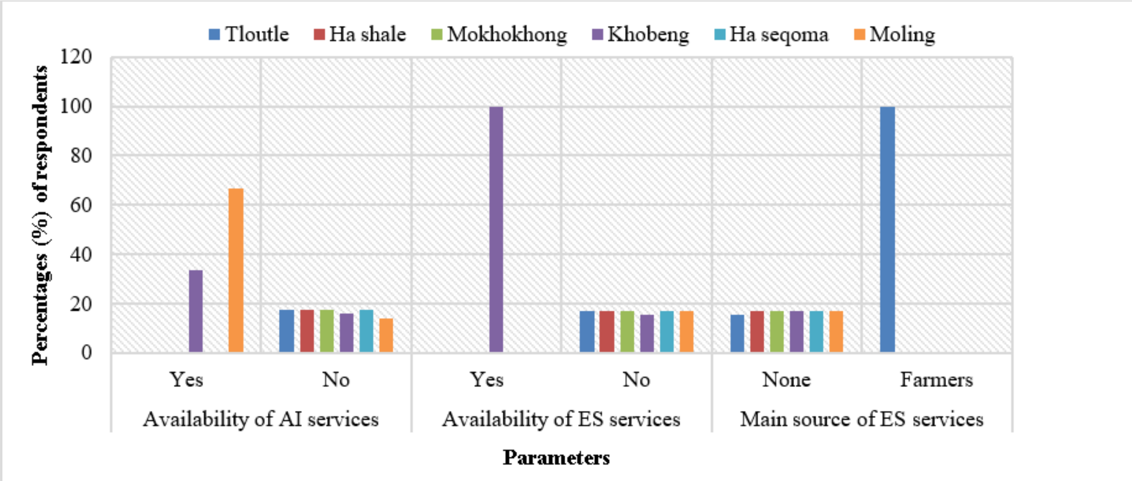

Figure 1: Availability and sources of oestrus synchronization and Artificial insemination

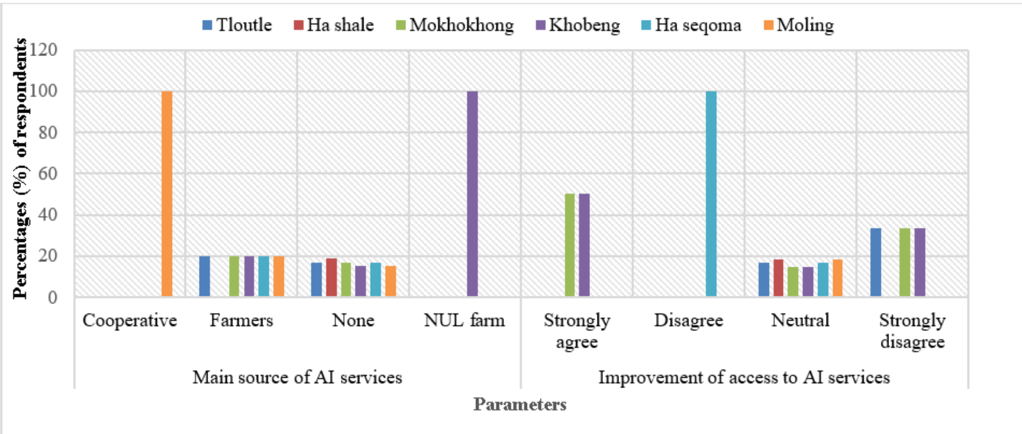

Figure 2: Main source and improvement of Artificial insemination

Farmers' satisfaction with Artificial insemination and estrus synchronization services

Farmers' satisfaction with AI and ES services is presented in Figure 3. Overall, responses regarding AI service quality were predominantly neutral across villages. Moderate satisfaction was observed in Moling and Ha-Seqoma, while dissatisfaction levels remained relatively low. Communication between service providers and farmers also received mostly neutral responses, although some moderate satisfaction was reported in Moling and Ha-Seqoma. Regarding affordability, neutral responses dominated; however, dissatisfaction was more

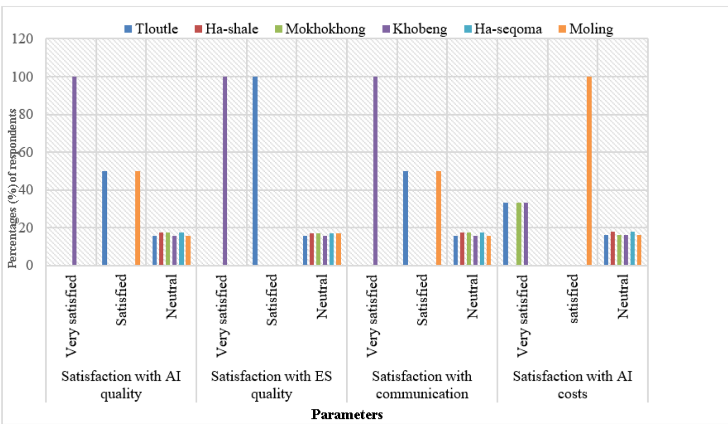

Figure 3: Farmers satisfaction with quality and costs of Artificial insemination and oestrus synchronization

pronounced compared to other aspects such as quality and communication. Farmers in Mokhokhong and Khobeng expressed greater concerns about cost, whereas those in Moling and Ha-Seqoma reported relatively higher satisfaction. These findings indicate that although service quality and communication are generally acceptable, financial constraints remain a significant limitation to adoption. Similar observations were reported by Abera *et al.* (2023), who noted that although farmers recognize the benefits of AI, high costs and logistical challenges discourage adoption. Communication between farmers and service providers appears limited, which may affect timely heat detection and service delivery. Effective communication is essential for successful implementation of AI programs, as improved interaction between farmers and technicians has been shown to enhance conception rates (Silva *et al.*, 2022). The neutral satisfaction levels observed in this study suggest the need for strengthened extension services and improved communication strategies.

Perceptions of professionalism of AI and ES services are presented in Figure 4. AI services were consistently rated as highly professional across villages, indicating strong farmer confidence in these services. In contrast, perceptions of ES services were mixed, with some villages reporting varied levels of professionalism. These differences may be attributed to variations in technician expertise, consistency of service delivery, and the level of institutional support. Service delivery timeliness and satisfaction with outcomes are illustrated in Figure 5.

Farmers generally reported low satisfaction with the timeliness of both AI and ES services, with most indicating inconsistent or delayed service provision. Satisfaction with reproductive outcomes also varied across villages. Farmers in Ha-Shale and Ha-Seqoma reported relatively better results, whereas those in Mokhokhong, Khobeng, and Moling reported inconsistent outcomes. These variations may be associated with differences in technician skills, timing of insemination, and follow-up practices. These findings align with Rahman *et al.* (2023), who reported that successful synchronization programs require skilled personnel and proper monitoring. Similarly, Nibret *et al.* (2022) found that delays in AI service delivery negatively affect conception rates due to improper timing relative to estrus. Therefore, the observed variation in satisfaction across villages likely reflects differences in service quality, technician competence, and timing accuracy.

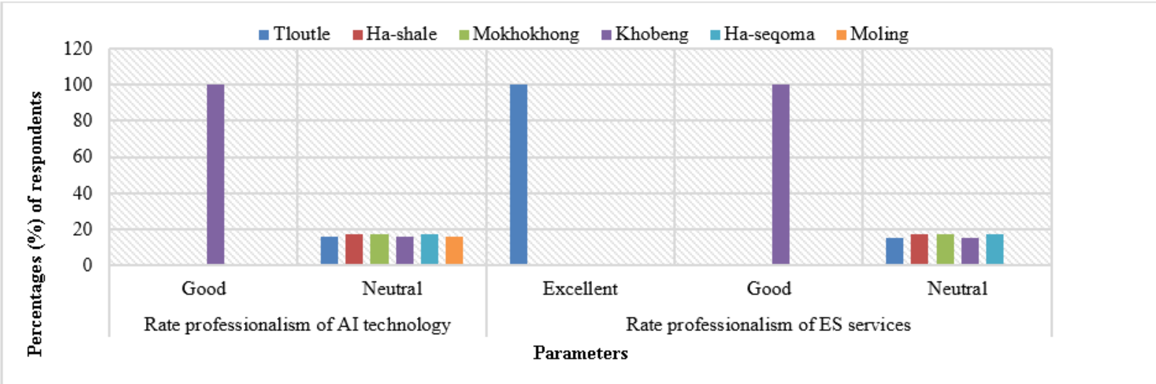

Figure 4: Rating the professionalism of Artificial insemination and oestrus synchronization

Role of extension and training in promoting artificial insemination and estrus synchronization

The role of extension services and training is summarized in Table 3. There were no statistically significant differences among villages regarding

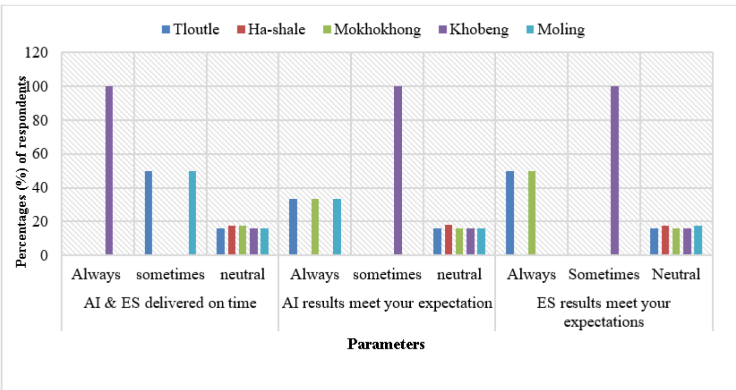

Figure 5: Service delivery of Artificial insemination and oestrus synchronization results

proposed improvements to AI and ES services ($p > 0.05$). Extension officer visits varied considerably, with Mokhokhong reporting weekly visits, while other villages reported limited or no visits. Farmers across all villages emphasized the need for improved accessibility, reduced service costs, enhanced training opportunities, and increased availability of skilled technicians. Participation in training and workshops was generally low (Figure 6), indicating limited extension outreach and knowledge dissemination. Most farmers had not received formal training on AI and ES, suggesting reliance on informal sources of information. These findings are consistent with Abate *et al.* (2024), who highlighted the critical role of extension services in promoting the adoption of livestock technologies. Gebremedhin *et al.* (2023) further demonstrated that training significantly increases the likelihood of technology adoption and improves reproductive performance. Limited awareness, particularly regarding ES, contributes to low adoption rates. Kumar *et al.* (2022) also emphasized that awareness campaigns and farmer field schools enhance knowledge and uptake of synchronization technologies. The results therefore highlight the urgent need to strengthen extension services and training programs.

Table 3: Improvement of Artificial insemination and oestrus synchronization services

Parameters	**Different villages (%)**						
	Tloutle	Ha-shale	Mokhokhong	Khobeng	Ha seqoma	Moling	p-values
Visit from extension officers							
Weekly	0.0	0.0	100.0	0.0	0.0	0.0	0.406
Never	16.9	16.9	15.3	16.9	16.9	16.9	
Important improvement of AI and ES services							
Better accessibility	16.7	16.7	22.2	11.1	16.7	16.7	0.744
Lower costs	18.2	18.2	9.1	18.2	13.6	22.7	
Better training and awareness	16.7	25.0	25.0	8.3	8.3	16.7	
More skilled technicians	12.5	0.0	12.5	37.5	37.5	0.0	

Means within a row with different superscript are significantly significant ($p<0.05$) and means within a row with different superscript do not differ significantly ($p<0.05$).

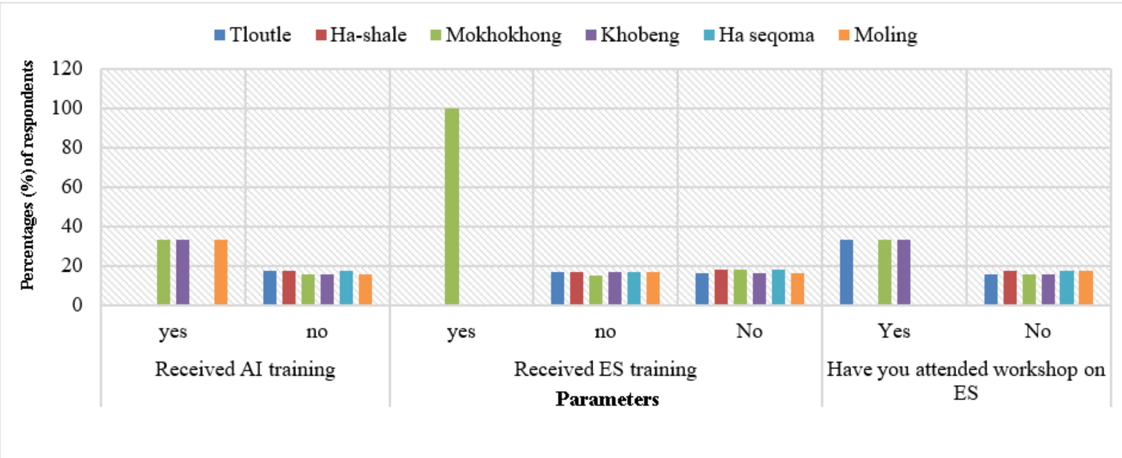

Figure 6: Trainings and workshop on Artificial insemination and Oestrus synchronization

Potential strategies for improving artificial insemination and estrus synchronization service delivery

Farmers' perceptions of potential strategies for improving AI and ES services are presented in Figure 7. Support for subsidizing AI services varied significantly among villages, with farmers in Moling and Mokhokhong expressing stronger support due to affordability concerns. In contrast, farmers in Ha-Shale and Khobeng expressed neutral or negative views. Perceptions regarding ES subsidies were more varied, with uncertainty observed in Tloutle and Ha-Seqoma, and more negative responses in Khobeng and Ha-Shale. These differences may reflect varying levels of exposure to ES services and differences in extension outreach. Overall, improving accessibility of AI services was widely supported, while acceptance of subsidies, particularly for ES, varied across villages. Farmers recommended improved access to services, reduced costs, increased training, and availability of skilled technicians. These recommendations are consistent with Tesema *et al.*

(2023), who identified subsidies and technician training as effective strategies for improving adoption. Similarly, Bwala *et al.* (2024) reported that subsidized reproductive technologies significantly enhance utilization among smallholder farmers. Mutua *et al.* (2022) further noted that farmer perceptions of subsidies are influenced by prior experiences and trust in service providers. Strengthening institutional support, improving extension systems, and enhancing technical capacity are therefore essential for effective implementation of AI and ES programs.

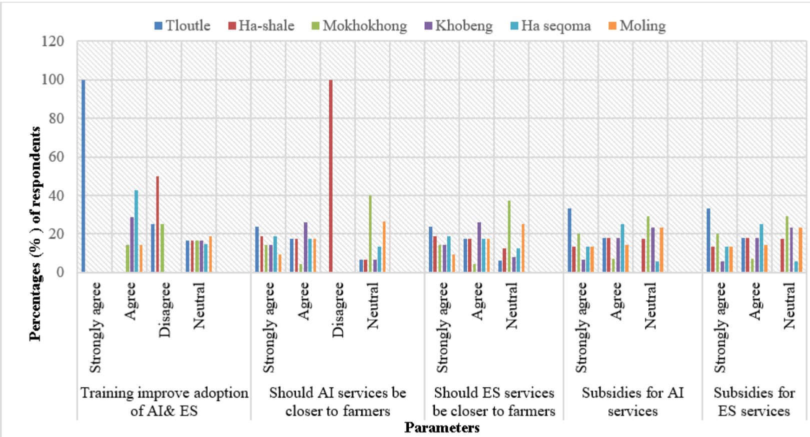

Figure 7: Adoption and subsidies for Artificial insemination and Oestrus synchronization

CONCLUSION

This study concluded that access to artificial insemination and oestrus synchronization services in the Roma community is still limited despite their benefits for cattle productivity. Major challenges include high costs, long travel distances, shortage of skilled technicians, and weak extension support. Farmers reported dissatisfaction with affordability, service quality, and timeliness, while limited training and awareness further restrict adoption. Improving institutional support, accessibility, cost efficiency, and farmer training is essential to enhance adoption and livestock production outcomes.

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