

## Review Article

# Challenges and Opportunities on Estrus Synchronization and Mass Artificial Insemination in Dairy Cows for Smallholders in Ethiopia

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In this paper, the potentials and constraints on estrus synchronization (ES) and artificial insemination (AI) practice for dairy cattle producers were overviewed. Compared to other African countries, Ethiopia has large numbers of dairy cattle population. However, the self-sufficiency in milk production is not yet attained due to the presence of a lot of limitations that hamper the success of ES and mass AI practice in many parts of the country such as improper selection of cows/heifers, inseminating a large number of cows/heifers in one day at a specific place (which creates stress for both AI technicians and female animals), absence of a data recording system, lack of clearly defined share of responsibilities among stakeholders, poor communication and collaboration among stakeholders, lack of motivations and skills of AI technicians, lack of support and readily available inputs, feed shortages, improper heat detection by smallholders and time of insemination, and lower reproductive performances of both indigenous and crossbred cows which consequently contributed to the unsuccessfulness of the technology.

## 1. Introduction

Dairy cattle production plays a key role in socioeconomic and cultural value of Ethiopia via generation of income and the satisfaction of the people as a source of food [1]. Although Ethiopia has a high number of cattle populations in Africa, the self-sufficiency in milk production is not yet attained [2, 3]. This is mainly due to low number of improved breeds and lower reproductive performances of both local and crossbred cows. Despite the past three decades' cross breeding program exercised in the country, there are no good sources of breeding stock in our country [4]. However, the application of reproductive biotechnology such as estrus synchronization (ES) and mass artificial insemination (AI) in dairy cows of smallholders can greatly enhance the rate of desirable characteristics [5].

Although implementation of these technologies requires controlling female animals' estrus cycle, ES and mass AI remain the most prominent technologies available to smallholder dairy cattle producers for genetic improvement,

reproductive management, and breeding their cows approximately at the same time [6]. It also requires a good management, cows with regular estrous cycles, and a good body condition, and if the service could be undertaken by AI technicians at smallholder's district, these technologies can work very well [7].

Nevertheless, AI technicians are mainly providing the services for dairy cows in urban or periurban areas; rather, little or no AI services are available for the smallholders in rural areas of Ethiopia. The smallholders usually bring their cows to AI sites or the district offices to get service; this leads to perform poor field practice, and it could be associated with several factors since the conception rate of the cows/heifers is dependent on time of insemination [8].

In spite of the wide application of ES and mass AI, the rate of success in our country is still low [1, 9–17]. Fertility in dairy cows may be expected towards of ES [18] which is one of the alternatives for the control and manipulation of reproduction [19]. Generally, effectiveness of ES followed by mass AI service/practice is below expectation of smallholder

farmers in Ethiopia [1, 2, 9–17, 20–31]. The aim of the paper was, therefore, to overview the challenges and opportunities on ES and AI practice in dairy cows for smallholders in Ethiopia with the following specific objectives:

- (i) To outline the opportunities of estrus synchronization and mass artificial insemination practice in dairy cows for smallholders
- (ii) To identify the challenges on estrus synchronization and mass artificial insemination practice in dairy cows for smallholders

## 2. Opportunities for Estrus Synchronization and Mass Artificial Insemination Practice in Dairy Cows for Smallholders

The existence of synthetic hormones for ES, veterinary service and experts, availability of large dairy cattle population, interest of smallholders, and high demands for milk were among the opportunities that were mentioned by many smallholders of dairy cows in Ethiopia [2, 25–29].

## 3. Challenges on Estrus Synchronization and Mass Artificial Insemination Practice in Dairy Cows for Smallholders

Many researchers such as Bainesagn [22], Gizawu and Dima [30], Belete et al. [10], and Fekata et al. [25] explained that common challenges linked to ES and mass AI practice for smallholders in Ethiopia are the competence of AI technicians, the knowledge of farmers on heat detection and time of insemination, management systems of dairy herds, types of breeds, absence of AI technician, and distance of AI center, even if there was difference in the magnitude of each problem. Similarly, Mekonene et al. [32] noted that reproductive efficiency is poor in most smallholder dairy cattle production systems, which leads to cows failing to become pregnant with various factors including management problems, nutrition, and semen handling practice. In addition, Shiferaw et al. [33] reported that there are many factors which affect the duration of the estrus cycle in dairy cows such as age, breed, and body weight, level of nutrition, season of the year, hormonal imbalance, lactation, suckling, and level of milk production.

On the other hand, Gebremedhin [28] and Fekata et al. [25] explained that, in the appropriate season of breeding, having less feed and water access (i.e., January, February, and March), silent heat, poor management, lack of awareness of smallholders, poor body condition of dairy cows selected for ES and mass AI program, distance of the AI center from the dairy farmers, and limited number of AI technicians assigned at each district are the major challenges on ES and mass AI practice in dairy cows for smallholders.

In general, the most challenging factors for the success of ES and mass AI service delivery in dairy cows for smallholders in Ethiopia are the absence of a data recording system, lack of clearly defined share of responsibilities among stakeholders, poor communication and collaboration among stakeholders from the kebele to national level,

lack of motivations and skills of AI technicians due to lack of on career training, improper selection of cows/heifers, inseminating large number cows/heifers in one day by one or two AI technicians, and lack of support and readily available inputs (car or motor bicycle); all these cumulative of factors consequently contributed to the unsuccessfulness of the service [9, 10, 17, 19–24, 33–38]. Also, almost in all areas of the country, most smallholders must travel with their cows a long distance to get AI service since AI technicians are unable to get transport facilities (motor bicycles, fuel, etc.) to go to each smallholder's site having scattered cattle population over a large area [5, 8, 27, 31, 39–45]. However, AI is known to be a time-dependent activity, while such a long journey/waiting time leads to past the correct heat period before the service have been delivered [46].

*3.1. Competence of Artificial Insemination Technicians.* Most of the time, there has been a tendency to ignore AI technician's related factors, but it can dramatically affect the successfulness of ES and mass AI practice in dairy cattle [37]. An AI technician who is not well trained is not able to examine the cervix, uterus, and ovaries correctly; this leads to a serious practical challenge to the success of ES and mass AI program for smallholders [47].

Similarly, Gebremedhin [28] described that the site of semen deposition has been an important factor in the success of AI in dairy cattle. The deposition of semen in the uterine body resulted in a 10% higher nonreturn rate than did cervical deposition and an increase in the conception rate [48]. Insemination into the cervix produces a lower fertilization rate, while insemination deeper into the uterus has the risks of either inseminating into the uterine horn contralateral to the ovulation site or scaring the endometrium with the tip of the insemination catheter. Reduced fertility is the consequence of both latter two errors [37, 48]. These researchers also noted that failure to understand the anatomical and functional relationships among the various tissues and organs of the reproductive system may lead to consistent insemination errors. Regarding the depth and time of insemination, Arthur [37] and Morell [49] recommend that very deep insemination can enhance sperm delivery. Morrell [49] also explained hygiene, thawing methods, and temperature maintenance between thawing to insemination do play a role in achieving pregnancy. However, lack of motivations and skills of AI technicians due to the shortage of on-site training and poor collaboration among stakeholders might be one the challenges for success of ES and mass AI practice in dairy cows for smallholders in the country [20, 40].

*3.2. Lack of AI Inputs and Semen Handling Practice.* Proper handling, placement, and evaluation of the postthaw of semen is necessary to enhance the rate of fertilization and embryo quality [50] since fertility of frozen thawed semen is poorer than that of fresh semen [3, 37]. Conversely, a lot of researchers confirmed that there were improper handling and thawing of semen, lack of different AI inputs such as liquid nitrogen container, and semen were not accessible on

time [1–3, 5–8, 10–18, 25–33, 39–62]. These can be one of the most hindering factors for successful ES and mass AI practice in smallholder dairy cow producers of Ethiopia.

**3.3. Management of Dairy Herds.** Haugan et al. [51] noted that nutritional management and shelter among others play key roles in dairy cows for successful pregnancy. However, seasonal fluctuation in tropics (such as Ethiopia) has a negative influence on the availability of feeds which is linked to high number of services per conception, late age at first calving and first service, and longer calving interval [57]. In addition, Mebrate et al. [56] explained that feed shortage in terms of quality and quantity is the major challenge in smallholder dairy producers in Ethiopia. In the same way, Ulfina et al. [44] also expressed that both roughage and concentrate feeds are either too expensive or unavailable in sufficient quantity and quality to improve smallholder dairy production. In addition, inadequate supply of quality feed and low productivity of the indigenous cattle breeds are the major factors limiting smallholder dairy cow productivity in the country [14, 20]. As a result, efficiency of ES followed by AI service is below expectation of smallholders in Ethiopia.

**3.4. Heat Detection and Time of Insemination.** Iftikhar et al. [52] mentioned that heat detection is one of the major factors that determine AI practice in smallholders. Heat detection in cows is carried out by experienced herd persons/inseminators who can identify those animals which would be in standing heat while being mounted by other female cows or vasectomized bulls, since the period is the shortest period between two successive estrus cycles. Similarly, Arthur [37, 61] stated that the expression of heat can be influenced by many factors such as heritability and number of days postpartum; lactation number, milk production, and health are known to influence estrus expression.

The majority type's dairy herds reared in many parts of the country are indigenous breeds having lower reproductive performances [22, 35]. Galina et al. [26] and Barros et al. [23] mentioned that zebu cattle have a shorter (10.7–11.6 hr) standing heat period and less intense estrus period (10–15 hrs) which occurs later relative to the estrogen stimulus than in taurine cattle. Also, they have low fertility; this might be due to poor heat detection, poor signs of estrus, and irregularity of the estrous cycle [58]. Chaundhari and Sabo [11] addressed that, up to 15% of the cattle presented for insemination are really not in heat; this leads to loss of cost to the owners. Usually, detection of heat is known to be one of the most difficult tasks for successful AI activities [41]. Most of smallholders found in many parts of Ethiopia were not able to detect the actual heat period of their dairy cows [35, 63]. This can be the causes of the failure of the ES and mass AI services. Consequently, ES and mass AI practice in smallholders of the country is less successful as compared to many other countries [21, 55].

ES and correct time of mass AI depend on accurate early heat identification of individual animal and informing the inseminator at the correct time [53]. A cow that is first seen in estrus in the morning is usually inseminated in the

afternoon of the same day, whilst a cow that is first seen in estrus in the afternoon is inseminated early the next day [37]. Frequently, where large numbers of cows are inseminated at the incorrect time, the estrus detection rate is poor, thus generally reflecting a poor standard of herd management. In such circumstances, some of the methods described above should be used to improve the estrus detection rate in the herd [37].

#### **4. Smallholders' Perception on Estrus Synchronization and Mass Artificial Insemination Practice**

Solomon et al. [40] noted that, in the highland, regional states showed that smallholder's breeding methods have significantly shifted to AI, where this service is accessible. They also expressed willingness to pay for AI service. However, Desalegne et al. [16] reported that availability, regularity, and efficiency of the ES and mass AI practice are below expectation of smallholders and AI service efficiency as low as 27% and low conception rates [40]. On the other hand, Riyad et al. [59], Alemayehu et al. [35], and Fekata et al. [25] explained that a majority of smallholders having an access for the technology had low perception towards synchronization and mass AI since their thoughts were highly determined by the calf born achieved rather than by the rate of response to hormone treatment. Also, Gebremedhin [28] and Bainesagn [22] described that smallholders had low perception towards synchronization and mass AI in Tigray and Oromia regional states, respectively. This might be due to wrong procedures used in the campaign and false report without doing necessary conditions at grass root level [25]. In addition, Solomon et al. [40] found that some of the smallholders seek insemination of their cows in the same morning the heat signs were observed. Similarly, when heat signs were detected in the afternoon, some others seek AI service in the same afternoon. This could indicate lack of awareness among farmers as the right time for effective AI would be within 8 to 14 hours after standing heat is manifested. This is because ovulation occurs 10 to 14 h after the cessation of behavioral signs of estrus [36].

As a result of dissatisfaction with delivery of ES and mass AI service having low conception rates, 60.6% of the respondents preferred to use natural mating rather than AI [12]. Samuel [62] identified that heat detection problem and distance to the AI center were the main reasons for failure of the AI service smallholders of dairy cows in Amhara regional state, Ethiopia. On the contrary, most of the smallholders surveyed in Tigray, Ethiopia, were satisfied with the current AI service [29]. As listed above, we can simplify that the majority of smallholder dairy cow producers' satisfaction with the current ES and AI service is low in Ethiopia.

#### **5. Conclusions**

The existence of synthetic hormones for ES, interest of smallholders to accept technology, and high demands for milk production were among the opportunities of the technology in Ethiopia. On the other hand, a lot of

limitations that hamper the success of ES and mass AI practice in many parts of the country were also addressed. Commonly, the most challenging factors for the success of ES and mass AI service delivery in dairy cows for smallholders in Ethiopia were improper selection of cows/heifers, inseminating a large number of cows/heifers in one day at a specific place (which creates stress for both AI technicians and female animals), the absence of a data recording system, lack of clearly defined share of responsibilities among stakeholders, poor communication and collaboration among stakeholders, lack of motivations and skills of AI technicians, lack of support and readily available inputs, feed shortages, improper heat detection by smallholders and time of insemination, and lower reproductive performances of both indigenous and crossbred cows which consequently contributed to the unsuccessfulness of the technology. Moreover, availability, regularity, and successfulness of ES and mass AI practice are below expectation of smallholder dairy cow producers in the country since their thoughts were highly determined by the calf born achieved rather than by the rate of response to hormone treatment. Based on the conclusion above, the following recommendations are forwarded:

- (i) There should be a well-defined share of responsibilities, communications, and collaborations among all stakeholders in the country; this is crucial to identify where the specific limitations are there
- (ii) Future ES and mass AI practice in the country should consider smallholders' knowledge and skills and perception of farmers including AI technicians
- (iii) Knowledge and skill-based training should be given specially for both smallholders of dairy cow producers and AI technicians which may greatly enhance the technology's effectiveness, and the attitudes of smallholders towards to the technology will be changed simultaneously

## Data Availability

The data used to support the review of this article are available from the corresponding author upon request.

## Conflicts of Interest

There are no conflicts of interest related to the publication of this manuscript.

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