

Artificial Insemination: Coverage and Constraints in Central High Land of Ethiopia

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Abstract: A cross-sectional and retrospective investigation was conducted from November, 2017 to April, 2018 with objective of assessing service coverage and constraints that were affecting Artificial Insemination (AI), success rate in Welmera District, special Zone of Oromiya Regional State. Semi-structured questionnaires were pretested and administered to 395 respondents that were composed of a group small-holder dairy farmers (n=384), animal health and production professionals (AHPPs) (n=8) and artificial inseminations technicians (AITs) (n=3). Additionally retrospective data from 2011 to 2017 was considered to evaluate the previous situation of AI services in study site. The survey result showed that from 384 interviewed farmers; majority of them 71.1%, (273) didn't use AI, 18.8% (72) used both AI and natural breeding, while 10.2% (39) used solely AI services to breed their cows. The distribution of AI services between small-holders located in urban, peri-urban and rural localities in the study area was 78.95%, 46.25% and 12.88% respectively, with statistically significant difference ($p < 0.05$). Many farmers (273) solely depended on natural breeding than using artificial insemination due to lack of awareness (27.7%), unfitness of their dairy cows for AI breeding (26.4%), long distance from AI center (24.4%), insufficient capital (13.3%) and shortage of feed (8.1%) to keep dairy cows. The major constraints among AI users were shortage of inputs 7.1%, unavailability of AI technicians 13.4% and conception failure 50.9%. In Wolemera district many farmers 73.3% used to take their cows to AI station for services while 26.7% call-up to technicians to have them at their farm gate for AI services. Generally from this study it was concluded that AI service coverage was inadequate with unequal distributions between small-holders in urban, peri-urban and rural localities. Therefore, AI service in the district requires serious attention so that appropriate solutions be given to alleviate the prevailing constraints.

Keywords: Artificial Insemination (AI), AI Service Coverage, Constraints, Welmera District

1. Introduction

Ethiopia possesses the largest livestock population compared to any other country in Africa [1]. Livestock, especially, cattle in Ethiopia are one of the important and promising sources of wealth. Cattle population of the country is about 53.99 million [2]. Livestock production in Ethiopia contributes to about 80% of the farmers income [3], 45% of the agricultural GDP (including draught power), 20% of all the national exports (official and cross border trade) and 5% of the total manufacturing GDP [4]. It is also reported that, livestock contributes about 16.5% of the national Gross Domestic Product (GDP) and 30% of agricultural employment [5]. Out of the total cattle population the country possesses, about 98.95% are local breeds, 0.94%

crossbreds and the remaining 0.11% pure exotic breeds [2].

Artificial Insemination (AI) technology maximizes the use of outstanding males, dissemination of superior genetic material, improve the rate and efficiency of genetic selection, introduction of new genetic material by importing of semen rather than live animals [6].

However it is widely believed that the AI service in Ethiopia has not been successful to improve reproductive performance of dairy industry [7]. AI service is getting weak and even declining due to inconsistent service delivery in the small holder livestock production systems of Ethiopian highlands [8]. This could be due to various reasons like technical inefficiency, system related, financial and managerial problems [9]. This could be also related to monitoring of heat in small holder dairies is quite difficult for

the farmers as they are engaged in various farm activities [9].

There are a number of reproductive technologies available to transfer desirable genetic materials, of which only Artificial insemination (AI) is the most commonly used technique in developing countries including Ethiopia [10]. Since it is simple, economic and successful, AI is the most important assisted reproductive technology in developing countries [11]. Artificial insemination has become one of the most important techniques ever devised for the genetic improvement of farm animals. It has been widely used for breeding dairy cattle as the most valuable management practice available to the cattle producer and has made bulls of high genetic merit available to all [12]. According to [13], AI provides the opportunity to choose sires that are proven to transmit desirable traits to the next generation and minimizes the risk of spreading sexually transmitted diseases and genetic defects. So far AI using frozen semen has played an important role in increasing genetic progress by upgrading the reproductive rate of the male sire.

In Ethiopia, AI service has been usually undertaken not more than two AI technicians (AITs) at each district [14]. The owners reports to AI technicians when his/her cows were in heat. Woreda AI Technicians sometimes used to visit the farm to inseminate the cow, or in most cases the farmers bring the cows to the district agricultural offices for insemination. Based on the national statistics, each year one AI technician inseminates about 300 cows; the pregnancy rate after first insemination was reported to be around 27%. According to [14], the shortage of AI technicians and the low output per technician, the impact of AI on the number of genetically improved dairy animals for fluid milk in and around urban areas has been limited, and genetic improvement of dairy and meat animals in rural areas has been said almost negligible. However it was widely believed that the AI service in Ethiopia also has not been successful to improve reproductive performance of dairy industry [7].

In Welmera district, there are three AI technician and 23 *kebeles* (the smallest grass root administrative village (*keble*) from those only 10 *kebeles* have AI service full access while 13 *kebeles* rarely have access to AI service. Data from the district indicated that each AI technicians inseminate 800 cows per year. Each individual was charged four Ethiopian Birr for a single AI service. Hence, study the impact of artificial insemination given in the study area, was of a paramount important since there was no well-organized systematic assessment or study on the extent of coverage and constraints of artificial insemination service in Welmera district [15]. Hence, this study was incited to assess the extents AI utilization in Welmera district and identify major constraints affecting the success rate of AI among small-holder, peri-urban and urban dairy farmers.

2. Material and Methods

2.1. Study Area

The study was conducted from November, 2017 to April,

2018 in Welmera district of Oromia Regional State. The district is located at longitude 38° 30' E and latitude 9° 3' N and at altitude about 2400 meters above sea level and characterized by cool sub-tropical climate with mean maximum and minimum temperatures of 22.3°C and 6.16°C, respectively with mean relative humidity of 59%. The mean annual rainfall ranged from 818 to 1247 mm with an average of 1014 mm. The district has three rainy seasons, short rainy season (March to May), long rainy season (June to September) and dry season (October to February) [16].

2.2. Study Population

The study population for this particular investigation includes all artificial insemination technicians (AITs), small-holder dairy cattle owners, animal production and animal health professionals (AHPPs) in the district. The investigation of this study included a sample of small-holder dairy cattle owners (n=384), artificial insemination technicians (n=3) and animal health and production professionals (n=8). Small-holder dairy cattle owners, were interviewed using semi-structured questionnaire format which was administered after translated into *Oromiffa* language. Artificial insemination technicians, animal production and health professionals were also interviewed using semi-structured questionnaires designed for the particular purpose.

2.3. Study Design, Sampling Method and Sample Size

A cross-section study design supported with questionnaire survey and retrospective data was carried out. The total number of animal owners required in this study for questionnaire survey was determined based on a 50% expected coverage of artificial insemination in study area to obtain maximum sample size; and following a formula for survey sample size determination given by [17]. The sample size calculated for obtaining the expected estimate of AI coverage with a $\pm 5\%$ desired absolute precision ($d = 0.05$), and a 95% level of confidence ($\alpha = 0.05$) was 384. Accordingly, a total of 384 smallholder farmers were selected by random sampling procedure. Additionally, all artificial insemination technicians in the district (n=3) and all the animal health and production professionals (n=8) in the district were included.

2.4. Questionnaire Survey

A semi-structured questionnaire were administered to 384 dairy owners selected from urban, peri-urban and rural Kebeles of Welmera district to evaluate the coverage of AI service delivery and the major problems affecting the utilization of AI service by dairy farmers of the study area. The selected Kebeles (villages) include three from urban (Burka-Welmera, Madda-Gudina, and Wajitu-Arbu); three from peri-urban (Gilgal-Kiyyu, Welmera-Cuke, and Sadamo); five from rural part of the district (Girasu-Sida, Barfata 1st, Barfata 2nd, Qore-Iiddo, and Tullu-arbu). The questionnaires also were administered to a total of 11, farm attendants,

managers, veterinarians and AI technicians to collect data on the status of AI services and constraints associated with the service. Different questionnaire formats were used for farmers, and AI technicians and animal production and animal health professionals (AHPPs) in the district.

In the survey information on the developed questionnaires included address of the owner's, technique of AI service, time of commencement of heat, failure to conceive, distance of service center at the time of AI, service per conception, skill of the AI technicians (level of training, on-job training, year of service, condition of the service delivery (mobile or stationed), Duration of AI service was further sub-grouped as too early (0-6 hrs), good (6-12 hrs), excellent (12-24 hrs), too late (>24 hr). Information regarding the source of semen including storage, semen handling facilities, availability of transport system, availability of finance and logistics for procurement of materials for AI (liquid nitrogen, fuel, spare parts etc.), regarding the importance of AI for herd owners related to genetic improvement, milk production and information about general status of the AI practices in the area were also assessed.

In the retrospective study, secondary data were collected from the 6 year service provision record of the district, from inseminators' record book, covering the period from 2011 to 2017. The number of services delivered, animals examined for pregnancy, user, and sex of calf born were collected.

2.5. Statistical Analysis

Data derived from a sample of small-holder dairy cow farmer, AITs, AHPP, during the study period were entered into Microsoft Excel spread sheet (Microsoft Corporation, 2010) where all the data management tasks were performed. Data was summarized using descriptive statistics (frequency, proportions). Proportions were compared using Chi-square test. The relationships between variables were computed using Pearson correlation. The level of significance was held at $p < 0.05$ to show statistically significant differences among variables.

3. Results

A total of 384 small-holder dairy owners in Welmera district were included in the questionnaire survey. The result of questionnaire survey revealed the overall coverage of AI services in study area was 29% (n=111), where 39 (10.2%) used artificial insemination only, and 72 (18.8%) used both artificial and natural breeding methods. The remaining 273 (71%) responded they did not use AI for reproduction and solely depend on natural breeding (Table 1).

Table 1. Coverage of artificial insemination in study area.

Method of breeding	Frequency	percent
Artificial insemination only	39	10.2%
Natural mating only	273	71. %
Both	72	18.8%
Total	384	100%

The distribution of AI service coverage between small-holders located in urban, peri-urban and rural localities in the study area was 78.95%, 46.25%, and 12.88% respectively, with the mean differences being statistically significant ($p < 0.05$) (Table 2).

Table 2. Distributions AI service coverage in study area based on locations.

Location	AI and Natural mating	Natural mating only	Total	X ²	P-value
Urban	15 (78.95%)	4 (21.05%)	19 (100%)	72.08	0.00
Per-urban	68 (46.25%)	79 (53.75%)	147 (100%)		
Rural	28 (12.88%)	190 (87.02%)	218 (100%)		
Total	111 (29%)	273 (71%)	384 (100%)		

The study revealed that among 384 small holder dairy farmers 273 (71%) them used natural mating only due to lack of awareness 76 (27.7%), unfitness of animal for AI breeding 72 (26.4%), long distance 67 (24.4%), lack of capital 36 (13.3%), and lack of feed 22 (8.1%) (Table 3).

Table 3. AI service during weekend, holidays and main reasons for not using AI for breeding in small-holder dairy owners.

Variable	Frequency	Percentage
AI service in weekends and holy days	Yes: 18 No: 93	16.1 83.9
Total	111	100
Main reasons for not using AI		
Lack of awareness	76	27.8%
Lack of feed	22	8.1%
Lack of capital	36	13.3%
Unfitness of animals for AI	72	26.4%
Long distance	67	24.5%
Total	273	100%

Among one hundred eleven (111) artificial insemination users 18 (16.4%) have got AI service regularly without interruption during weekends and holiy days while 93 (83.9%) bitterly complained that they couldn't get AI services regularly as services discontinued on weekends and holidays (Table 3).

As showed on Table 4 the farmers of study area were confronted with many problems associated AI service which was witnessed by 77 (69.36%) of users of AI service. These include conception failure 57 (51.35%), long distance 31 (27.9%), shortage of AIT 14 (12.6%), and shortage of input 9 (8.1%).

Table 4. Problems associated with AI service among users and means of communication.

Variable	Response	Frequency	Percentage
AI service problem	Yes	77	69.36%
	No	34	30.63%
Problems	Conception failure	57	51.35%
	Long distance	31	27.9%
	Shortage of AIT	14	12.6%
	Shortage of input	9	8.1%
Way of communication	Telephone/Mobile	36	32.4%
	At artificial insemination center	75	67.6%

Less proportion of farmers (32.4%) communicate with AI technicians through cell phone while the majority (67.6%)

get AIT service at the station (Table 4). These two systems were based on distances between AI service station, duration of heat detection and personal agreements. Regarding the awareness of farmers on proper heat detection and accurate time of insemination, 24.3%, 28.8 were good and excellent respectively while 23.4% and 23.4% were too early and too late respectively (Table 5).

Table 5. Awareness of AI beneficiary on time of insemination among user in study area.

Time of insemination	No. of respondents	Percentage
0-6 hr (Too early)	26	23.4%
6-12 hr (good)	27	24.3%
12-24 hr (excellent)	32	28.8%
>24 hr (Too late)	26	23.4%
Total	111	100%

According to the response from farmers dairy cows that failed to conceive the first service were about 56.1% and hence used natural mating since some farmer have their own bull where as 43% used AI again and again. Most of small holder dairy farmers (56%) use natural mating while 54% waited for the next 21 days for onset of estrus cycle. More than fifty percent of

Table 7. Trend of artificial insemination service and number of pregnant cows and calves born in Wolemera District from 2012 to 2017.

Year	2012/2013	2013/2014	2013/2014	2014/2015	2015/2016	2016/17	Total	
No of AI service	552	681	754	725	795	350	3857	
Pregnant cows /Conception rate	440/79.7%	460 67.5%	481/63.8%	508/70.1%	556/69.9%	248 /70.8%	2693/69.8%	
Total number of Calf born/%	330/75%	345 /75%	250/52	317/62%	498/89.6%	223/90%	1963/73.1%	
Sex	Female	160/48.5%	181/52.5	130/52%	166/52.4	242/48.6%	111/49.8	990 /50.4
	Male	170/51.5%	164/47.5	120/48%	151/47.6	256 /51.4%	112/50.2%	973/49.6
Unsuccessful pregnancy	110/25%	115/25%	231/48%	191/38%	58/10.4	25/10%	730/(27.1)	

Retrospective data also was obtained from AIT recording book to see the trend of AI service starting from years 2011/12 to 2016/17 G. C. From the data information like number of cows inseminated per year, different sex of calves born and conception rate of inseminated cows was obtained as it indicated on (Table 7). The conception rate of inseminated cows during those years was ranged from 63.8% to 79.9% even though all conceived cows did not give birth or had unsuccessful pregnancies showing that the existence of prenatal death or embryonic mortality (Table 7). The proportion of male and female calves born was similar during those years.

Artificial insemination technicians were also interviewed for how long period of time they were trained to perform their job. Their response was that all artificial insemination technicians were trained at different time and place for short time. One was trained for six months and the other two for 45 days. Artificial insemination technicians normal used to give service both on AI center and on call travelling 10-30 and sometimes 30-40 k.ms by motor cycle.

All of the AI technicians responded that they never got on job trainings and other incentives. Some of them used to provide services during weekends and holidays on personal agreements with the farmers and receive additional payments while others did not. Also AI technicians complained that liquid nitrogen was not readily available in some places while

respondents said that they have animal health problems while others said that they don't have disease challenges. Major animal health problems that prevail in the study area were studied depending on the information from clinical diagnoses. The main were internal parasite 11 (9.8%), external 14 (12.5%), mastitis 15 (13.4%), and bloat 6 (5.4%) (Table 6).

Table 6. Presence of Animal health problems and type of disease in study area.

Presence Animal health problems	Frequency	Percentage
Yes	57	51%
No	54	49%
Total	111	100%
Type of diseases		
Mastitis	15	13.5%
External parasite	14	12.5%
Internal parasite	11	9.8%
Bloat	4	5.4%
Black leg	1	0.9%
Dystocia	2	1.8%
Lump skin diseases	6	5.4%
Respiratory diseases	2	1.8%
Foot and mouth diseases	2	1.8%

the other had no problem in getting liquid nitrogen. Two of the AI technicians believed that there was a risk of indiscriminate insemination while the others either did not have any idea about the problem or believed it can be controlled. Again they said that the National Artificial Insemination Center (NAIC) has to appreciate the extent of the problems of AI to bring appropriate solution and the necessary supports by all concerned bodies have to be visible.

Animal Health and Animal production professionals (AHPs) were also interviewed. From eight total professionals six of them responded that there are no functionally effective bodies at regional, zonal and district level to coordinate AI service and others forwarded unavailability of strong mechanism of controlling and monitoring AI service by concerned bodies. They also added that the absence of strong collaboration and communication between NAIC, regional, zonal, and district and another stalk holder to strengthen AI service in the area. Majority of them (62.5%) also said that AI service success stories were by far less than what was expected to be at all level (national, regional, zonal) in general. Also (87.5%) of the respondent explained the absence of controlling or evaluating mechanism of semen quality in all terms from production, storage, transportation, distribution and insemination. Others (50%) said the inadequate budget allocation, irregular supplies like liquid nitrogen, means of transportation absence of incentive for AI

technician and inadequate awareness creation for end users made the distribution and utilization of AI to be scaled down.

4. Discussion

This study was conducted to investigate the coverage and constraints of AI that affect its success rate with assessing the attitude and perception of animals' owners, AITs and Animal health and production profession in Welmera district. The result of artificial insemination coverage assessment revealed that among 384 small holder dairy farmer 39 (10.2%) use only AI, 72 (18.8%) both breeding system and 273 (71%) natural mating only.

The overall coverage of artificial insemination coverage was 29% (n=111) whereas the remaining 71% (n=273) solely depend on natural mating. This result revealed that most of respondents didn't use AI service (71%). This finding is supported by [18] that insemination services to rural bovine are influenced by farmers' status, large marginal, small and land less farmers exist.

There was different degree of adoption of AI technology among respondents based location: urban (78.95%), per-urban (46.26%), Rural (12.88%) with statistically significant ($p < 0.05$) among location. The result showed that artificial insemination user concentrated around urban and per-urban area of study site. This finding supported with [19] reported that urban and per-urban dairy farming with different level of intensification from less than 1% to 40% growth while mass farmers remain non-user of this technology.

The present study revealed lack of awareness (27.7%) was the major constraint in the success of AI in the study area. This is due to immoderate linkage between the AI service center about the education and training by AITs and other responsible bodies. These constraints lead them to keep endogenous cattle with low productivity and productions.

Farmers were aware of the existence of improved technologies that can offer them higher returns as compared with their conventional practices. However, most of the poor farmers do not have the financial means required to make the initial investment and acquire the associated technological inputs. Financial support or credit facilities to smallholder farmers who intend to enter into commercial dairy farming are very much limited [20]. The study revealed that many farmers (13.5%) reported scarcity of capital much less than [21] (46%) study conducted in and around Mekele City. This difference may be due to status of farmer, cost of feed, price of improved animal breed and agrio-ecological variability of between two study areas.

Study result showed that about 16.1% of AI user have got service regularly while 83.9% didn't have got continuous service on weekend and holiday which less and greater than study reported by [21], (31.8% and 68.9) respectively. This difference may be made due to personal agreement, AI technician personal motivation and logistic he has.

In the present study it revealed that (50.9%) conception failure as very serious problem that requires immediate solution. This was associated with semen quality, improper

handling practice, inappropriate time of heat detection and insemination, cow fertility, body condition and skill of inseminators. This finding was in line with findings of [22].

Owner were subjected to shortage of AIT in case of un even distribution of AIT, increment dairy cattle supported with [14] indicated that AI technician shortage and low capacity of technician, the impact of AI to improve dairy and meat animal genetic in rural areas is almost negligible and long distance problem was of due to limited AI station construction and obligated high cost AIT called to service supported by [23].

73.3% respondents get AIT service at station where as 26.7% get service through cell phone. These two systems were based on distance between owner resident and AI service station, duration heat stress, personal agreements. AI technicians are unable to get transport facilities like motor bicycles, fuel as needed so farmers have to move their cows for long distance in search of AI service. Since AI is known to be a time dependent activity, in which during this long journey/waiting time, heat period is passed away before the service have been given [24].

Present study revealed that about 46.9% (too early and too late) don't have awareness to detect heat consequently repeat breeding and conception failure in line with Nijar *et al* (47%), which is contradict to [25] indicate that accurately identifying cows to be inseminated in a timely manner is necessary to have them become pregnant, calve, and return to peak milk production, and to produce a consistent supply of replacements.

Present study showed that (46.3%) AI beneficiary use natural mating and 53.7% of AI user pass and wait 21 days for service when service discontinuous due to holidays and absence of AIT during onset cow and heifer which is supported by [29].

The study revealed most of the technicians do not get on job trainings shows that there was some deficit indicating a need for upgrading the capacity of technicians through giving proper trainings particularly for those who poor technical expertise. 66.7% of them have indicated that they are not motivated to work as AI technicians due to associated problems and constraints. This is fully supported by the reports of the [22] that indicated a very high turnover of AI technicians all over the country. The situation is closely associated to the discontinuation of in-service trainings and incentive mechanisms which had been practiced during the past.

Also it was revealed that all responsible bodies from federal to wereda levels, particularly the NAIC, are not giving proper attention to the AI service which indicates that decision makers need to work hard improvement of the situation of the AI operation at national level in line with [23].

66.7% of AITs said that they do not believe that NAIC was doing its responsibilities properly. The findings regarding the constraints associated with the AI service at national level/regional levels are in supported with the suggestions of [26] indicated that the NAIC was not functioning well and was consistently losing the confidence of stakeholders in the country.

Result of animal health and production professionals revealed 6 (75%) them responded that there is no functionally effective bodies at regional, zonal and district level to coordinate AI service and no proper mechanisms of controlling indiscriminate inseminating/breeding in line with [27]. Seventy five percent (75%) of AHPP confirmed that there was no appropriate collaboration and communication between NAIC, regional, zonal, and district. The finding of current study was greater than the report of [28] who reported 69% and less than that of [32] 82%. This difference could be due to level of awareness of different respondents.

The retrospective data result that covered years from 2012/13- 2017 indicates that as the number of AI user increase from year to year, rational number of farmers participatory and number of calves born increased in relation to number of cows inseminated. However, AI service was decreased in 2014/2015 due to scarcity of inputs.

The number of female calves born using AI was less than male calves and this proportion was not in line with interest of most beneficiary/farmers/. This was become the source of dissatisfaction for AI user, even though the reason why natural mating give more female progenies than artificial insemination was so far unknown [29].

The AI service in study area was not good in relation with its application times due to low attention this sectors, poor communications concerned body and stalk holder and lack of awareness of farmers about heat detection and overall management. This finding supported with [30, 31] reported that AI service is weak and even decline due to inconsistency of service in small holder dairy farmer system of Ethiopian high land.

5. Conclusions and Recommendations

According to the result of the study on assessment of coverage and constraints associated with artificial insemination rate in Wolmera district, AI service has been given low consideration from concerned bodies. The success rate in study site is still very low due to time of insemination, heat detection problem, and lack of technician, diseases, and lack of awareness about AI, financial, infrastructural, and managerial. Overall coverage of AI service in rural only was 12.88%. In the other hand 83.9% of small holder respondents couldn't got the AI services without interruption and 50.9% conception failure was urgent call for solution. Weak of structural linkage between AI center and service giving unit, absence of collaboration and regular communications between zonal, district, and another stalk holders, as well as absence incentive and reward to motivate AI technicians. These constraints finally resulted with poor production system, inadequate financial profit and keeping animals without conceiving for many months or years with addition cost for these animals. It can be stressed that the AI service in study area is inadequate if not urgent corrective measure must be taken on all concerned body and responsible body. Based on problem and constraints identified in this study regarding to artificial inseminations service, coverage and its

constraints, the following were recommended:

- 1) Linkage between federal, regional, zonal and district should be strong enough to encourage AIT and farmers to increase involvement of stalk holders in the activities of country.
- 2) Awareness should be created among animal owner and attendants through training and extension programs.
- 3) Private sectors should be encouraged to be involved in the AI service sector.
- 4) Endeavor should be made to improve the current status of conception rate at large by improving the efficiency of AI.
- 5) The government should provide motor cycle as well as fuel for AI and animal health professionals to perform fast and active service for the community.

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