

Full Length Research Paper

Assessment on artificial insemination service delivery system, challenges and opportunities of artificial insemination services in cattle production in Western zone of Tigray Region, Ethiopia

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Received 3 August, 2020; Accepted 23 September, 2020

The aim of the survey was to assess artificial insemination (AI) service delivery system and identify the challenges and opportunities of AI service in cattle production in Western Zone of Tigray Region, Ethiopia. Twenty Kebeles (lowest administrative units) and 353 respondents were purposively involved in face-to-face interview. Data analysis was performed using SPSS and mainly summarized by frequency and percentages. Chi-square test was the statistical method used to test proportions of variables. There was statistically significant ($P < 0.05$) differences in AI service interruptions in both regular working hours and weekends and holiday hours. AI service interruption was a critical challenge in regular working days and in weekends and holidays. This is because 73% of the respondents reported that AI service was interrupted in Monday through Friday and 75% of the respondents also reported that Artificial Insemination Technicians (AITs) were not available to deliver AI service in weekends and holidays. Above half (63%) of the small scale farmers reported that AITs were very poor. Most of the very poor AITs were in midland (48%) and lowland (36%) agro-ecologies compared to the AITs in highland (16%) agro-ecology. Mobile AI service delivery system through motor bikes was the most common AI service delivery system used. The major challenges of AI service in order of their importance were lack of community awareness, poor animal management, unskilled AITs and inadequacy of AITs. The government and NGOs should solve the current challenges of AI service. The current approach and system of AI delivery should be restructured. Adequate numbers of skilled manpower should be assigned based on the standard numbers of breedable cows per AI center or per AIT. Moreover, agro-ecology based human management system and infrastructure development should be adequately addressed.

Key words: Communication means, AI service interruption, distance between homestead and AI service center, AI service delivery system, agro-ecology.

INTRODUCTION

The total cattle population of Ethiopia in the rural sedentary areas is estimated to be about 60.4 million.

About 55% of the total cattle population constitutes female cattle whilst 45% of the total population are

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male cattle. 98% of the total cattle population are local breeds whilst crossbred and pure exotic breeds accounted for just about 1.5 and 0.2%, respectively (CSA, 2017/18). The most important factor for the success and profitable dairy and beef farming is efficient reproduction (Sheldon et al., 2006). Ethiopia began crossbreeding work in the early 1950s, however, the crossbreeding activities were not based on clearly defined breeding policy with regard to the level of exotic blood inheritance and the breed types to be used (Aynalem et al., 2011). The total number of crossbred female cattle produced through the crossbreeding programme for decades in the country is extremely low. This was due to the unsuccessful crossbreeding through artificial insemination (Sinishaw, 2004; Desalegn, 2008; CSA, 2011). In Ethiopia, crossbred dairy cattle are mainly crosses of Zebu and Holstein-Friesian (Nuraddis and Ahmed, 2017).

Profitability in livestock production is highly related to the reproductive success of livestock (Newton, 2014). The application of biotechnologies must include good practices in animal husbandry, animal health and nutrition, and reproduction (Bertolini and Bertolini, 2009). Artificial insemination (AI) is a valuable biotechnological tool, and most commonly used in Ethiopia over the last 30 years (Webb, 2003). AI has many advantages compared with natural service (Lima et al., 2010; Lamb and Mercadante, 2016). AI is a time dependent activity, and thus heat period could be passed away before the cows receive AI service during long journeys of cows for the service (Lemma, 2010). Practice of a good cow management and selection of cows which have good body condition score are the two most essential requirements for successful estrous synchronization and AI service (Getabalew and Alemneh, 2019). AI service in Ethiopia has not been successful to improve reproductive performance of dairy industry of the country (Desalegn et al., 2009).

Tesfay et al. (2019) reported on the assessment and analysis of the participatory agricultural production constraint appraisal of Western Zone of Tigray and noted that efficiency of AI service was poor. However, the causes and challenges for the poor efficiency of AI service in this region were not clearly known. Therefore, it was compulsory to assess AI service delivery system in cattle, and assess the associated risk factors and/or challenges and opportunities of AI service in the area.

MATERIALS AND METHODS

Description of the study area

The survey was carried out in Kafta Humera, Tsegede and Welkait districts. Kafta Humera district is the lowland part of Western Zone of Tigray Region, Ethiopia whereas Welkait and Tsegede districts are the highland areas of Western Zone of Tigray. Kafta Humera district has two agro-ecologies which consist of 86% lowland (*kola*) and 14% midland (*weina dega*). Welkait district also has two agro-

ecologies which include 60% lowland (*kola*) and 40% midland (*weina dega*). Tsegede district has three agro-ecologies which comprise 70% lowland (*kola*), 22% midland (*weina dega*) and 9% high land (*dega*). Kafta Humera district is characterized by an altitude of 500 to 1849 m above sea level (masl), rainfall of 650-750 mm and temperature of 25-48°C. Welkait district is characterized by an altitude of 700 to 2354 masl, rainfall of 700 to 1800 mm and temperature of 18 to 25°C. Tsegede district is also characterized by an altitude of 680 to 3008 masl, rainfall of 1200 to 2500 mm and temperature of 12 to 35°C (Tesfay et al., 2019). Moreover, Kafta Humera district was covered by 33% of forestry land and 5% of pasture land/grazing land, Welkait district had 18% of grazing land and 19% of forest land whilst Tsegede district accounted 35% of forest land and 22% of grazing land (Tesfay et al., 2019).

Data collection and analysis

Sample size, sampling technique and data collection methods

The survey was conducted in twenty rural and peri-urban Kebeles (lowest administrative units), 353 small scale farmers and 10 artificial insemination technicians (AITs), and purposive sampling was used to select Kebeles, households of small scale farmers and AITs. Kebeles with more than ten AI beneficiaries and who bred animals in two and above breeding seasons were involved in face-to-face interview. A structured questionnaire was used to collect the data from each household.

Method of data analysis

SPSS software (SPSS, v20, 2012) was used to analyze the data. The data were summarized using descriptive statistics (frequency, percentage and mean) and index method. The index method was used in ranking the challenges and opportunities of AI service:

Index = sum of (3 x number of households who ranked first + 2 x number of households who ranked second + 1 x number of households who ranked third) given for each variable divided by sum of (3 x number of households who ranked first + 2 x number of households who ranked second + 1 x number of households who ranked third) for all variables.

Moreover, an asymptotic chi-square test (X^2 -test) was computed to test significance of proportions.

RESULTS

Household characteristics

Most of the household heads (HHs) (93%) interviewed were males (Table 1). The mean household family size was 6.04 ± 1.993 . Majority (92%) of the interviewed HHs were married, and most (54%) of the interviewed HHs were in the age category of 46-65 years old followed by HHs (32%) in the age category of 36-45 years old. About 45% of the interviewed HHs attended lower primary school whereas 31% of the HHs interviewed were illiterate. Majority (80%) of the household occupation was livestock-crop mixed farming. Extensive production system (88%) was the production system followed by the households interviewed while very few (7%) of the households followed intensive production system (Table

Table 1. Household marital status, Household head (HH) gender and age, HH education level, household occupation and production system (N=353).

Marital status (N=353)	Frequency (%)	χ^2	P value
Single	2(0.6)	847.782	0.000
Married	325(92.1)		
Divorced	12(3.4)		
Widowed	14(4.0)		
HH gender			
Male	328(92.9)		
Female	25(7.1)		
HH age (N=353)			
Age categories of HH			
Below 25 years	1(0.3)	354.408	0.000
25-35 years	21(5.9)		
36-45 years	114(32.3)		
46-65 years	189(53.5)		
Over 66 years	28(7.9)		
Educational level of HHS			
No education	108(30.6)	219.762	0.000
Lower primary school	160(45.3)		
Upper primary school	47(13.3)		
Secondary school	30(8.5)		
College	8(2.3)		
Household occupation			
Off farm and livestock production	28(7.9)	568.144	0.000
Livestock-crop mixed farming	281(79.6)		
Livestock production only	5(1.4)		
Off farm and mixed farming	39(11.0)		
Production system followed			
Extensive production system	312(88.4)	481.773	0.000
Semi-intensive production system	16(4.5)		
Intensive production system	25(7.1)		
Cross tabulation test			
Educational level * production system followed		19.059	0.015

Numbers in parentheses are the percent of respondents.

1). The relationship between educational levels of household heads and the production systems followed were negatively significantly ($P \leq 0.05$) different.

Availability of artificial insemination technicians (AITs) on regular working hours and in holidays and weekends, distance of homestead from AI service center, and means of communication used by the small scale farmers

Most (73%) of the respondents reported that there was

interruption of AI service in regular working days of Monday through Friday. Moreover, about three fourth of the respondents also indicated that AITs were not available in weekends and holidays (Table 2). However, 90% of the AITs reported a contradictory opinion that as they provided AI service in weekends and holidays. When the AITs were not available, 28% of the respondents decided to pass the date without insemination and wait the next 21 day of estrus cycle whilst 47% of the respondents used natural service. All AITs reported that the main reasons for AI service interruption were lack of incentives and infrastructures.

Table 2. Availability of AITs Monday through Friday and in weekends and holidays (N=353).

Availability of AIT Monday up to Friday		X²	P value
Categories	Frequency (%)		
Always available (regular service)	97(27.5)	71.618	0.000
Not always available (there was interruption)	256(72.5)		
Cross tabulation of agro-ecology (AE)*availability of AITs in Monday up to Friday			
Always available*AE			
Highland	26(26.8)	39.523	0.000
Midland	66(68.0)		
Lowland	5(5.2)		
Not always available*AE			
Highland	47(18.4)		
Midland	108(42.2)		
Lowland	101(39.5)		
Availability of AIT in weekends and holidays			
Yes, s/he was available	88(24.9)	88.751	0.000
No, s/he was not available	265(75.1)		
Cross tabulation of agro-ecology (AE)*availability of AITs in weekends and holidays			
Always available*AE			
Highland	22(25.0)	33.735	0.000
Midland	61(69.3)		
Lowland	5(5.7)		
Not always available*AE			
Highland	51(19.2)		
Midland	113(42.6)		
Lowland	101(38.1)		
Remedies taken by the farmers when AITs were not available			
Pass the date without insemination	99(28.0)	30.295	0.000
Use natural mating	166(47.0)		
AIT is available	88(24.9)		
Availability on weekends and holidays (AITs response)			
Available	9(90)		
Not available	1(10)		

Few respondents (6%) received AI service in a distance of 21-30 km whilst 32% of the small scale farmers obtained AI service travelling a distance of 11-20 km. However, 50% of the AITs reported that they travelled a distance of 11-20 km whereas 40% of them travelled a distance of 21 to 30 km (Table 3). The mean number of Kebeles per AIT was 4.2±1.3 and 60% of the AITs reported that the number of Kebeles were beyond their capacity. It was also noted that the mean number of cows and heifers inseminated per AIT/day in the breeding season was 6.7±8.8.

Payment per insemination on AI service and farmers' evaluation on the knowledge and skill of the AITs

Few respondents (27%) did not pay for the AI service

(Table 4). Majority (63%) of the small scale farmers reported that the AITs were very poor whilst very few (6%) of the respondents rated the knowledge and skill of the AITs as very good (Figure 1).

Major challenges and opportunities in AI service

There were many challenges in AI service. Based on the index ranking, lack of community awareness was the prime challenge in AI service (Table 5). Poor animal management and unskilled AITs were the second and third challenges of AI service, respectively. Most (78%) of the respondents indicated that there were opportunities in AI service whilst 22% of the respondents reported that there were no opportunities. Milk market access and feed access were the first and second attractive opportunities

Table 3. Distance of homestead from AI service center and means of communication used by the small scale farmers (N=353).

Distance categories (farmers response)	Frequency (%)	X²	P value
Household site (AIT come)	5(1.4)		
<1 kilometer (km)	12(3.4)		
1-5 km	115(32.6)	224.751	0.000
6-10 km	87(24.6)		
11-20 km	112(31.7)		
21-30 km	22(6.2)		
Cross tabulation of agro-ecology (AE)*distance between homestead and AI service center			
Household site (AIT come)			
Highland	4(80.0)		
Midland	1(20.0)		
Lowland	0		
<1 kilometer (km)			
Highland	3(25.0)		
Midland	9(75.0)		
Lowland	0		
1-5 km			
Highland	41(35.7)	121.510	0.000
Midland	57(49.6)		
Lowland	17(14.8)		
6-10 km			
Highland	25(28.7)		
Midland	38(43.7)		
Lowland	24(27.6)		
11-20 km			
Highland	0		
Midland	69(61.6)		
Lowland	43(38.4)		
21-30 km			
Highland	0		
Midland	0		
Lowland	22(100.0)		
Mean number of Kebeles covered by a unit of AIT	4.2±1.3	Minimum of 1	Maximum of 6
Did you think that you have Kebeles beyond your capacity?			
Yes		6(60)	
No		4(40)	
Distance cover (AITs response)			
1-5 km		1(10)	
11-20 km		5(50)	
21-30 km		4(40)	
Number of cows and heifers inseminated per AIT per day during the breeding season	6.7±8.8 (Minimum of 1 and maximum of 30)		
Means of communication (farmers response)		Percent (%)	
AIT visits us daily in the breeding season		12.9	
AIT comes to home when S/he wants		64.9	
We call AIT when we need him/her (mobile)		64.9	
We take our cows to the AI service center		13.7	

Table 4. Payment per insemination on AI service and farmers' evaluation on the knowledge and skill of the AITs (N=353).

Do you pay for AI service?	Frequency (%)	X²	P value
Yes	258(73.1)	75.266	0.000
No	95(26.9)		
Cross tabulation of AE*payment for AI service			
Yes			
Highland	63(24.4)	27.489	0.000
Midland	137(53.1)		
Lowland	58(22.5)		
No			
Highland	10(10.5)		
Midland	37(38.9)		
Lowland	48(50.5)		
Amount paid per unit insemination (ETB)			
2.00	258(73.1)		
0.00	95(26.9)		
Farmers' evaluation levels on the knowledge and skill of AITs			
Very poor	221(62.6)	172.085	0.000
Good	112(31.7)		
Very good	20(5.7)		
Cross tabulation of AE* Farmers' evaluation levels on the knowledge and skill of AITs			
Very poor			
Highland	35(15.8)		
Midland	106(48.0)		
Lowland	80(36.2)		
Good			
Highland	30(26.8)	16.590	0.002
Midland	58(51.8)		
Lowland	24(21.4)		
Very good			
Highland	8(40.0)		
Midland	10(50.0)		
Lowland	2(10.0)		

ETB=Ethiopian Birr.

in AI service, respectively (Table 5).

DISCUSSION

Majority (93%) of the household heads (HHs) interviewed were males. The participation of female headed households in AI service was poor and future attention is needed. Most (54%) of the interviewed HHs were in the age category of 46-65 years old. 45% of the interviewed HHs attended lower primary school whereas 31% of the HHs interviewed were illiterate. The small scale farmers

were academically poor and calls introduction of adult education because it is basic for the success of AI service. However, it should be noted that change in education level in Western Zone of Tigray, Ethiopia did not influence production system; educated farmers could not shift from extensive production system to intensive production system. Only 1.4% of the respondents were involved in sole livestock farming. The awareness of the community on sole livestock farming is poor and needs to demonstrate on sustainable livestock production and nutrition and food securities. Extensive production system (88%) was the prominent production system followed by

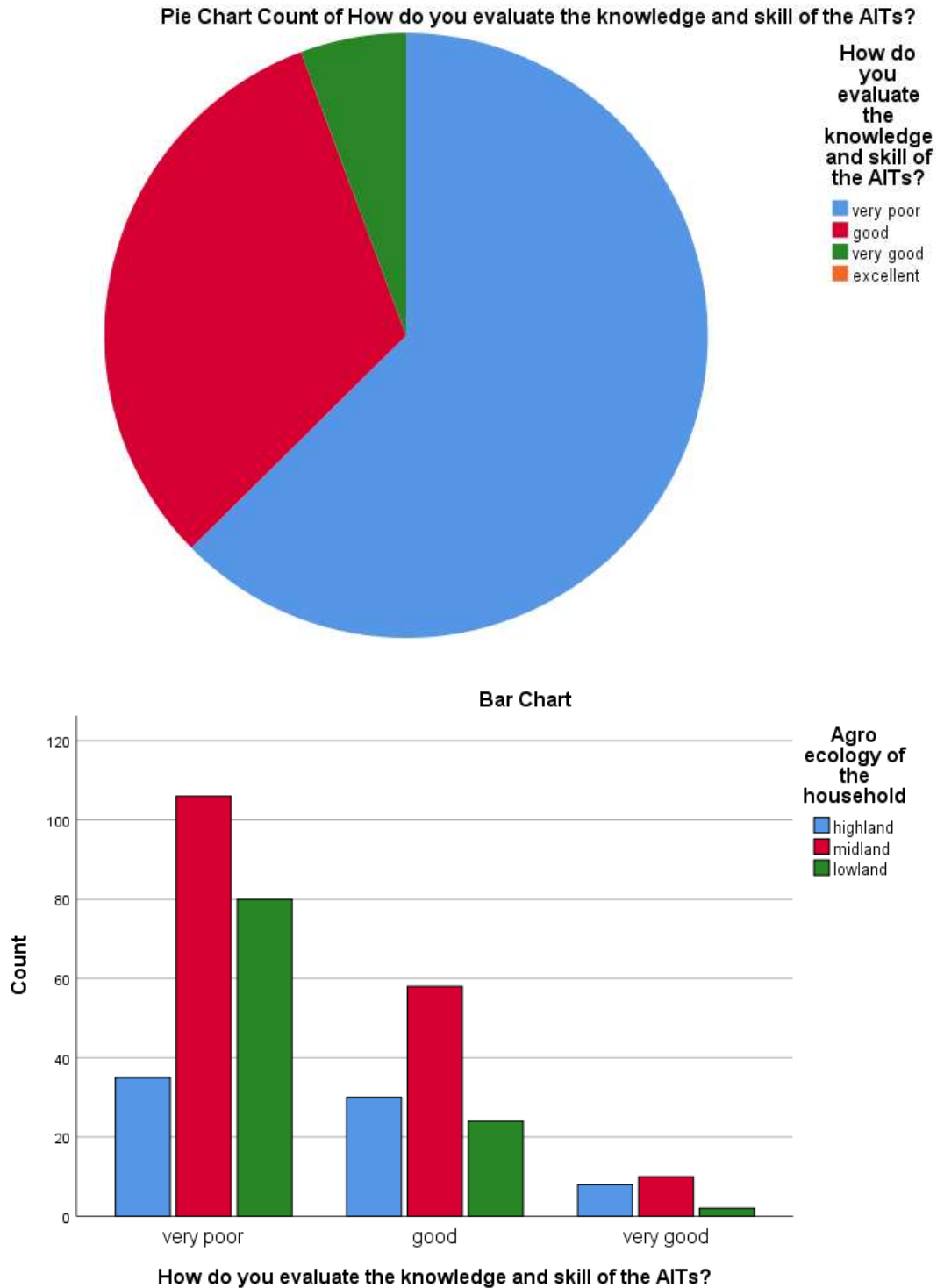


Figure 1. Evaluation levels of farmers on the knowledge and skill of AITs.

the households interviewed. The small scale farmers were resource poor and could not practice intensive production system.

The AI service interruption in Western Zone of Tigray, Ethiopia was a critical challenge because 73% of the

respondents reported that there was service interruption in Monday through Friday and 75% of the respondents also reported that AI service was interrupted in weekends and holidays. A large proportion of AI service interruption was in midland (42%) and lowland (40%) agro-ecologies

Table 5. Challenges in AI service (N=353).

Challenges	R1	R2	R3	Index
Lack of awareness in the community	93	53	42	0.206
Delayed time of insemination	9	18	9	0.035
Inadequacy of AITs	49	61	36	0.147
Animal management problem	62	66	65	0.185
Heat detection problem	25	24	28	0.073
Unskilled AITs	76	38	29	0.160
Interruptions in holydays and weekends	19	44	62	0.100
Disease problem	5	7	19	0.023
Abortion	1	1	2	0.003
Dystocia	1	6	5	0.010
Lack of infrastructure	12	14	11	0.036
Long distance from AI service center	1	6	7	0.011
Poor communication	2	5	9	0.012
Opportunities in AI service				
Feed access	116	8	0	0.410
Market access (milk)	145	22	0	0.533
Best breed for crossing*	11	5	0	0.046
Presence of irrigation	2	2	0	0.010

R1=Rank one, R2=Rank two, R3=Rank three, *=Begait cattle.

of Western Zone of Tigray, Ethiopia as compared to highland (18%) agro-ecology in Monday through Friday. Almost a similar AI service interruption was reported in midland (43%) and lowland (38%) agro-ecologies as compared to highland (19%) agro-ecology in weekends and holidays. The variation in AI service interruption across agro-ecology could be due to the differences in weather conditions. However, 90% of the artificial insemination technicians (AITs) in Western Zone of Tigray, Ethiopia reported that they did not interrupt the AI service in weekends and holidays. The present AI service interruption in Western Zone of Tigray, Ethiopia is in line with the report 76% of respondents in Tiyo district and 60% of respondents in Sagure district did not receive regular AI service (Feyera and Tegenu, 2016); Ephrem (2019) reported lack of regular and consistent AI service (99%) and lack of weekend AI service (93%); Ashebir et al. (2016) reported that 60% of the respondents in Eastern and Southeastern of Tigray, Ethiopia did not receive AI service in weekends and holidays, 68% of the small scale farmers of selected districts of Arsi Zone did not receive AI service regularly, and 55% of the respondents reported that there was no service in weekends and holidays (Feyera and Tegenu, 2016), Riyad et al. (2017) reported that there was AI service interruption in weekends and holidays (51%) in Tullo district, West Hararghe, Ethiopia, 67% of AITs were not providing AI service in the weekends in West Gojjam Zone (Malede et al., 2013), Bemrew et al. (2015) reported that there was 66% AI service interruption in dairy cattle owners of Debretabour Town, Ethiopia

Nuraddis et al. (2014) reported that 59% of the small scale farmers in Selected Districts of Jimma Zone, Ethiopia did not obtain regular AI service, and Tilahun and Yohanis (2018) reported 53% of the small scale farmers in and around Adama Town did not obtain regular AI service due to different constraints.

The AI service interruption in Western Zone of Tigray, Ethiopia is not in agreement with the report of Nuraddis et al. (2017) that 85% of the small scale farmers in Western Shoa Zone, Ethiopia obtained regular AI service. This large deviation of service could be due to differences in awareness of the small scale farmers and commitment of the AITs.

When there was AI service interruption, 47% of the respondents in Western Tigray, Ethiopia used natural service whilst 28% of the respondents reported that they decided to pass the cycle without insemination. A comparable 41% of the respondents in West Gojjam Zone used natural service whilst incomparable proportion of respondents (44%) in West Gojjam Zone decided to pass the cycle without breeding (Malede et al., 2013). Riyad et al. (2017) reported that 33% of the small scale farmers in West Haraghe, Ethiopia used natural service during AI service interruption. When the AITs were not available to deliver AI service, 28% of the small scale farmers in Western Zone of Tigray, Ethiopia decided to pass the date without insemination. This is in agreement with the report of Bemrew et al. (2015) in dairy cattle owners of Debretabour Town, Ethiopia because 29% of the small scale farmers decided to pass the date without insemination. But the proportion of small scale farmers

(47%) in Western Zone of Tigray, Ethiopia who used natural service and the proportion of the dairy cattle owners (28%) of Debretabour Town, Ethiopia who used natural service are different. Moreover, 62.5% of the small scale farmers in Selected Districts of Jimma Zone, Ethiopia decided to pass the estrus cycle without insemination (Nuraddis et al., 2014) when AITs were not available to deliver AI service. These differences in decision on whether to use natural service or pass the cycle without insemination may be due to differences in awareness of the communities and on availability of bulls for natural service. However, the present AI service interruption in Western Zone of Tigray, Ethiopia is not in line with the works of Riyad et al. (2017) who reported that 44% of the respondents in West Hararghe did not use regular AI service whilst 56% of the dairy cattle owners obtained AI service without interruption. Ashebir et al. (2016) reported that 25% of the small scale farmers in Eastern and Southeastern of Tigray, Ethiopia did not obtain regular AI service. These differences may arise from the differences in awareness of the communities, distance between homestead and AI service center and commitment of the AITs.

The distance between homestead of small scale farmers and AI service centers of Western Zone of Tigray, Ethiopia was largest in midland and lowland agro-ecologies compared to the distance in highland agro-ecology. Some of the small scale farmers (14%) in Western Zone of Tigray, Ethiopia took their cows and heifers to the AI service centers and is not comparable with the study of Feyera and Tegenu (2016) which reported 61% of the small scale farmers took their cows to the AI service station whilst the remaining used AIT call to their vicinity. This difference may arise from differences in community awareness on AI service. Small scale farmers in West Gojjam Zone trek their cows for more than 28 km to AI service center due to lack of transport facilities by the AITs (Malede et al., 2013) is not in line with animal trekking distance in Western Zone of Tigray, Ethiopia because most of the animals trekked 1-20 Km to the AI service center(s).

A daily mean of 6.7 ± 8.8 of cows and heifers were inseminated in each breeding season in Western Zone of Tigray, Ethiopia. Riyad et al. (2017) reported that average daily numbers of cows inseminated by AITs ranged from 1 to 10. One local AI center for every 5,000 breedable cows is a rule of thumb in AI service (Raymond and Saifullizam, 2010). Above half (63%) of the small scale farmers in Western Zone of Tigray, Ethiopia reported that AITs were very poor in their knowledge and skill. It was also noted that a large proportion of the small scale farmers who reported the existence of very poor AITs were in midland (48%) and lowland (36%) agro-ecologies compared to highland (16%) agro-ecology. This variation may be from the differences in academic background of the AITs and the level of provision of on-job trainings. The technical knowhow of most AITs in Western Zone of

Tigray, Ethiopia was under the classification of very poor (63%) and is not in agreement with Desalegn (2008) report on the evaluation of the technical knowhow of AITs that they were categorized as good (57%) and very good (27%), poor (10%) and excellent (10%), and Malede et al. (2013) report on AITs in West Gojjam Zone were categorized as excellent (15%), very good (40%), good (23%) and poor (22%). This difference may arise from academic background of the AITs and on the frequency of access to on-job trainings.

The main challenges of AI service which negatively influenced the efficiency of AI service in Western Zone of Tigray, Ethiopia were lack of awareness in the community, animal management problem, unskilled artificial insemination technicians (AITs) and inadequacy of AITs. The present challenges are similar with Ashebir et al. (2016) reported that lack of awareness (18%) and management problem (14%) were some of the major constraints of AI service in Eastern and Southeastern Zone of Tigray. Bemrew et al. (2015) reported inadequacy of artificial insemination technicians (AITs) (16%), one of the major problems identified in Debretabour Town, Ethiopia, Malede et al. (2013) reported that inadequacy (60%) of AIT (Sekela district of West Gojjam Zone), distance to AI service center and unskilled AITs were the main problems in AI service in West Gojjam Zone. Ephrem (2019) reported that lack of regular and consistent AI service (99%), lack of weekend AI service (93%), inadequacy of AITs (92%) and lack of awareness (92%) were the major constraints in AI service in selected Districts of Wolaita Zone, Ethiopia. Riyad et al. (2017) reported that shortage of AITs (18%) and discontinuation of service on weekends and holidays (51%) was one of the problems in AI service. Tehetna et al. (2015) reported that lack of awareness (22%) and lack of AITs (18%) were among the major constraints of AI service in and around Alamata District, Tigray, Ethiopia, Belete et al. (2018) reported animal management problems (19%) and lack of skill in AITs (6%), and all are similar with the current challenges in Western Zone of Tigray, Ethiopia. These all reports indicate the limited number and skill of AIT are national challenges, therefore, the government should primarily solve the limited number and skill of the AITs.

All the major constraints in AI service in smallholder dairy cows of Harar were fed shortage (93%), heat detection problem (82%) and AI service charge (72%) (Engidawork, 2018) are not similar with the constraints in Western Zone of Tigray, Ethiopia. This is because all agro-ecologies and production systems could not have similar challenges; the challenges depend on the existing conditions.

CONCLUSION AND RECOMMENDATION

Education level of the households interviewed was very poor because 31% of the households were illiterate whilst

45% of the households attended lower primary school. There was poor AI service delivery system and poor AI coverage in Western Zone of Tigray, Ethiopia because there was little emphasis on AI service. Lack of community awareness, poor animal management, unskilled Artificial Insemination Technicians (AITs), AI service interruption and inadequacy of AITs were the main challenges in AI service. Therefore, many stakeholders should be involved in AI service to solve the existing challenges of AI service. The participation of female headed households in AI service was extremely poor. There were some opportunities in AI service, however, there was no effort to use the opportunities.

The mean and maximum number of Kebeles covered by a unit of AIT was four and six Kebeles, respectively. AI should not be practiced in scattered communities approach because AI service in scattered communities is not achievable. Therefore, AI should be practiced based on community-based approach to allocate adequate resources and particularly adequate number of skilled manpower should be assigned to each community. AITs should be provided frequent on-job trainings on how to detect heat and on effective insemination procedure, and they should be provided achievement-based incentives to enhance overall motivation and solve interruptions because the main reasons for AI service interruption were lack of incentives and infrastructures. The consequences of AI service interruption were that the farmers were exposed to uncontrolled natural service (47%) and pass the cycle without insemination (28%). Therefore, special commitment should be built in each AIT and institutionalized all day hours AI service system should be set. The community should also be provided adequate training on how to detect heat of cows and on proper husbandry practices. The types of communication channels were very limited (cellphone based), and many types of communication channels (magazine, newspaper, television, radio, and social media) should be used to create awareness in the community for the ease and sustainable use of AI service. There was negative relationship between educational level of household heads and production systems they followed. Educated households in the area did not practice intensive cattle production system. Household occupation system and livestock production system were basic constraints in AI delivery system because 80% of the households were involved in livestock-crop production system and 88% of the households followed extensive animal production system. Extensive cattle production system negatively affected AI delivery system. Therefore, AI delivery system is also successful when household occupation system is only involved in cattle production and when improved cattle management is practiced.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

The authors would like to thank to Agricultural Growth Program Π (AGP- Π) and Humera Agricultural Research Center for their financial and transport supports.

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